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Extraction and Enhancement of Collisions Database

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Extraction and Enhancement of Collisions Database

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0	Issued to HSE, February 1999
1	Incorporating HSE Comments, February 1999
2	Final Report, May 1999

COLLISION DATABASE STUDY

CONTENTS

1. INTRODUCTION

This report has been prepared by MSL Engineering Limited (MSL) for the Health & Safety Executive (HSE) and covers the work undertaken on the HSE Collisions Incident Database (1,2). The original Incident Database developed by AME for the HSE (3) relates to data up to 1991. In 1995, MaTSU undertook a study for HSE to update the Incident Database to July 1995 (1) and subsequently updated this in 1997 (2). The objectives of the study were as follows:

- To undertake baseline statistical appraisal of the most recent Collisions Incident Database (2) for internal use by HSE on other related projects.
- To enable information from the database to be used in the Joint Industry Project (JIP) on Minimum Structures currently being executed by W S Atkins, MSL Engineering (MSL), Ramboll and University of California on behalf of the Offshore Safety Division of the Health & Safety Executive and a number of oil companies and design houses.

MSL's scope of activities within the JIP on Minimum Structures cover reliability studies of four minimum structures subjected to ship collision. The request to undertake an appraisal of the Collisions Incident Database stemmed from a desire to use the most up-to-date information in the JIP on Minimum Structures.

The scope of work is presented in Section 2. Analysis of the database is presented in Section 3 and conclusions are given in Section 4.

2. SCOPE OF WORK

The scope of work was essentially to undertake baseline statistical appraisal of the updated Collisions Incident Database for HSE use and release of same to JIP with HSE approval.

The baseline analysis involved the following:

(i) Authorised vessels servicing the installation.

(ii) By-passing ships and fishing vessels.

For each of the above the following assessments were to be undertaken

(i) Variation of incident frequency with time.

(ii) Weather conditions, vessel speed, wave height.

(iii) Vessel size, location and orientation at time of impact.

(iv) Operating circumstances and cause of incident.

3. ANALYSIS OF DATABASE

This section presents an assessment of the collision database. It is important to note that as a result of the subsequent updated Collisions Incident Database being made available, the statistics relating to incident frequencies with time have been considered in some detail and have been presented by MaTSU in Reference (2). Therefore efforts were concentrated on obtaining information on the parameters which are important in evaluating the energy due to an impacting vessel and assisting in the reliability studies of ship impact for the Minimum Structures JIP.

The vessel impact energy E is defined as follows:

$$E = 0.5.a.m.v^2$$

where a = 1.4 or 1.1 (added mass factor for broadside and bow/stern impact respectively).

m = Displacement tonnage of vessel.

v = Speed of vessel.

The speed of vessel is related to the following:-

$$v = 0.5.H_s \text{ per second}$$

where H_s is the significant wave height.

It can be deduced from the above that the energy during impact is dependent on a number of important parameters.

To assist in the reliability ship collision studies for the Minimum Structures JIP information on the distribution of these parameters caused either by non-human error (i.e. mechanical failure) or human error (i.e. misjudgement) as defined in Reference (2) are also considered.

Assessments for each of the sectors of the North Sea (i.e. Northern, Central and Southern) were undertaken for each of the following parameters:

- Vessel size - authorised vessels only (i.e. Supply, Standby, Diving Support).
- Vessel orientation (i.e. broadside, stern, bow).
- Weather conditions (i.e. sea state).
- Causes of incidents (i.e. Causation Factors - external factors, mechanical control failure, human control failure, watch-keeping failure).

3.1 Distribution of Vessel Size

On examining the contents of the database MSL identified that information relating to the displacement tonnage of the vessels was not available (i.e. only the gross tonnage was given). This information is particularly important in evaluating both the distribution of vessel sizes within each of the sectors of the North Sea and the impact energy (as the impact energy is based on the displaced tonnage of the vessel) to be used within the JIP on Minimum Structures.

MSL identified a number of possible references which could possibly contain details of the displaced tonnage for each of the vessels identified (e.g. References 4-9). Despite a detailed review of these documents, the required information was not available. It was therefore decided after consultation with HSE that an approximation would be made by reference to BS 6349 (9) which contains some guidance on factors which can be applied to the gross tonnage for various vessel types. The Database was therefore updated to reflect this for subsequent analyses.

Assessments of the database were undertaken for each of the sectors of the North Sea as follows:

(i) All incidents involving attendant vessels (gross and displaced tonnage) as shown in Figures 1 and 2 respectively.

(ii) All incidents involving supply vessels only (gross and displaced tonnage) as shown in Figures 3 and 4 respectively.

(iii) Comparison of the displaced tonnage for supply vessels used in this study with that from AME (3) is shown in Figure 5.

(iv) Incidents with and without human control error involving supply vessels and displaced tonnage only, is shown in Figures 6 and 7 respectively.

The data presented in Figures 1-5 for items i-iii above have been evaluated and are presented in Table 1. The following observations can be deduced from Table 1:

- The largest impacting vessel sizes occur in the Northern and Central sectors of the North Sea.
- The largest vessels involved vessels which were not generally supply vessels.
- The 95% percentile based on results from this study for the Northern North Sea is in the range 5001-6000 tonnes for all authorised vessels and supply vessels only.
- The 95% percentile based on results from this study for the Central North Sea is in the range (5001-6000) tonnes for all authorised vessels and (4001-5000) tonnes for supply vessels only.

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- The 95% percentile based on results from this study for the Southern North Sea is in the range (3001-4000) tonnes for all authorised vessels and supply vessels only.

- The maximum displaced tonnage and 95% vessel size for supply vessels from the AME study are higher for the Northern and Central North Sea when compared to the results from this study.

- The maximum displaced tonnage for supply vessels from the AME study (i.e. 4001-5000) are lower for the Southern North Sea when compared with the results from this study (i.e. 5001-6000).

- The 95% percentile vessel size for supply vessels from the AME study for the Southern North Sea are similar when compared with the results from this study (i.e. 3001-4000).

- A significant number of incidents involved vessels which were unknown (i.e. 51 equivalent to nearly 25% of the total number of incidents (207) as shown in Figure 1).

- The AME Database contained 95 Incidents for supply vessels only compared to 105 from this study.

- The AME Database contained a total of 138 incidents for all authorised vessels compared to 207 from this study.

Information presented in Figures 6-7 for item iv. above are presented in Table 2. The following observations can be deduced from Table 2:

- The maximum displaced tonnage and 95% Percentile of vessel size for incidents involving non-human error are similar to that observed for supply vessels given in Table 1 for the Northern and Central Northern Sea.

- The maximum displaced tonnage and 95% Percentile for incidents involving human error are similar to that observed for supply vessels given in Table 1 for the Southern North Sea.

3.2 Impact Orientation

Assessments were undertaken for each of the sectors of the North Sea as follows:

(i) All incidents involving attendant vessels as shown in Figure 8.

(ii) All incidents involving supply vessels only as shown in Figure 9.

(iii) As (ii), for incidents with and without human control error, as shown in Figures 10 and 11 respectively.

From Figures 8-11 the following can be observed:

- Information concerning the direction of impact for over 100 of the total of 207 incidents was not specified as shown in Figure 8.
- All sectors of the North Sea involved impacts mainly from stern, bow or side as shown in Figures 8 and 9.
- It would appear from Figures 8-11 that no one direction of impact is more prevalent than another for each of the sectors of the North Sea. However, there is some evidence to suggest that the Central Sector of the North Sea experienced significantly more impacts from the Stern direction as shown in Figure 9.
- The number of incidents involving human error only are significantly higher for the stern direction and occur more frequently in the Central sector of the North Sea as shown in Figure 11.
- The number of incidents involving human error only are lower than those involving no human error when one compares Figure 10 and 11 respectively.

3.3 Weather - Sea State Condition

Assessments were undertaken for each of the sectors of the North Sea as follows:

(i) All incidents involving attendant vessels as shown in Figure 12.

(ii) All incidents involving supply vessels only. as shown in Figure 13.

(iii) Incidents involving supply vessels with out human error as shown in Figure 14.

(iv) Incidents involving supply vessels with human error as shown in Figure 15.

From Figures 12-15 the following can be observed:

- Information concerning the sea state condition at impact for over 130 of the total of 207 incidents was not specified as shown in Figure 12.
- The range of sea states recorded varied between 0-6m although most incidents tended to occur in sea states less than 4.1 metres, as shown in Figures 12 and 13 respectively. Note that 4m corresponds to a velocity of impact of 2m/s (i.e. $v=0.5.H_s$).
- Given the limited number of incidents, trends comparing the sea state condition and causation factor (i.e. human or non-human error) during impact for the different sectors of the North Sea could not be obtained.

3.4 **Primary Cause**

Assessments were undertaken for each of the sectors of the North Sea as follows:

(i) All incidents involving attendant vessels as shown in Figure 16.

(ii) All incidents involving Supply vessels only. as shown in Figure 17.

From Figures 16-17 the following can be observed:

- Information on the primary cause of incident was recorded for 127 of the 207 incidents.
- 37% of the total number of incidents involved human error as the primary cause.
- There was no trend that could be observed for the number of recorded incidents between the primary cause and location in the North sea.

4. CONCLUSIONS

An assessment of the current HSE Collision Database has been undertaken to evaluate the importance of key parameters which have a direct bearing on the ship impact energy during collision (i.e. vessel size, impact orientation, weather condition and primary cause). These results are seen as being of direct relevance in the ship impact reliability studies being undertaken by MSL in the JIP on Minimum Structures.

Distributions on the vessel sizes were obtained and compared with the original AME database. Due to the approximation used to calculate the displaced tonnage in this study and the different sizes of the databases, differences in results between this study and the AME database are to be expected.

The results from this study indicate that the largest vessel sizes are situated in the Northern and Central parts of North Sea. The 95% percentile vessel sizes from this study are as follows:

- Northern North Sea 5001-6000 Tonnes
- Central Northern Sea 5001-6000 Tonnes
- Southern North Sea 3001-4000 Tonnes

The maximum size of impacting vessel and the 95% percentile were evaluated for incidents involving either human or non human error as the prime cause. For the Northern and Central Sectors of the North Sea the maximum size of vessel and 95% percentile were higher involving non-human error. For the Southern Sector the maximum size of impacting vessel involving human error was higher.

Limited data were available to consider the importance of impact direction and sea state conditions. Information for nearly 50% and 65% of the incidents was not available for impact direction and sea state conditions respectively. It is therefore difficult to come to any firm conclusion as to whether there is any correlation between location, vessel size and impact direction and sea state conditions.

For those incidents for which information was available impacts from either stern, bow or side was observed. From the limited sea state condition it was noted that most incidents occurred in sea states less than 4.0m.

In analyses it is therefore considered appropriate to undertake studies for both broadside and stern directions, in sea state conditions of 4.0m.

Information on the primary cause of incident was available for approximately 60% of the total incidents. From this data it was noted that 36% of incidents involved human error as the prime cause.

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Sector North Sea	Vessel Type	Maximum Gross Tonnage	Maximum Displaced Tonnage	Distribution Displaced Tonnage*	Maximum Displaced Tonnage (AME)	Distribution Displaced Tonnage** (AME)
Northern	All Authorised	8001-8500	16001-17000	5001-6000	-	-
	Supply Only	3001-3500	6001-7000	5001-6000	9001-15000	6001-7000
Central	All Authorised	4501-5000	90001-10000	5001-6000	-	-
	Supply Only	2501-3500	5001-6000	4001-5000	6001-7000	5001-6000
Southern	All Authorised	2501-3000	5001-6000	3001-4000	-	-
	Supply Only	2501-3000	5001-6000	3001-4000	4001-5000	3001-4000

* 95% percentile (ignoring vessels >10,000 tonnes) from this study.

** 95% percentile (ignoring vessels > 10,000 tonnes) from AME Database.

Table 1: Comparison of maximum vessel size and vessel size distributions for different sectors of the North Sea

Sector North Sea	Vessel Type	Maximum Displaced Tonnage Non-Human Error	Maximum Displaced Tonnage Human Error	Distribution Displaced Tonnage Non-Human Error*	Distribution Displaced Tonnage Human Error*
Northern	Supply	6001-7000	5001-6000	5001-6000	4001-5000
Central	Supply	5001-6000	4001-5000	4001-5000	3001-4000
Southern	Supply	3001-4000	5001-6000	3001-4000	3001-4000

* 95% percentile (ignoring vessels >10,000 tonnes)

Table 2: Comparison of vessels sizes and vessel size distributions with and without human error

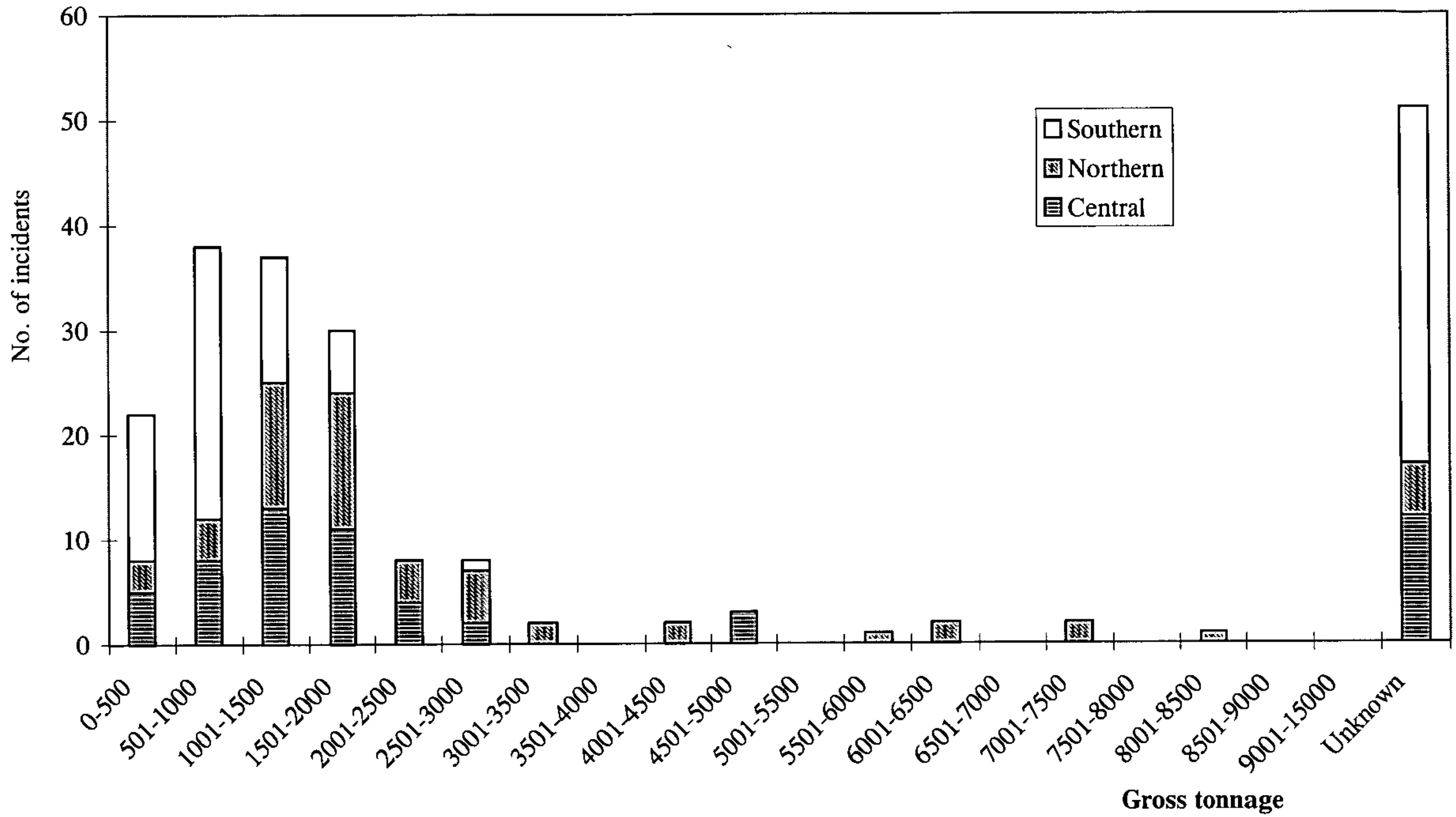

Figure 1: Number of Incidents to Fixed Steel Platforms by Location in the North Sea

Contents

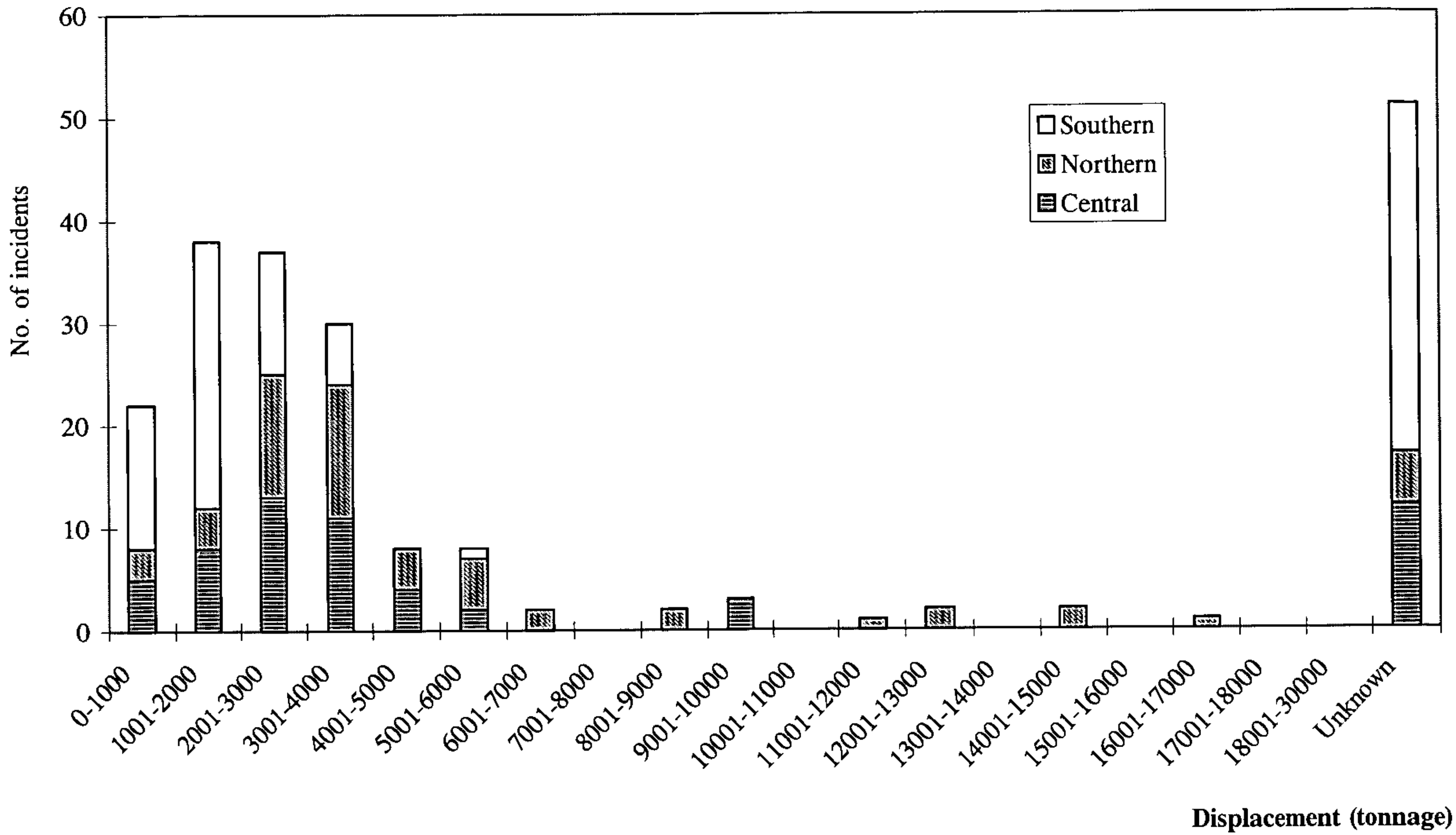

Figure 2: Number of Incidents to Fixed Steel Platforms by Location in the North Sea

Contents

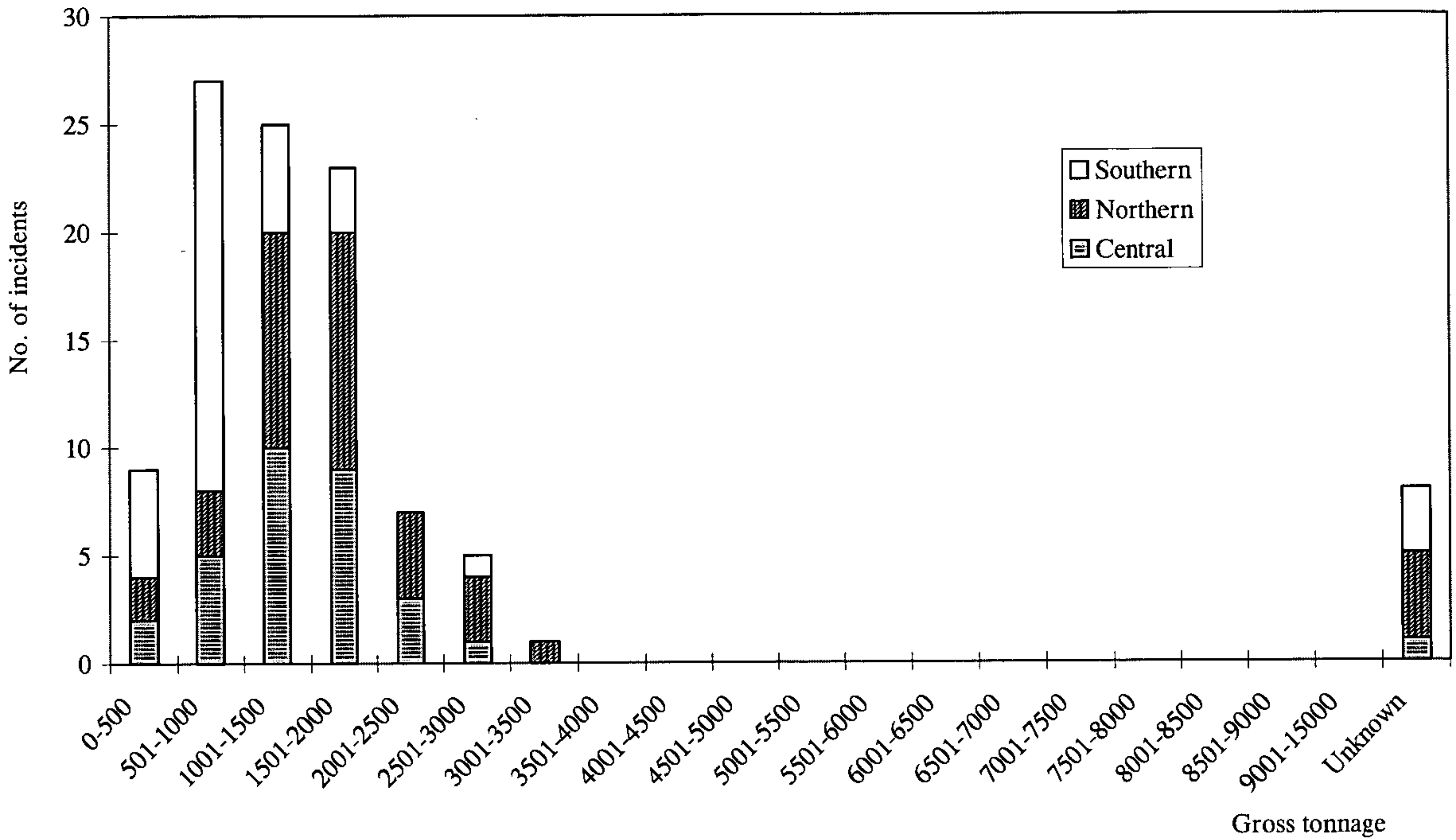

Figure 3: Number of Incidents to Fixed Steel Platforms by Location in the North Sea (Supply vessel type)

Contents

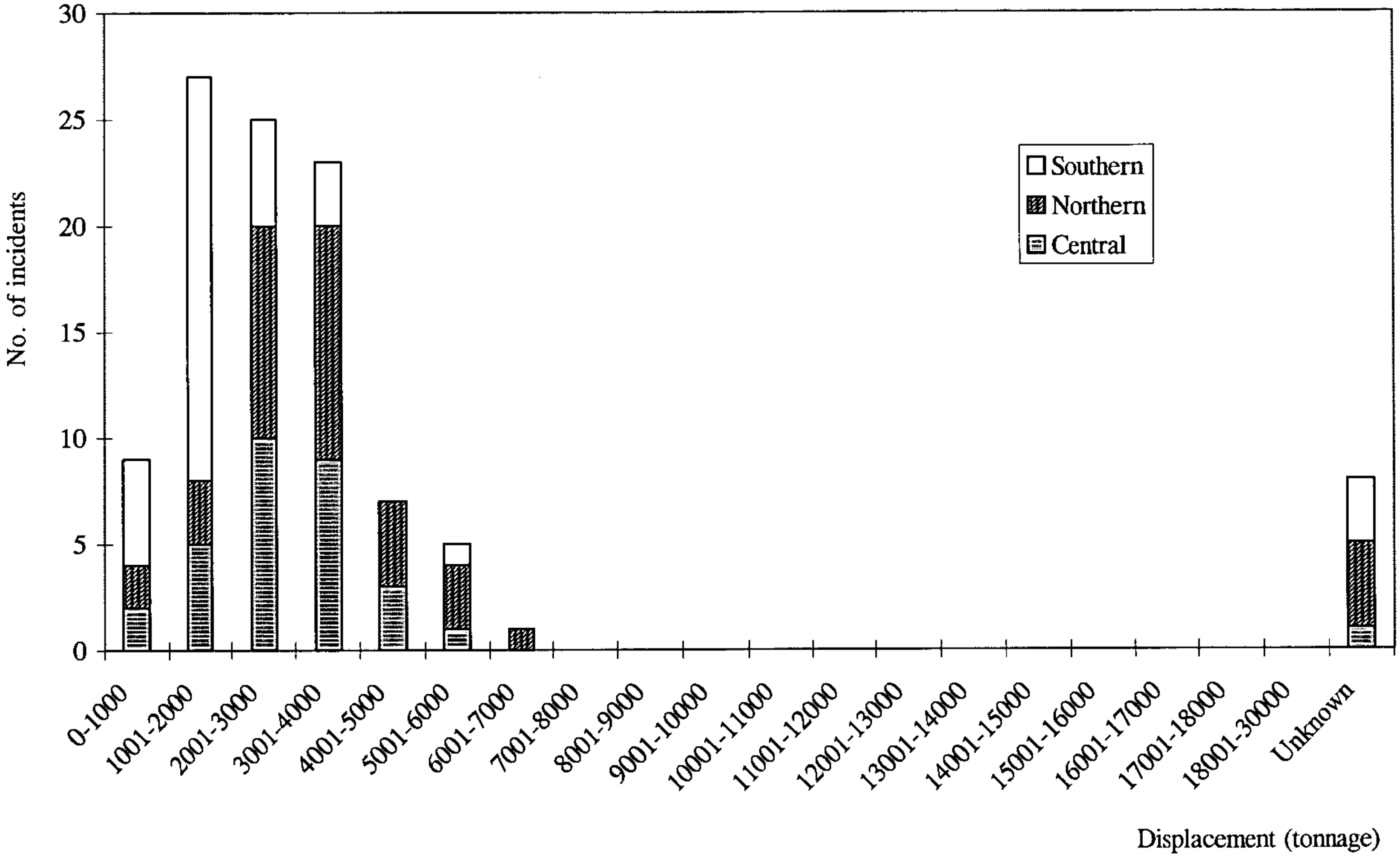

Figure 4: Number of Incidents to Fixed Steel Platforms by Location in the North Sea (Supply vessel type)

Contents

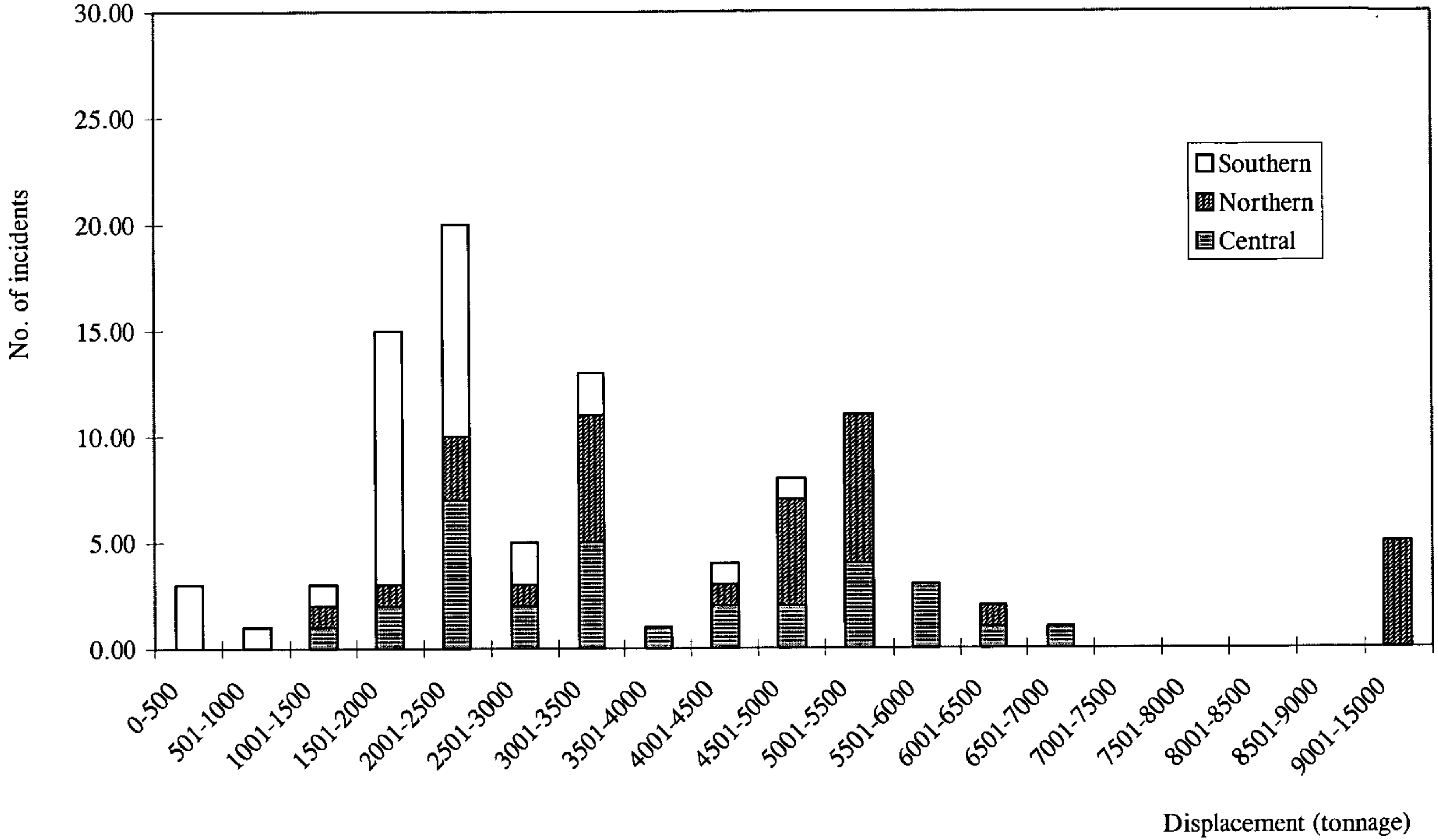

Figure 5: Number of Incidents to Fixed Steel Platforms by Location in the North Sea (Supply Vessel Type – AME Database)

Contents

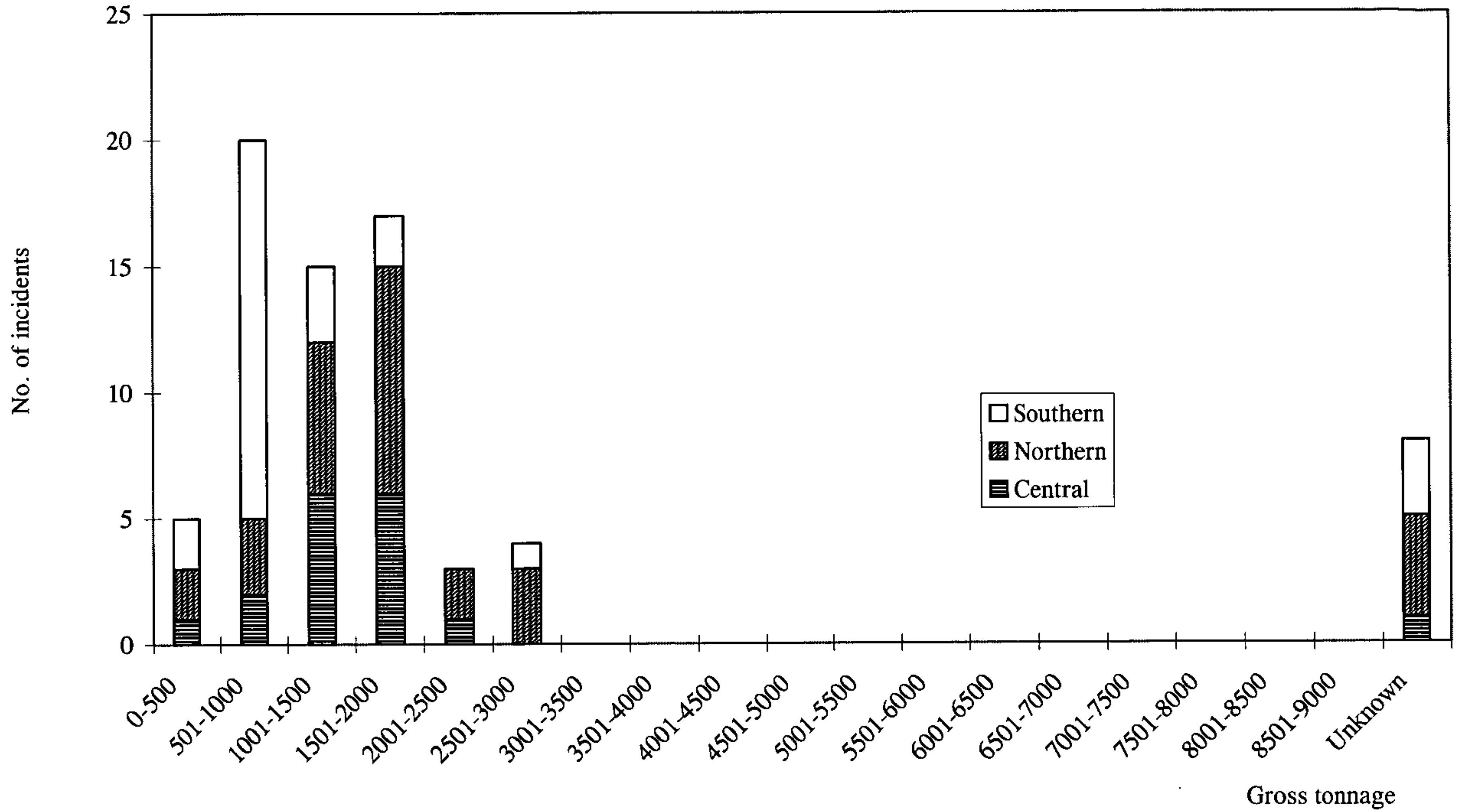

Figure 6: Number of Incidents to Fixed Steel Platforms for Supply Vessels (Human Error Only)

Contents

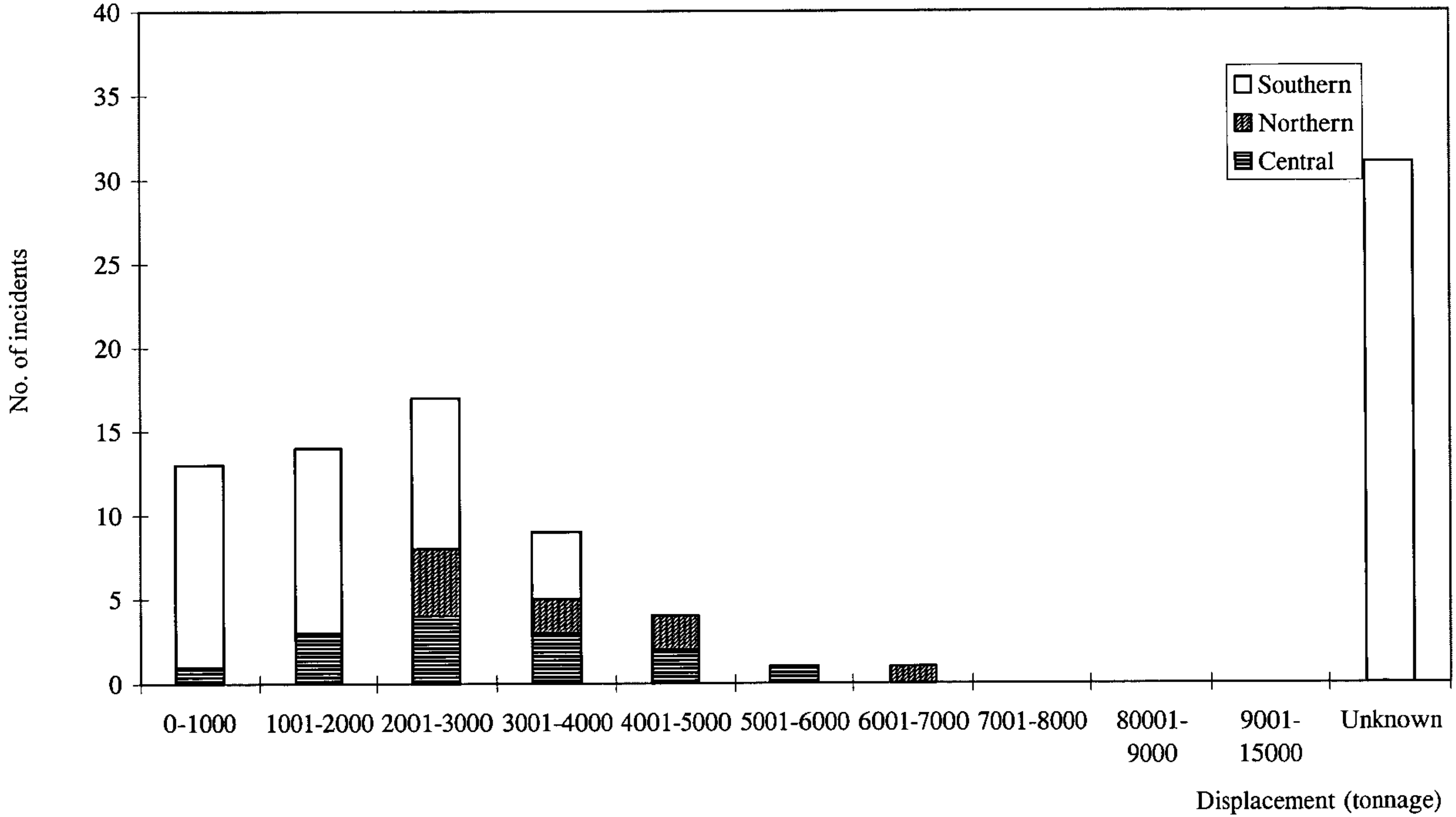

Figure 7: Number of Incidents to Fixed Steel Platforms for Supply Vessels (Non-Human Error)

Contents

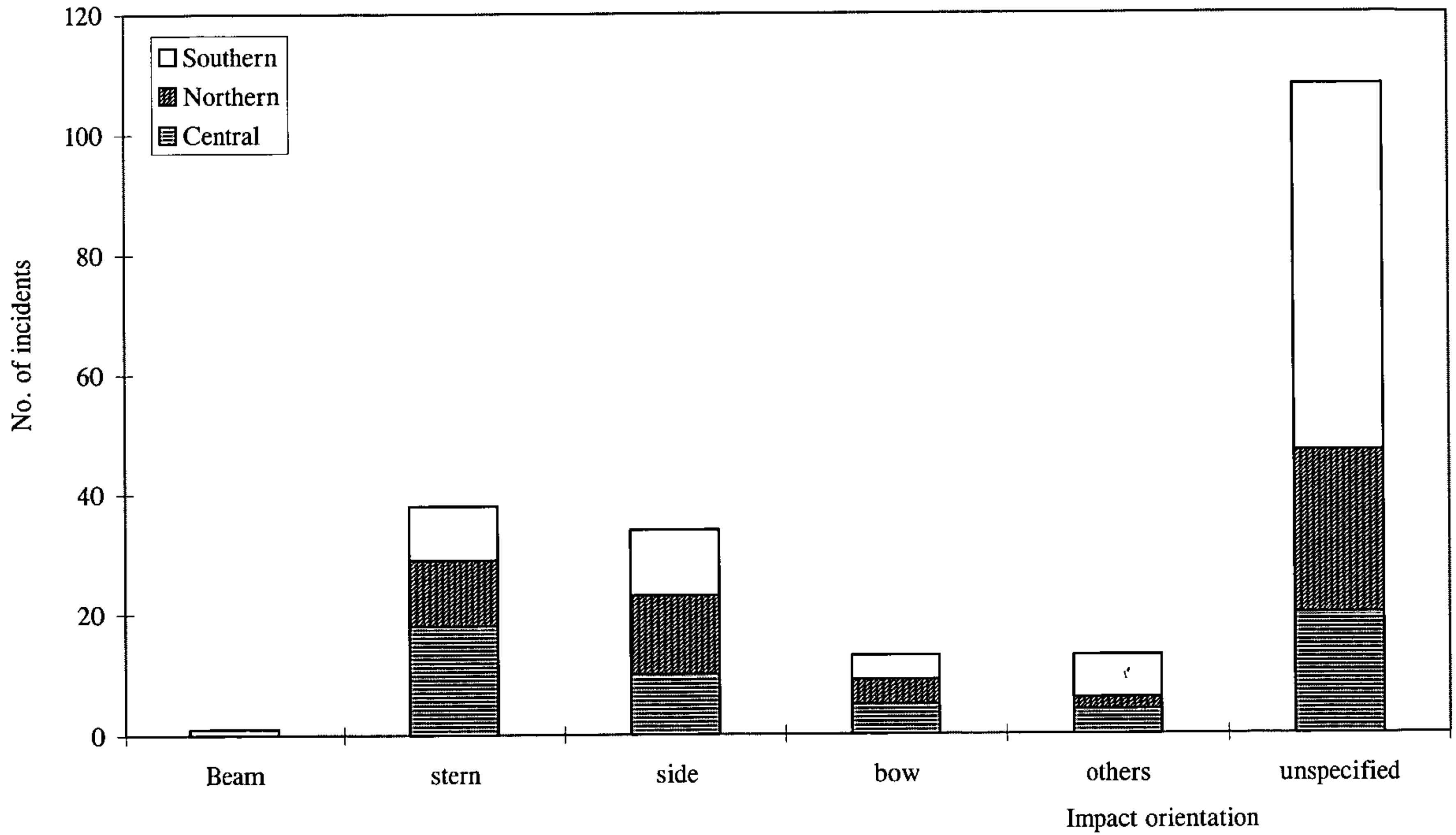

Figure 8: Distribution of Impact Orientation for all Vessels

Contents

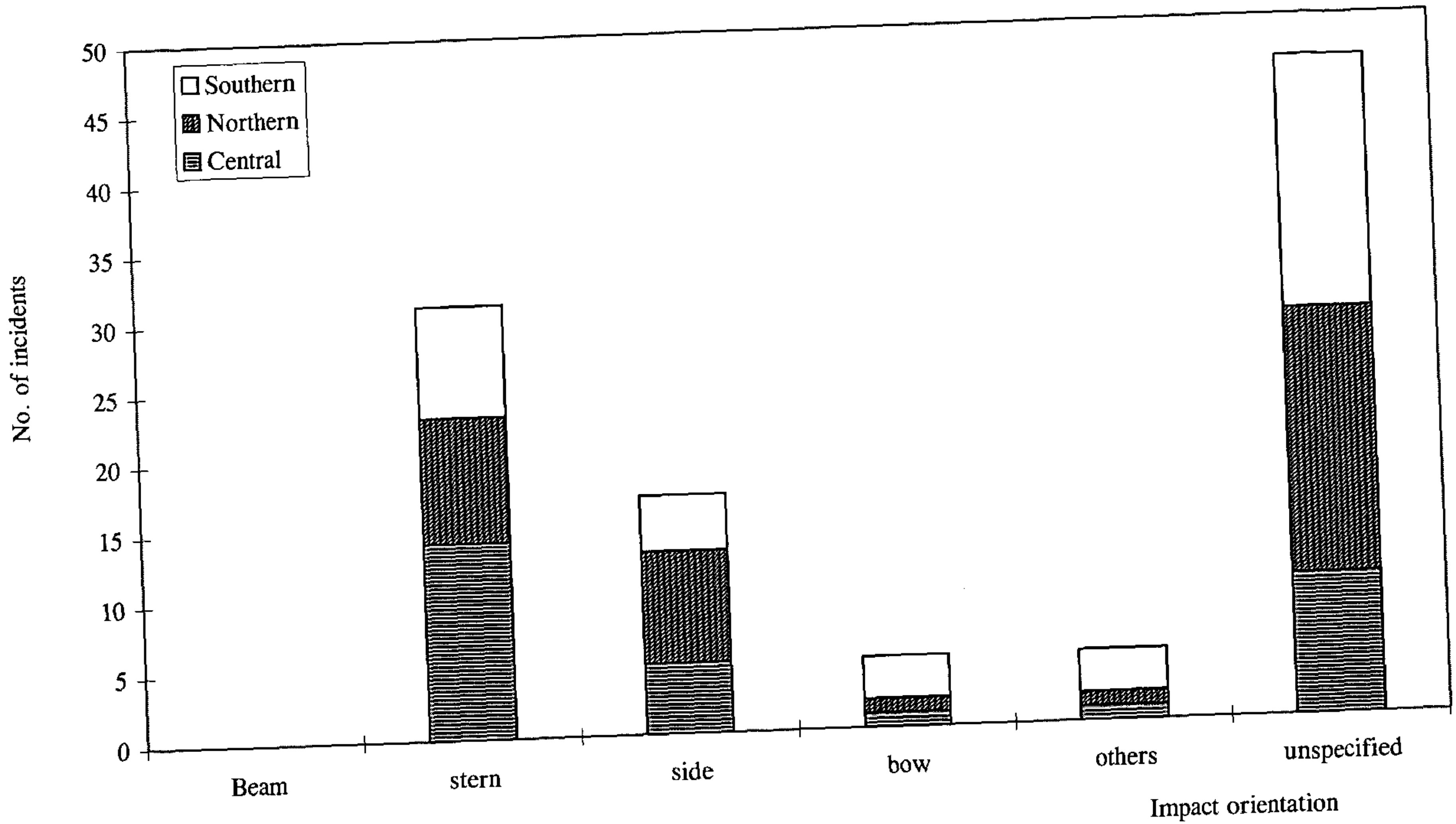

Figure 9: Distribution of Impact Orientation for Supply Vessels

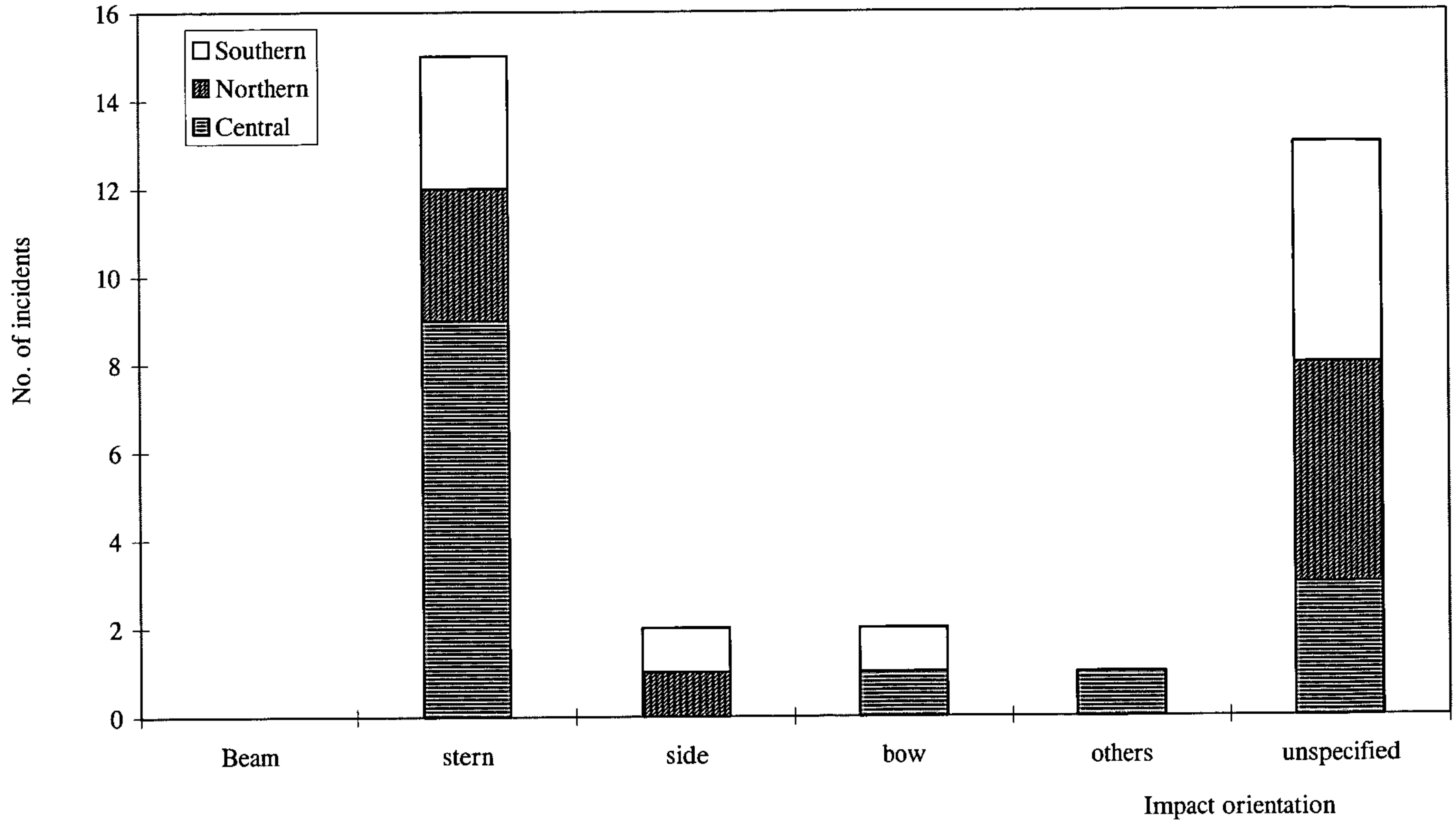

Figure 10: Distribution of Impact Orientation for Supply Vessels (Human Error Only)

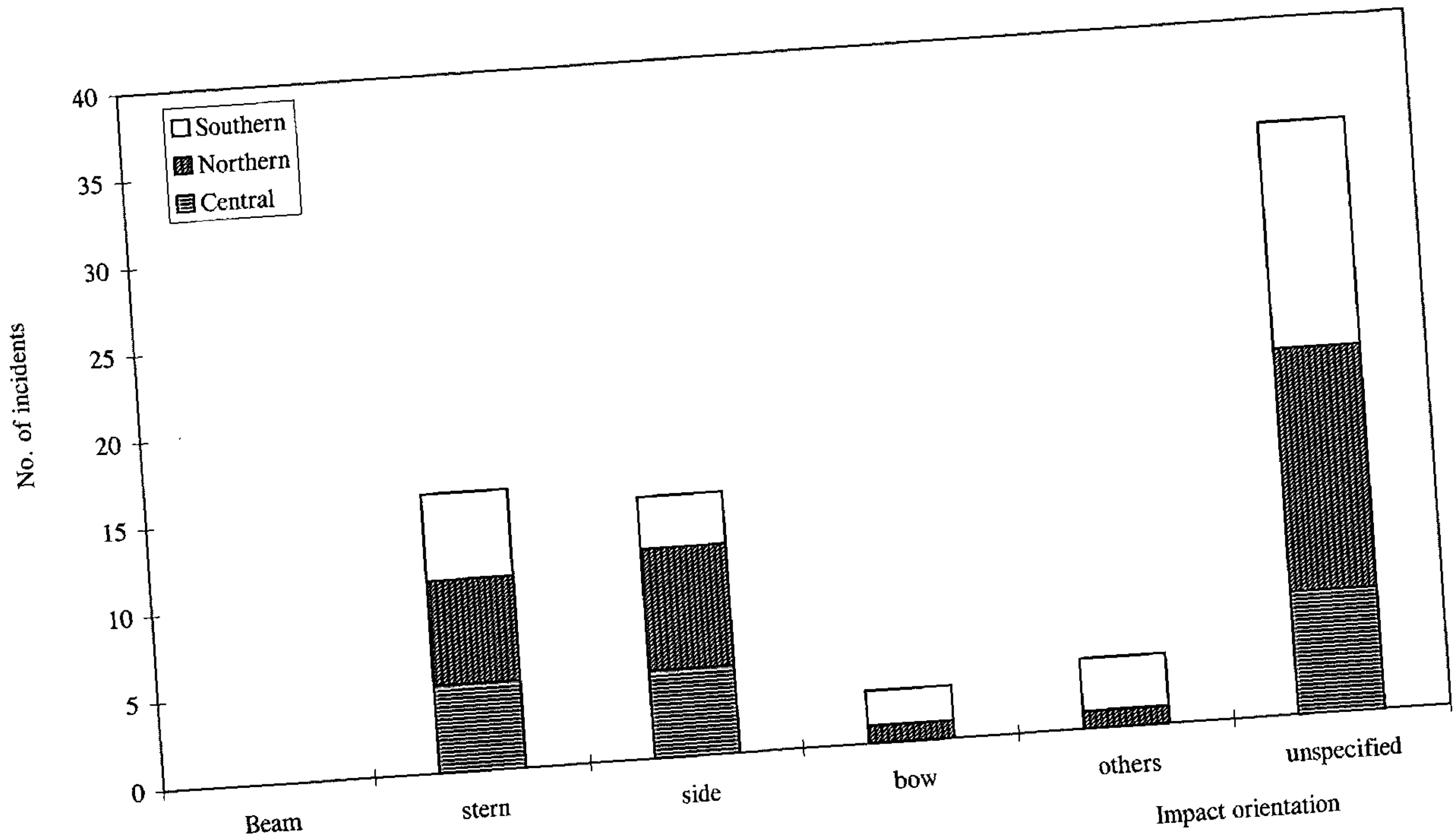

Figure 11: Distribution of Impact Orientation for Supply Vessels (No Human Error)

Contents

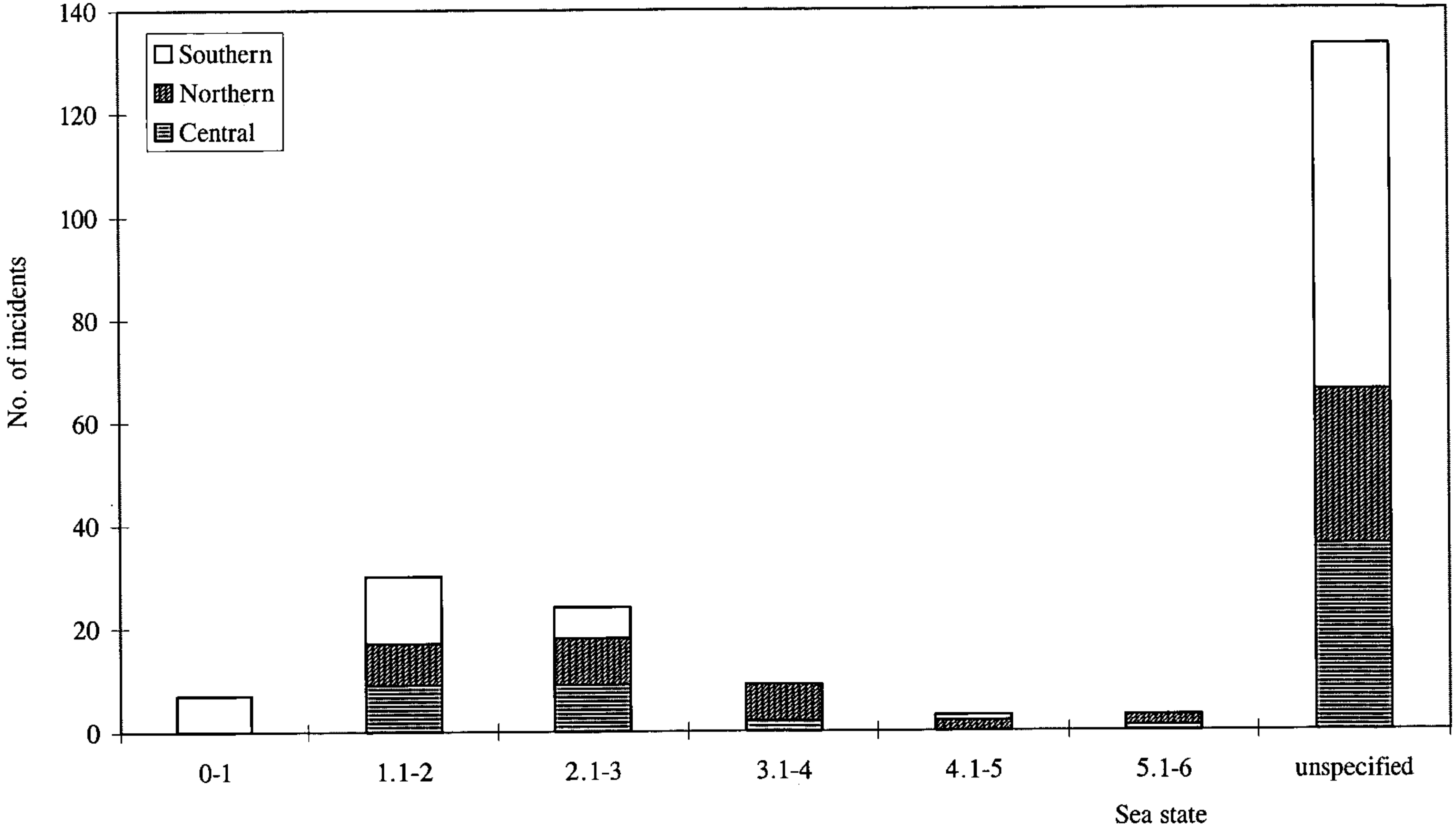

Figure 12: Distribution of Sea State for all Vessels

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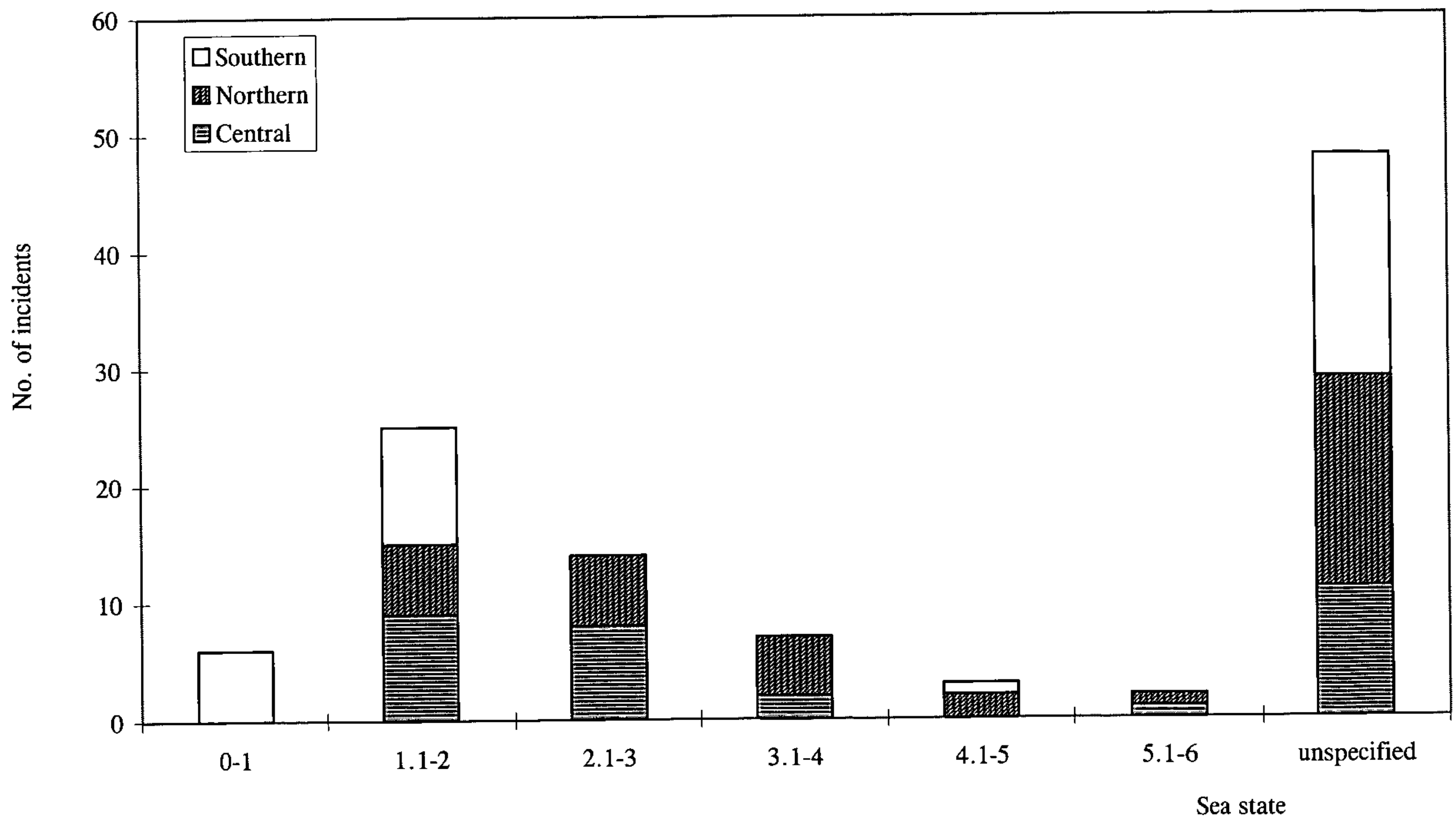

Figure 13: Distribution of Sea State for Supply Vessels

Contents

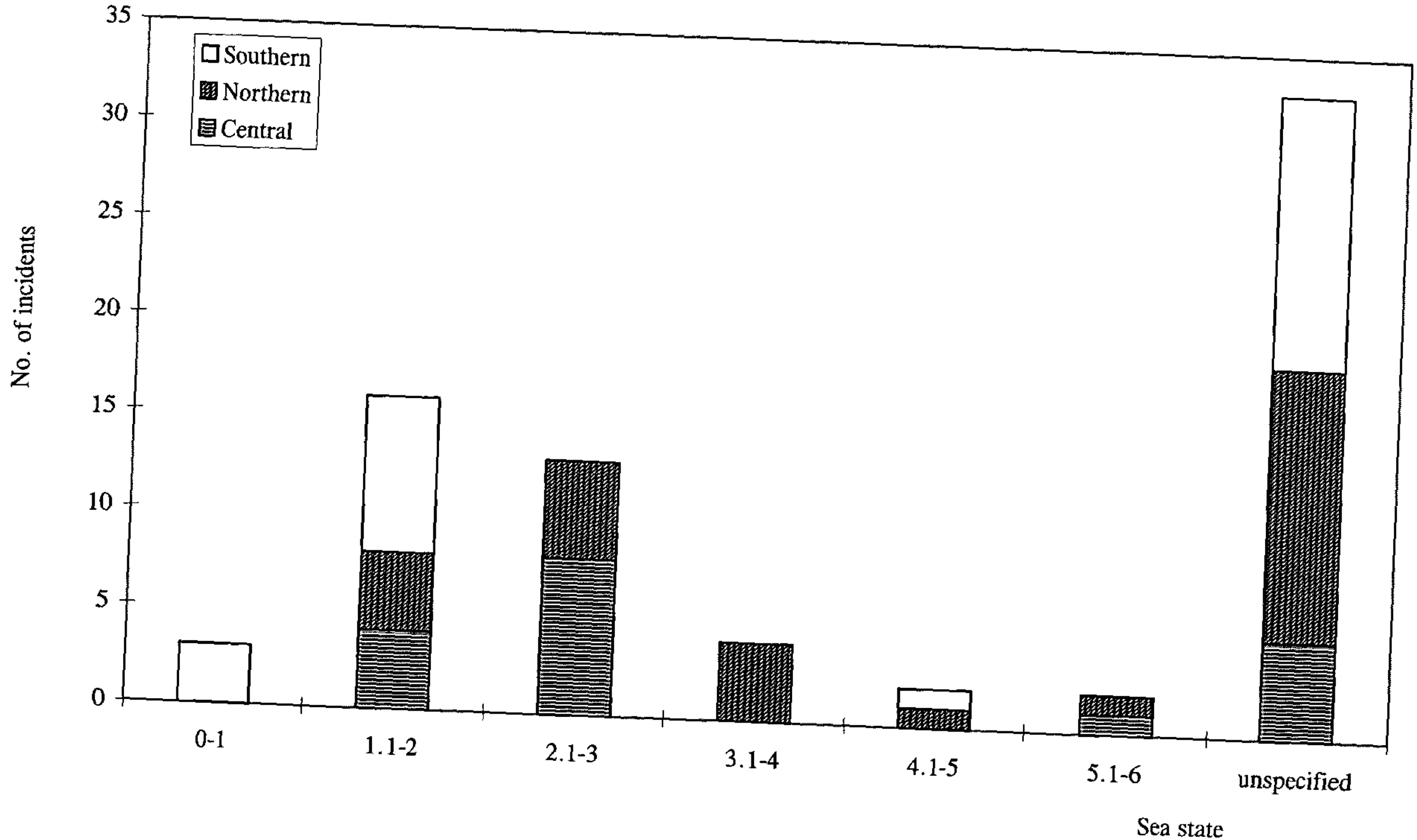

Figure 14: Distribution of Sea State for Supply Vessels (No Human Error)

Contents

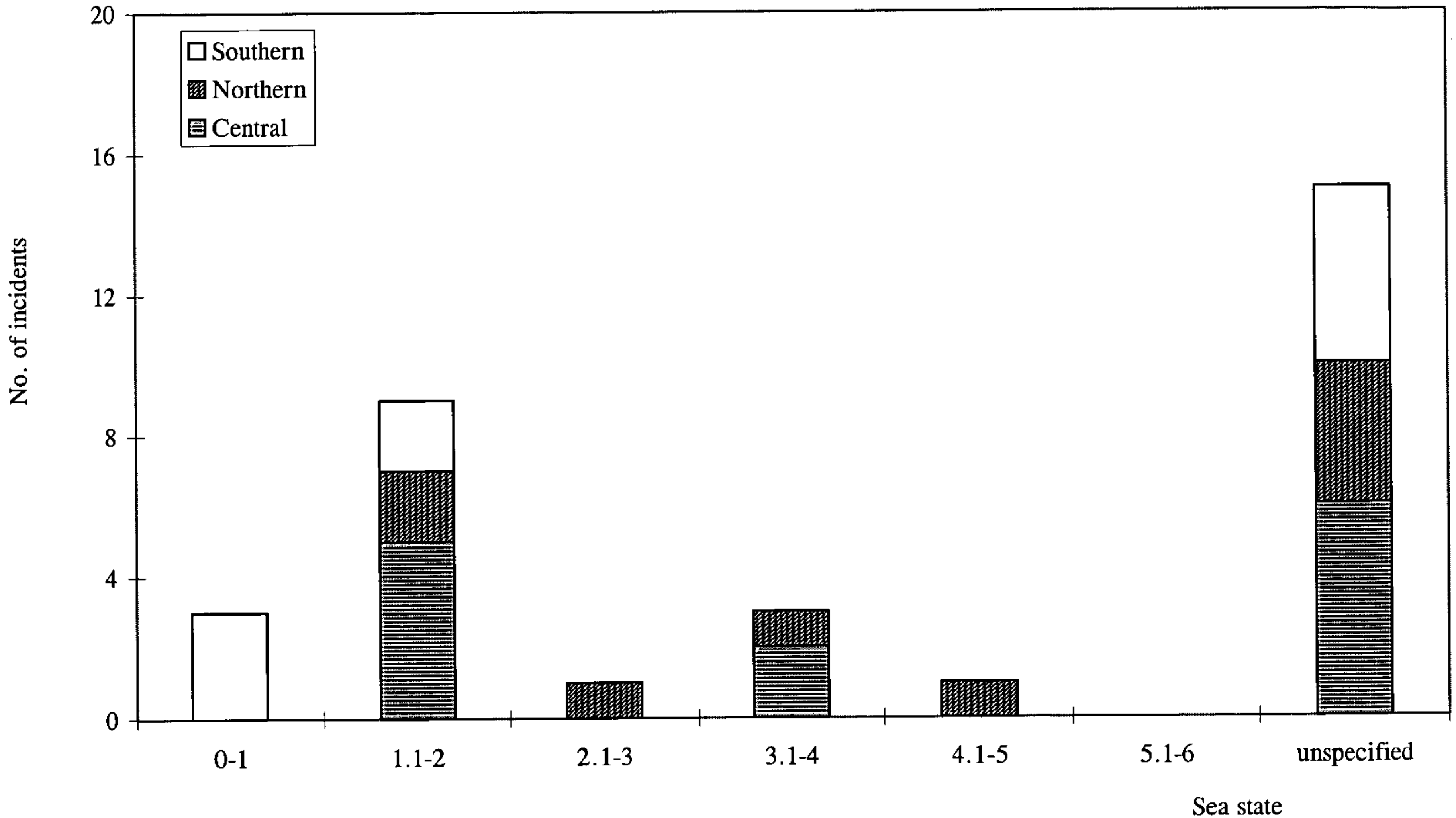

Figure 15: Distribution of Sea State for Supply Vessels (Human Error Only)

Contents

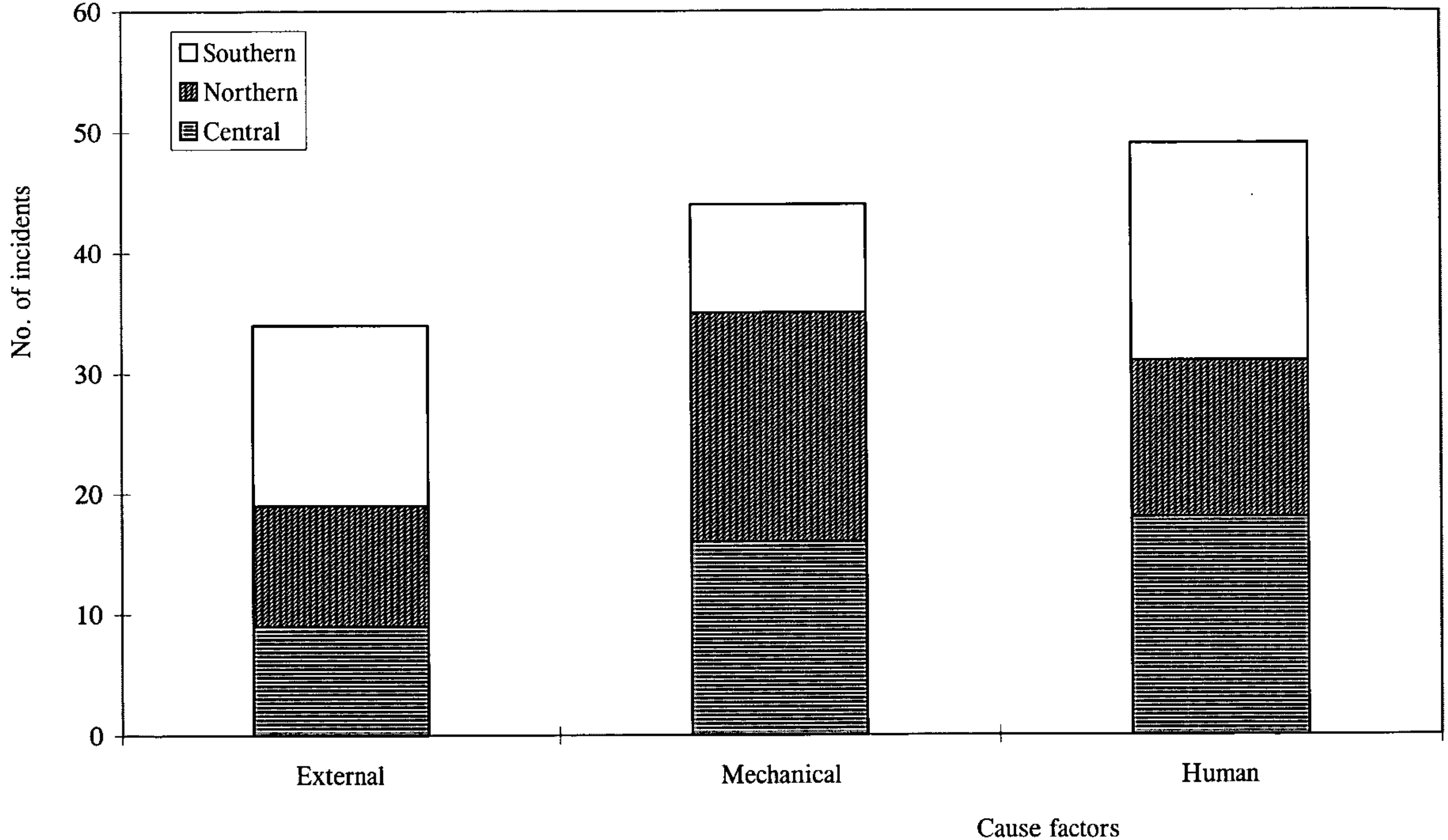

Figure 16: Distribution of Primary Cause Factors (All Vessels)

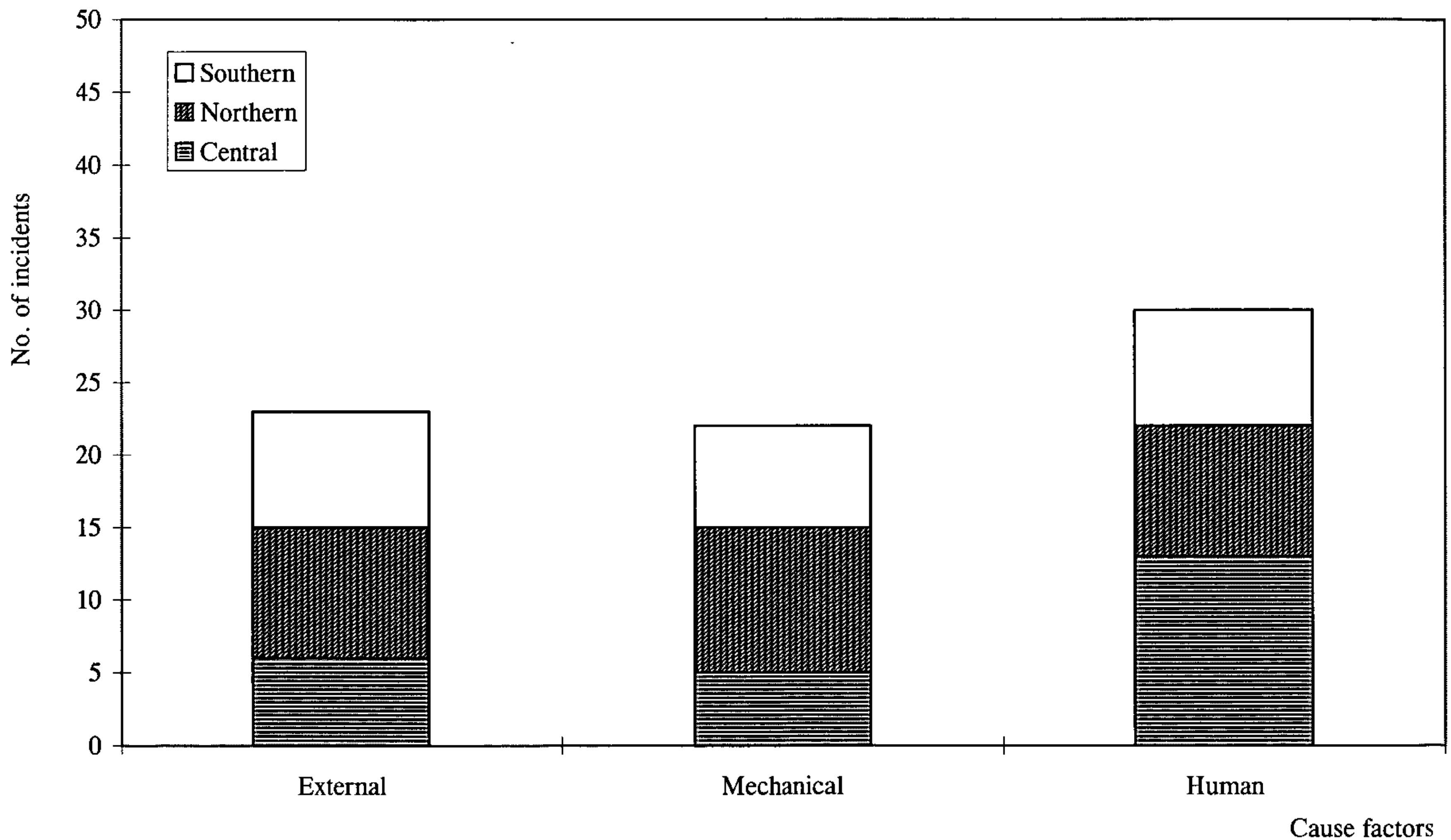

Figure 17: Distribution of Primary Cause Factors (Supply Vessels)

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