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VESSEL TRAFFIC SERVICES HOUSTON/GALVESTON VTS CASUALTY ANALYSIS--ETC(U)

AUG 81 T A THOMPSON, J J OCKEN, J R YACOBI

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VESSEL TRAFFIC SERVICES
HOUSTON/GALVESTON VTS
CASUALTY ANALYSIS

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FINAL REPORT

AUGUST 1981

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16. Abstract This study was undertaken as a follow-on to the Vessel Traffic Systems Analysis of Port Needs study (August 1973). The criteria established in the Vessel Traffic Systems Analysis of Port Needs was used for this study so that a direct correlation might be drawn between the two studies. Vessel casualty data from the period FY1973-78 was used to form the basis of this analysis. 1019 casualty cases were examined to determine which accidents could have been prevented by VTS and what level of VTS would have been required. The study looked at the effectiveness of the VTS, possible areas for increased VTS involvement and trends in the commerce and transit patterns for the Houston/Galveston area.			
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GLOSSARY OF ACRONYMS page 1

EXECUTIVE SUMMARY page 1

REPORT page 12

I. Introduction page 12

II. Sources of Data page 14

III. The Casualty Analysis page 17

A. Data Base page 18

B. Accident Prevention Determinations..... page 21

IV. Findings and Determinations page 28

A. Casualty Analysis Results page 30

B. COE and/or VTS Results page 44

C. Measures of Relative Safety page 51

D. Relationships & predicting numbers of casualties..... page 64

E. Benefits of the VTS page 79

F. Sensitivity analysis page 87

V. Conclusions page 93

APPENDICES

I. Post-VTS preventable casualties

II. 3 Apr. 1972, Commandant Instruction 5943.7

Accession For	
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GLOSSARY OF ACRONYMS

CCTV.....Closed circuit television

COE.....Corps of Engineers

CY.....Calendar Year

FY.....Fiscal Year

GICW.....Gulf Intracoastal Waterway (also ICW)

HSC.....Houston Ship Channel

ICW.....Intracoastal Waterway (also GICW)

L₀.....A level of traffic management

L_R.....Traffic management by regulation(s)

L_B.....Traffic management by Bridge to Bridge Radiotelephone

L₁.....Traffic management by traffic separation scheme

L₂.....Traffic management by a vessel traffic service using a
vessel movement reporting system

L₃.....Traffic management by a vessel traffic service using
basic surveillance equipment

L₄.....Traffic management by a vessel traffic service using
advanced surveillance

L₅.....Traffic management by a vessel traffic service computer
aided advanced surveillance systems

MVCR.....Merchant Vessel Casualty Report

TSS.....Traffic Separation Scheme (see also L₁)

VMRS.....Vessel Movement Reporting System (see also L₂)

UTC.....Vessel Traffic Center

VTSS.....Vessel Traffic Service (called Vessel Traffic System prior
to 1976)

EXECUTIVE SUMMARY

Two previous studies were undertaken by the Coast Guard to appraise the Vessel Traffic Service Program and determine ports requiring Vessel Traffic Services (VTS). The first of these studies, the Vessel Traffic Systems Issue Study (March 73), defined what a Vessel Traffic Service would be used for. The original study also provided guidance for the planning, development, and operation of Vessel Traffic Services in U.S. ports and waterways. As a follow-on to the Vessel Traffic Systems Issue Study, the Vessel Traffic Systems Analysis of Port Needs (August 73) was completed to establish a relative ranking of ports and waterways and their need for a Vessel Traffic Service. Based partially on the results of these two studies the Coast Guard established the Houston/Galveston VTS on 4 February 1975.

In order to assess the effectiveness of the VTS, and determine if there are areas for increased VTS involvement, a casualty analysis update for the six year period FY-73 to FY-78 was initiated. The criteria established in the Vessel Traffic Systems Analysis of Port Needs was used in the casualty analysis update so that a direct correlation might be drawn between the two studies.

In assessing the effectiveness of the VTS, 1,019 casualty cases were reviewed; of these, 400 cases were in the VTS area of concern. The circumstances of each casualty were reviewed in a case-by-case analysis to make a determination of which accidents could have been prevented by VTS, and the level of VTS involvement required to prevent the casualty. Casualties were separated into three types; collisions, rammings, and groundings, with each type divided into preventable or non-preventable (by VTS) categories. Dollar damages, deaths, and injuries were determined for all preventable casualties and an estimated savings determined for a 10 year period. Estimated savings did not include benefits from facilitation of commerce, reduced probability of a major marine disaster, lost revenue while a vessel was undergoing repairs, loses to other transportation modes (bridge damage), or environmental damage and pollution cleanup costs.

Data was compiled for FY-73 through FY-78, and combined with FY-69 through FY-72 data from the Vessel Traffic Systems Analysis of Port Needs to form a ten year data base. Information from the analysis was then compared with data from the Corp of Engineers Waterborne Commerce of the U.S. and data from the Houston/Galveston VTS Casualty and Transit Statistics to form the conclusions of this study.

The conclusions of the analysis were as follows:

- 80% of all movements in the VTS area are towboat movements, and 20% are deep draft movements.

- Data obtained from the COE is understated when compared to statistics obtained from actual transits as recorded by Houston/Galveston VTS.

- With 100% more commerce in the Houston Ship Channel and only a 15% increase in transits over the nine year period CY69-77, the trend is towards larger or more heavily laden vessels and tows in the Houston/Galveston VTS area.

- Total casualties are rising (the rate of increase might also be rising) in the Houston/Galveston VTS area (fig.i).

- Since 1970 overall safety based on total casualties or casualties not preventable by VTS, versus tons of commerce or transits has decreased (figs. ii, iii, iv & v).

- The number of preventable casualties per 10,000 transits and per 10 million tons of commerce has decreased since Houston/Galveston VTS went on-line (1975) (figs.vi,vii).

- Range L Front Light at Baytown should be re-located to a less hazardous location.

- Bolivar Roads area below Buoy 31 had 39% of all casualties since 1969. This is the major problem area in the Houston/Galveston VTS area.

- Mandatory Participation and Traffic Management Authority is required for Houston/Galveston VTS to realize the full potential of the system.

- With a predicted savings of \$36.0M in preventable casualties and a operating cost of \$16.5M for a 10 year period, the benefits to cost ratio for Houston/Galveston VTS is 2.2 to 1.

CY 69-77 CASUALTY REPORTS

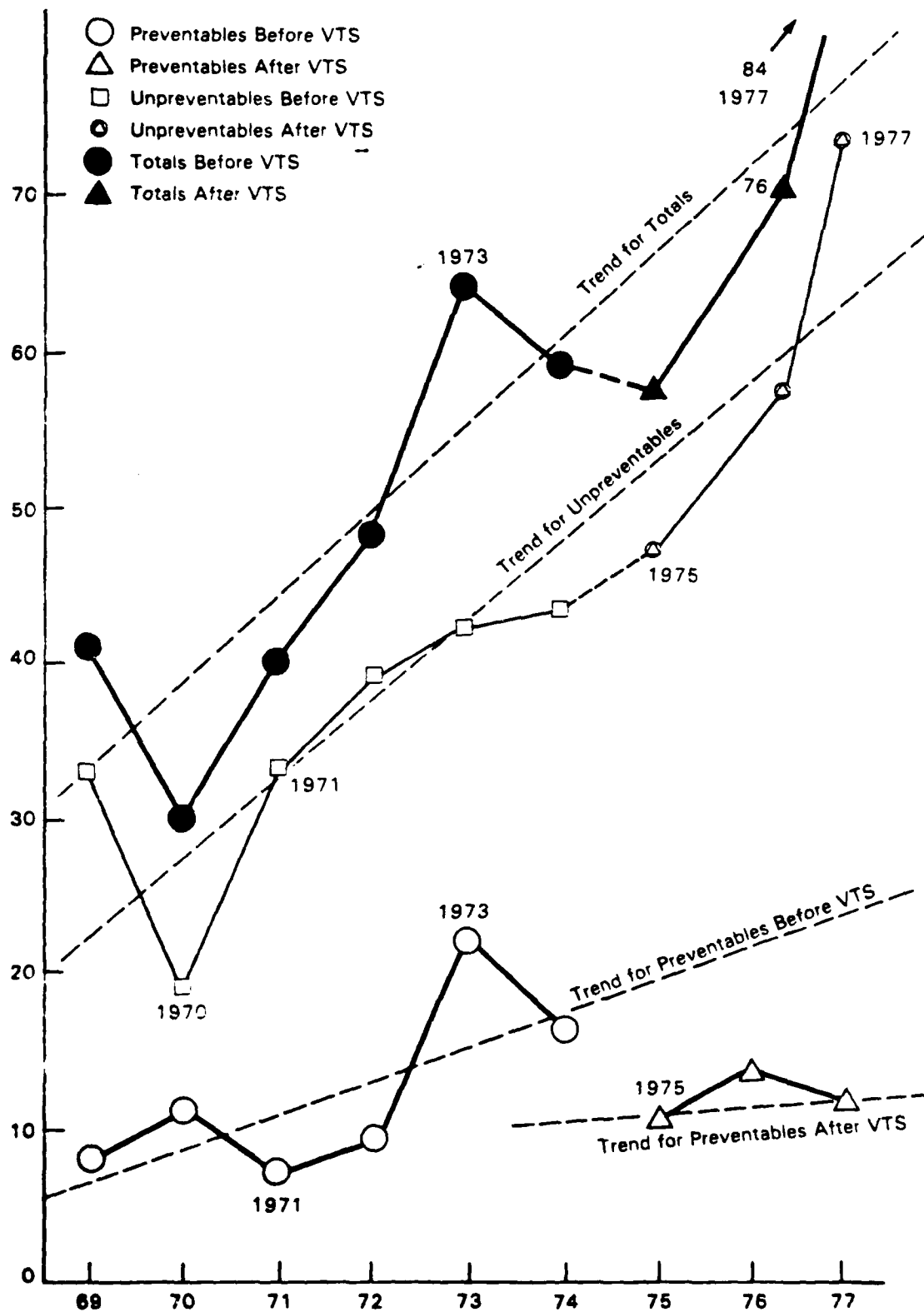


fig. 1

Total Casualties Per 10 Thousand Transits

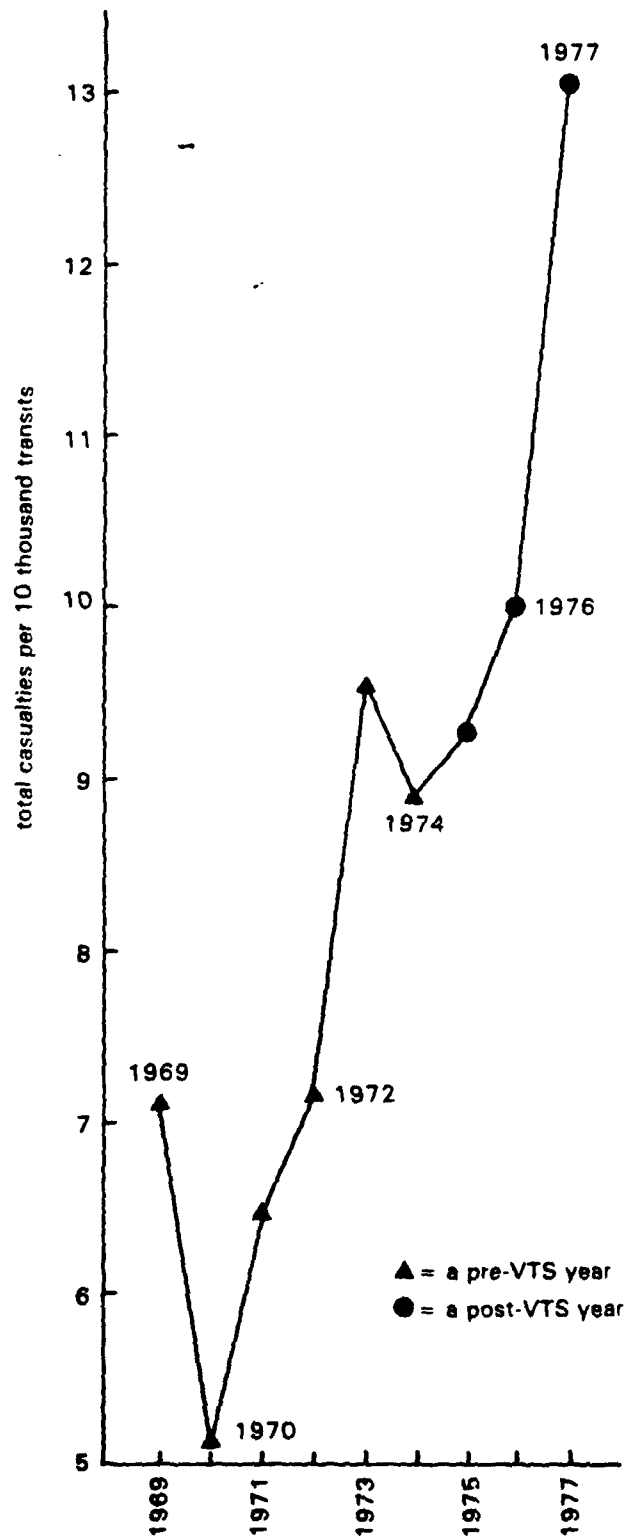


fig. 11

Unpreventable Casualties Per 10 Thousand Transits

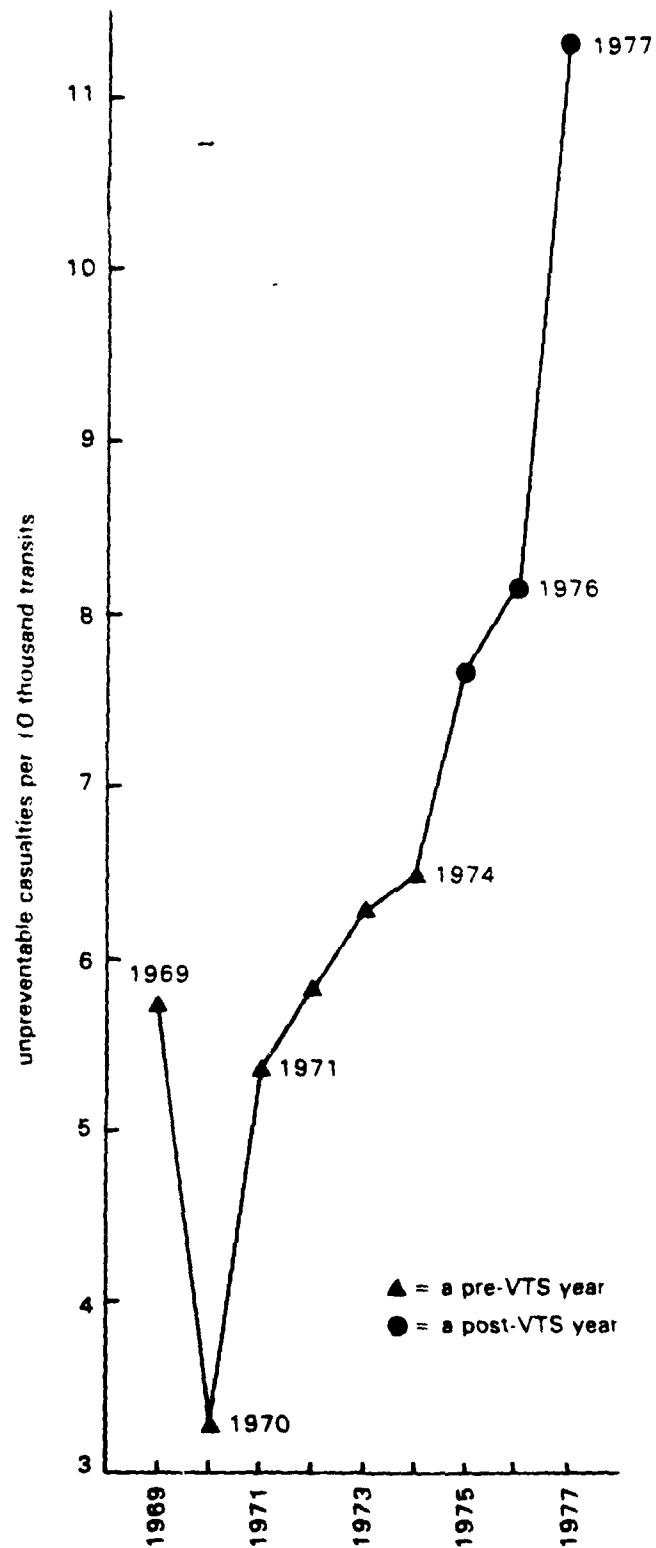


fig. 111

**Total Casualties Per 10 Million Tons
of Commerce**

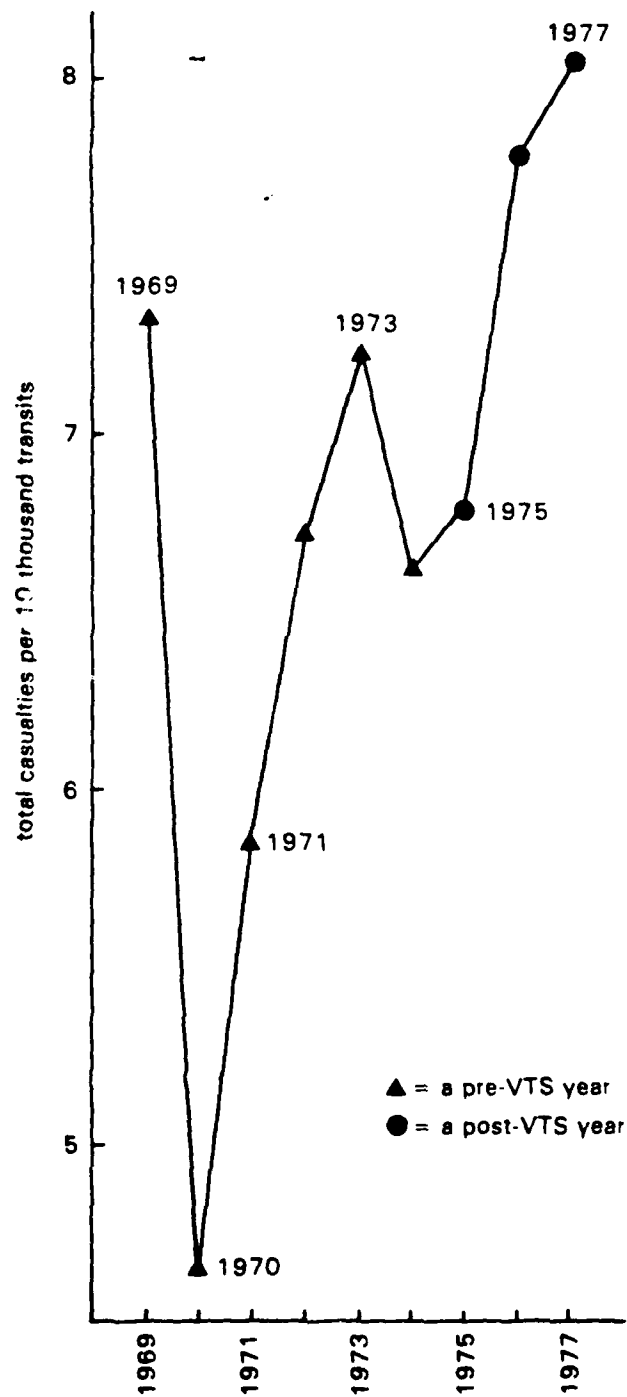


fig. 1v

Unpreventable Casualties Per 10 Million Tons of Commerce

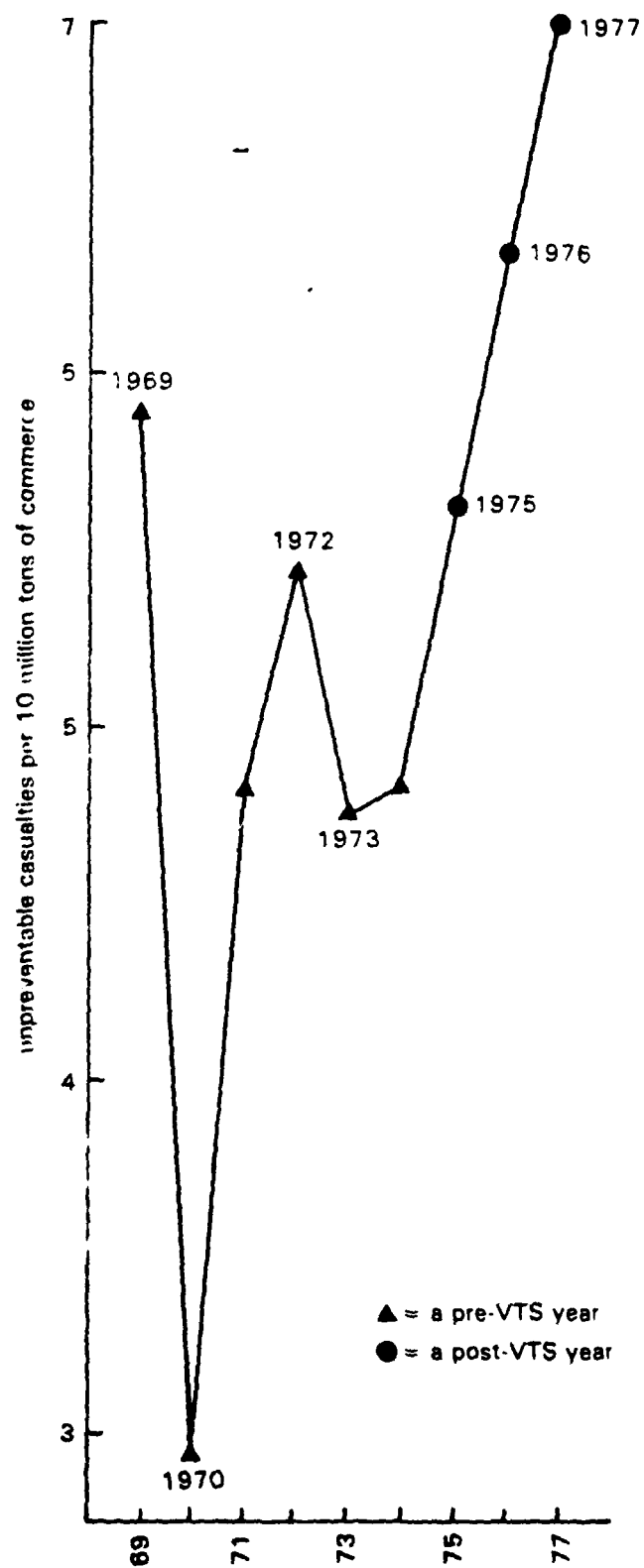


fig. 4

Preventable Casualties Per 10,000 Transits

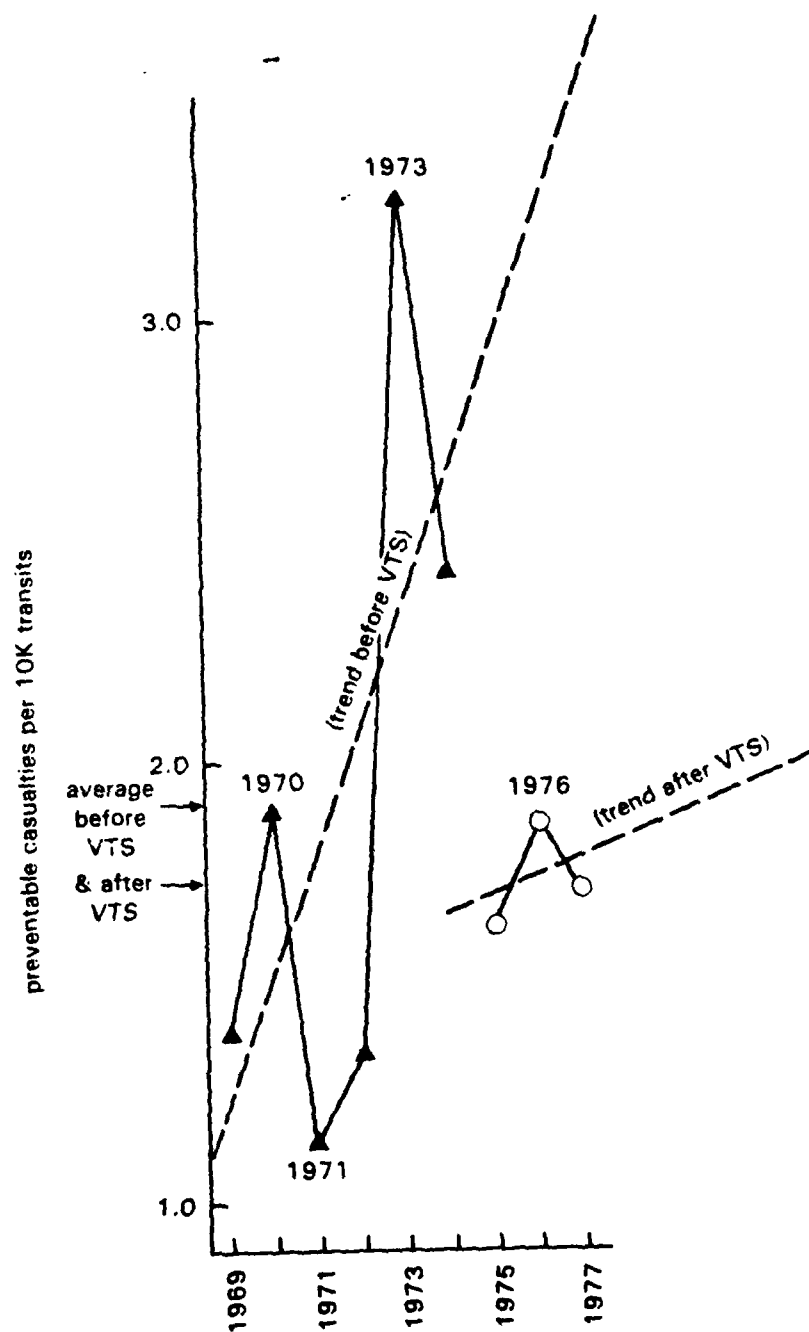


fig. v1

Preventable Casualties Per 10 Million Tons of Commerce

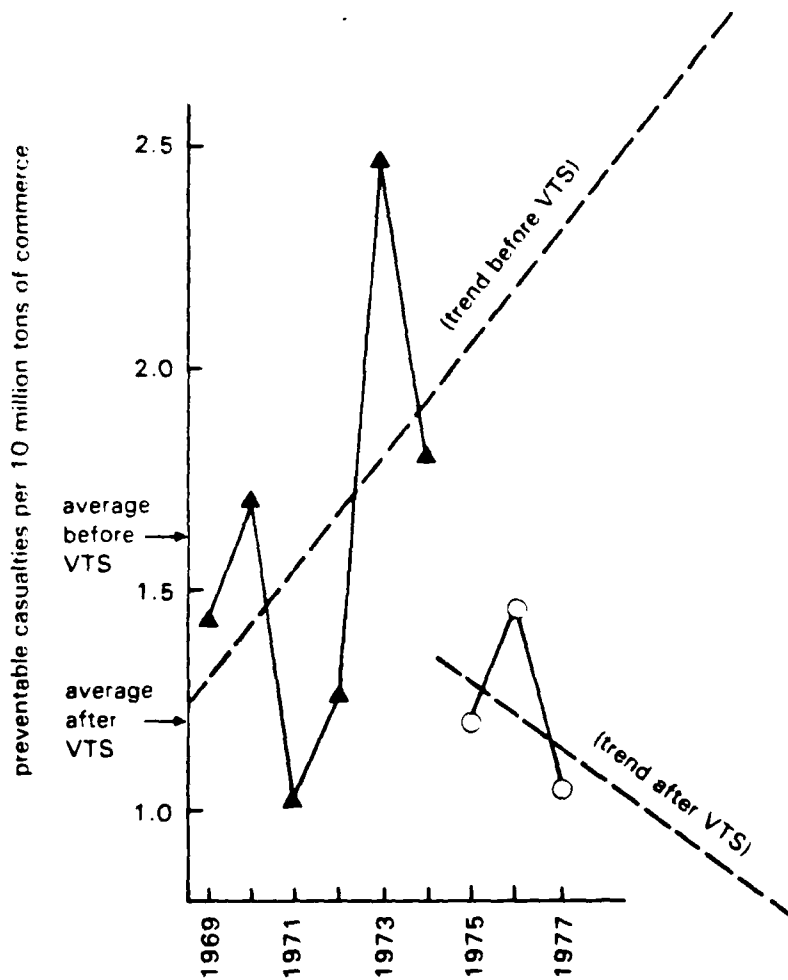


fig. vf1

REPORT

I. INTRODUCTION

In August 1973 the Coast Guard completed the Vessel Traffic Systems Analysis of Port Needs which included 22 major ports of the United States. This report used data obtained from the Coast Guard's Merchant Vessel Casualty Reports (MVCR) for a four year period, FY-69 through FY-72, to determine a relative ranking of ports and waterways and their need for Vessel Traffic Service (VTS).

This report, undertaken as the initial update of data originally presented in the Vessel Traffic Systems Analysis of Port Needs, will also present an analysis of the effectiveness of the Houston/Galveston VTS since it went on-line in 1975.

Based in part on the information provided by the 1973 study the Coast Guard established the Houston/Galveston VTS on 4 February 1975. The system consisted of a Vessel Movement Reporting System (VMRS) with low light level CCTV surveillance. In late FY-77 Radar surveillance of selected areas, along with a computer driven graphic display was added. The system presently has voluntary participation of 95+% of the marine community.

The methodology developed in the Vessel Traffic Systems Analysis of Port Needs Study for estimating casualty loss reductions (by VTS level) was used in this report so that a direct correlation could be made between the two studies. To ensure that the same criteria used in the Vessel Traffic Systems Analysis of Port Needs Study was being faithfully applied by this study group, the last year of that study (FY-72) was reviewed. Of the 36 casualty cases reviewed identical determinations were reached in 35 cases. This represents a 97+% agreement on accident prevention determinations.

The format this report will use in presenting the results of this study will be as follows:

- I. Introduction
- II. Sources of Data
- III. The Casualty Analysis
- IV. Findings and Determinations
- V. Conclusions

II. SOURCES OF DATA

After compiling casualty analysis data for FY-73 through FY-78, the data was added to the results of the casualty analysis from the Vessel Traffic Systems Analysis of Port Needs to form a ten year data base. The information from the analysis was then compared and evaluated with data from the Corp of Engineers Waterborne Commerce of the U. S., and data from the Houston/Galveston VTS casualty and transit statistics to form the conclusions of this study.

A computer printout of Merchant Vessel Casualty Reports (MVCR) was obtained from the Office of Merchant Marine Safety at Coast Guard Headquarters in Washington as the first step of the Houston/Galveston VTS casualty analysis. This printout listed all casualty cases that had occurred in the general area of the VTS.

During the course of this analysis it became apparent that the Coast Guard's fiscal year format for filing casualty reports had several inherent problems. One major problem is that the casualty numbering is based on the Fiscal Year date of HQ receipt of the casualty file, not on the actual date of the casualty. Data obtained from the VTS and COE are in calendar year formats. This was not critical in the Vessel Traffic Systems Analysis of Port Needs. However, for this (update) report, measures of safety and VTS effectiveness were to be attempted, and trends were apparent (statistics based on averaging techniques would be of questionable use). Therefore, all casualty analysis data will be presented in a calendar year format for this report. As the information required to complete calendar year (CY) 78 was incomplete, the period of the study will be from CY-69 through CY-77 (a nine year period).

There was some difficulty in using COE statistics as their method of compiling data was inconsistent with the area of concern for VTS. The COE data is presented by several areas of interest. These are the Gulf Intra-coastal Coastal Waterway (GICW) from Sabine to Galveston, the GICW from Galveston to Corpus Christi, Galveston Harbor, Galveston Channel, Texas City Channel, Anahuac Channel, Trinity River Channel, Cedar Bayou, Clear Creek, and the Houston Ship Channel (HSC) in general. Since the HSC data includes Galveston Harbor, which in turn reflects traffic to other areas such as Texas City, the HSC data was used as the primary source for comparisons of COE data to other data. Since the GICW could still have a lot of "through traffic" that might not be reflected in the HSC data, there was a comparison of HSC data and HSC + GICW data. This showed that there was no difference large or contrary enough to affect the overall HSC trend. While it is expected that some transits will have been missed by using only the HSC data, it is considered to be less consequential than the total overlap for all the component areas of interest.

Data from the Houston/Galveston VTS was also obtained during the study effort. VTS data includes casualty and transit information. Comparison of the VTS transit data with that of the COE showed that the two are not in agreement. Differences between the data collected by the COE and by VTS can be attributed primarily to different administrative requirements for data collection.

The COE is primarily interested in the movement of commodities and vessels between various ports and waterways in the U.S.. The VTS is interested in and records all vessel movements (except fishing vessels, recreational craft, and other small vessels) within its area of concern. Examples of movements not recorded by the COE would be barge fleeting operations, dock shifts, and vessels transiting a port area enroute to another port (ICW traffic). All of these would be recorded by the VTS as a transit in the VTS area. For this study effort COE data was used exclusively, predominantly for reasons of consistency over the years investigated. (See Section IV-B for further discussion)

VTS data and comparison of COE and VTS data follows:

<u>YEAR</u>	<u>COE DATA</u>	<u>VTS DATA</u>	<u>%DIFF</u>
1975	61,545	72,766	18.2%
1976	69,940	74,819	7.0%
1977	64,429	83,132	29.0%
1978	66,884	88,547	32.4%

Fig.1

III. THE CASUALTY ANALYSIS

Before undertaking the determinations of VTS preventability three basic assumptions were made concerning VTS operations and regulations. These were:

1. The VTS was a mandatory system.
2. VTC had traffic management authority (Active Management for unusual circumstances).
3. Regulations would be promulgated to meet special requirements for recurring problems.

These assumptions were used even though H/G VTS is a voluntary system. Further discussion on voluntary versus mandatory systems is found in Section IV-A.

In order to determine which casualties had occurred in the Houston/Galveston VTS area, a computer printout of the Merchant Vessel Casualty Reports was obtained from the Office of Merchant Marine Safety at Coast Guard Headquarters in Washington, D.C.. This printout listed 1,019 casualty cases which had occurred in the Houston/Galveston area during the six year period FY-73 through FY-78. Each casualty case was reviewed in order to determine if the casualty had occurred within the VTS area of concern. Those cases that occurred outside of the VTS area were eliminated from further consideration. No significant concentrations outside the VTS area were identified during the analysis.

Next, those casualties that solely involved vessels not subject to VTS regulations (i.e. fishing boats, recreational boats, etc.) were also eliminated from further consideration. This left 400 casualty cases which were subjected to a detail review and analysis.

A. DATA BASE

To establish a data base for the casualty analysis each casualty in the VTS area of concern was reviewed and these five types of data were extracted:

1. Date of casualty
2. Location of casualty
3. Type of vessel
4. Type of casualty
5. Dollar damages and deaths/injuries

The date of each casualty was obtained so that the casualty data from the MVCR, which uses a fiscal year format, could be converted to a calendar year format. This eliminated the errors inherent to the Coast Guard filing system and presented the data in the same format as other data utilized in the report.

The location of each casualty was recorded for further analysis in determining problem areas within the VTS; the results of which are presented later in this report.

Vessels involved in casualties were classified into six types; these were:

1. Passenger and cargo vessels
2. Tank ships
3. Tank Barges
4. Cargo Barges
5. Tug and Towboats
6. Government vessels, dredges, and misc. craft

Casualties examined in this report were classified into five types; they were:

Type 1-Collisions while meeting, crossing, or
overtaking

Type 2-Collisions while docking, mooring, or anchoring

Type 3-Ramming of fixed objects

Type 4-Ramming of non-fixed objects

Type 5-Groundings

Dollar damages of a casualty, which include vessel, cargo, and property damages, were combined into one single dollar loss. Deaths or injuries to crew, passengers, longshoremen, or others were similarly placed in one separate category.

When determining the effect a VTS might have on a casualty no effort was made to determine the following:

1. Less down time for vessel repairs; vessels which suffer damage requiring a dockside or shipyard service also suffer from lost revenue time. A large tanker may lose over \$40,000 (estimated) per day in revenue when the ship is out of service. In the case of small casualties this could easily amount to more money than the repair costs.

2. Facilitation of Commerce; it has been shown that a VTS can reduce the amount of transit time into and out of a port or waterway. In addition to less transit time; agents, longshoremen, harbor masters, and tug dispatchers frequently use the services of the VTS to assist them in their duties. European VTSS have traditionally justified their systems solely on the basis of facilitation of commerce. The Port of Rotterdam is an outstanding example.

3. Reduced Probability of Marine Disaster; each vessel casualty has the potential to turn into a major public health and safety catastrophe or environmental pollution incident. In a port such as Houston where large quantities of petroleum and chemical products are transported by barge and tankers, the potential for a major pollution incident is much higher than in other ports in the U.S.. The costs to industry or government associated with the oil or hazardous substance cleanup itself are also not included.

4. Cost to the government; any time a casualty occurs there are additional operational and administrative costs to government agencies. These costs include, but are not limited to, response by Coast Guard or other agencies with emergency resources; inspection of vessel damage; and investigation, preparation, and review of casualty reports by the Coast Guard.

B. ACCIDENT PREVENTION DETERMINATIONS;

The methodology developed in the Vessel Traffic Systems Analysis of Port Needs was used to determine accident preventability for this report to allow for combining the results of the two studies into one data base. Several minor changes were made to this (original) methodology due to changes in regulations since the previous report. Level L₀ (Bridge-to-Bridge) was not used for this study as the Bridge to Bridge Radiotelephone regulations were mandatory during the entire period of this study. The VTS levels used in this analysis were:

L_R Regulation

L₁ Traffic Separation Scheme (TSS)

L₂ Vessel Movement Reporting System (VMRS)

L₃ Basic Surveillance

L₄ Advanced Surveillance

L₅ Computer Aided Advanced Surveillance Systems

These levels will be discussed in detail later in this section.

To determine the effect that a VTS would have on a casualty, a case-by-case evaluation of accident reports was undertaken to ascertain the particulars of each casualty. Figure (2) shows a sample of the worksheet utilized in making accident prevention determinations. This is the same work sheet developed for and used in the Vessel Traffic Systems Analysis of Port Needs. The work sheet also aided in determining the level of VTS involvement capable of preventing the casualty. For each casualty a copy was made of the investigating officer's report accompanied by any additional documentation used by the researchers in reaching a judgement. In attempting to ensure as accurate a judgement as possible, each casualty case was reviewed by three different researchers with various backgrounds in the VTS program. In any case where the judgement was not unanimous, the merits of the case were debated by the three researchers and submitted to a fourth researcher for review and final determination. In this way debate was stimulated and consistency achieved in accident prevention determinations.

Accident Prevention Determinations

Case # _____ ☐ Preventable ☐ Unpreventable

If traffic patterns or congestion in the area are such that L(O)(B to B) would not prevent the accident, what assistance is required from a source external to the ship to prevent the accident.

1. Reduce amount or complexity of information processing required.

- ☐ a. reduce the number of ships in the area—L(2)
- ☐ b. reduce the uncertainty about other ships' positions—L(2)

2. Give the vessel more time for information processing.

- ☐ a. warn of other shipping—L(2)
- ☐ b. reduce speeds, increase clearances—L(2)
- ☐ c. environmental advisories—L(2)
- ☐ d. advance warning of critical or hazardous areas—L(2)

3. Give vessel more or better information.

- ☐ a. other ships' position—L(2)
- ☐ b. knowledge of other ships' intentions—L(2)
- ☐ c. position fixing—L(3)
- ☐ d. central collection and broadcast of traffic data—L(2)
- ☐ e. warning of ship standing into danger—L(3)

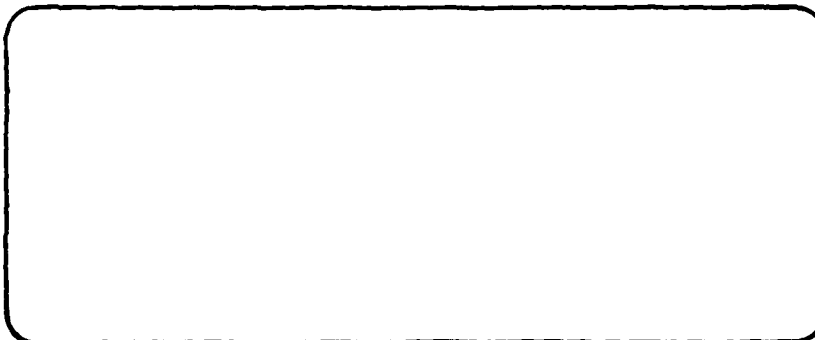
(only the lowest level which will produce the desired result is shown; levels are refined after considering data elements 4-6)

- 4. Traffic congestion ☐ Hi (judgement from a look at transits and use
☐ Lo of local knowledge)
- 5. Traffic patterns ☐ Complicated (judgement from a look at physical
☐ Simple characteristics of area)
- 6. Accident congestion ☐ Hi (from a plot of all accidents)
☐ Low

7. Final level selected _____

Diagram of Accident

Brief Narrative of
Accident



In making accident prevention determinations, each researcher relied on the following criteria when determining the VTS preventability of a casualty.

The casualty was deemed preventable if:

- a. There was confusion between operators regarding another vessel's location.
- b. There was confusion as to another vessel's intentions.
- c. There was a lack of timely communications.
- d. The Vessel Traffic Center had information which would have prevented the casualty.
- e. The casualty was preventable by traffic management.
- f. The casualty was preventable by detection from Radar or CCTV.

If the casualty did not have any of the preventable criteria present it was classified as non-preventable by VTS. In general, non-preventable casualties fell into three categories, which were:

- a. Maneuvering difficulty due to wind or current.
- b. Mechanical Failure which was sudden and unexpected.
- c. Personnel Error which was undetectable by the VTC.

Each casualty determined to be preventable by VTS was assigned a level of VTS involvement that would have been capable of preventing the casualty. In all cases the lowest level of VTS involvement was selected.

The six levels of VTS involvement used were:

L_R REGULATIONS APPLICABLE TO A SPECIFIC PORT

Casualties that were preventable by special regulations for a specific port were included in this category. As the casualty analysis of Houston/Galveston progressed, it became apparent that there were several instances which required special regulation that would not in itself be associated with the VTS. Based on the casualty analysis, meeting or overtaking situations at bends or blind corners in certain areas of the VTS were considered preventable had regulations prohibiting such encounters been in effect. Another example would be the prohibition of overtaking, crossing, or meeting (or any combination) of three or more vessels in the Houston Ship Channel. Level L_R is considered a passive form of traffic management not requiring a manned control center.

L₁ TRAFFIC SEPARATION SCHEME (TSS)

The TSS is a passive system component which does not require a shore-based, manned control center. A TSS is designed primarily to separate opposing traffic into traffic lanes with a separation zone between them. Because Houston/Galveston VTS consists primarily of narrow, restricted channels, a TSS was not selected for any casualty case.

L2 VESSEL MOVEMENT REPORTING SYSTEM (VMRS)

The VMRS is the lowest of the VTS levels which involves a manned shore-based control center or Vessel Traffic Center (VTC). A VHF-FM communications network allows vessel operators to communicate with the VTC for the purpose of information exchange. Certain classes of vessels are required to participate in the system and relay navigation information to the VTC concerning the vessel's movement through a port or waterway. The VTC advises a vessel of other traffic in its area; alerts them of hazardous areas in their intended path; and manages traffic, when necessary, to ensure safe passage for all vessels. Some examples of a VMRS are:

- Vessels are required to give advance notice of entering or leaving the system and report at various check points during their transit of the VTS area of responsibility.
- Having certain minimum equipment requirements before a vessel can transit or enter the VTS area.
- Management of traffic to ensure safe passage for all vessels. This can include, but is not limited to, restricting a vessel's movement in a channel, requiring a vessel to adjust speed, or delaying movement until traffic conditions clear.

L3 BASIC SURVEILLANCE

The 'basic surveillance' VTS includes radar and/or CCTV surveillance of selected or all parts of a port or waterway. The basic surveillance mode does not include sufficient features for positive control of vessel traffic, but does considerably improve the VTC's knowledge of the presence and movement of vessels in the area. Basic surveillance was considered essential for blind corners, bends, and intersections--especially in restricted waterways, where surveillance or traffic management were required to prevent casualties. H/G VTS is a L3 operation.

L4 ADVANCED SURVEILLANCE SYSTEMS

The advance surveillance systems differs from the basic system in that this type of system may have a limited computer feature along with a more complex radar or CCTV surveillance system. A higher and more accurate degree of traffic management can be achieved, such as lane assignments and fore and aft separation.

L5 COMPUTERIZED ADVANCED SURVEILLANCE SYSTEMS

Collision avoidance radar and full computer interface components comprise the final level of VTS dealt with in this study. These sophisticated system elements provide the highest degree of reliability in port management and maximize capabilities used in controlling vessel movements in complex, high density traffic areas.

IV. FINDINGS & DETERMINATIONS

Once the basic data was collected, organized (in a single useful format), and preventability established; relationships, trends, measures of safety, and measures of VTS effectiveness were sought.

Figure (3) shows the decision process utilized in forming the conclusions of this study. The findings and determinations of the study will be presented in six parts. They are:

- A. Casualty Analysis Results
- B. COE and/or VTS Results
- C. Measures of Relative Safety
- D. Relationships & predicting numbers of casualties
- E. Benefits
- F. Sensitivity

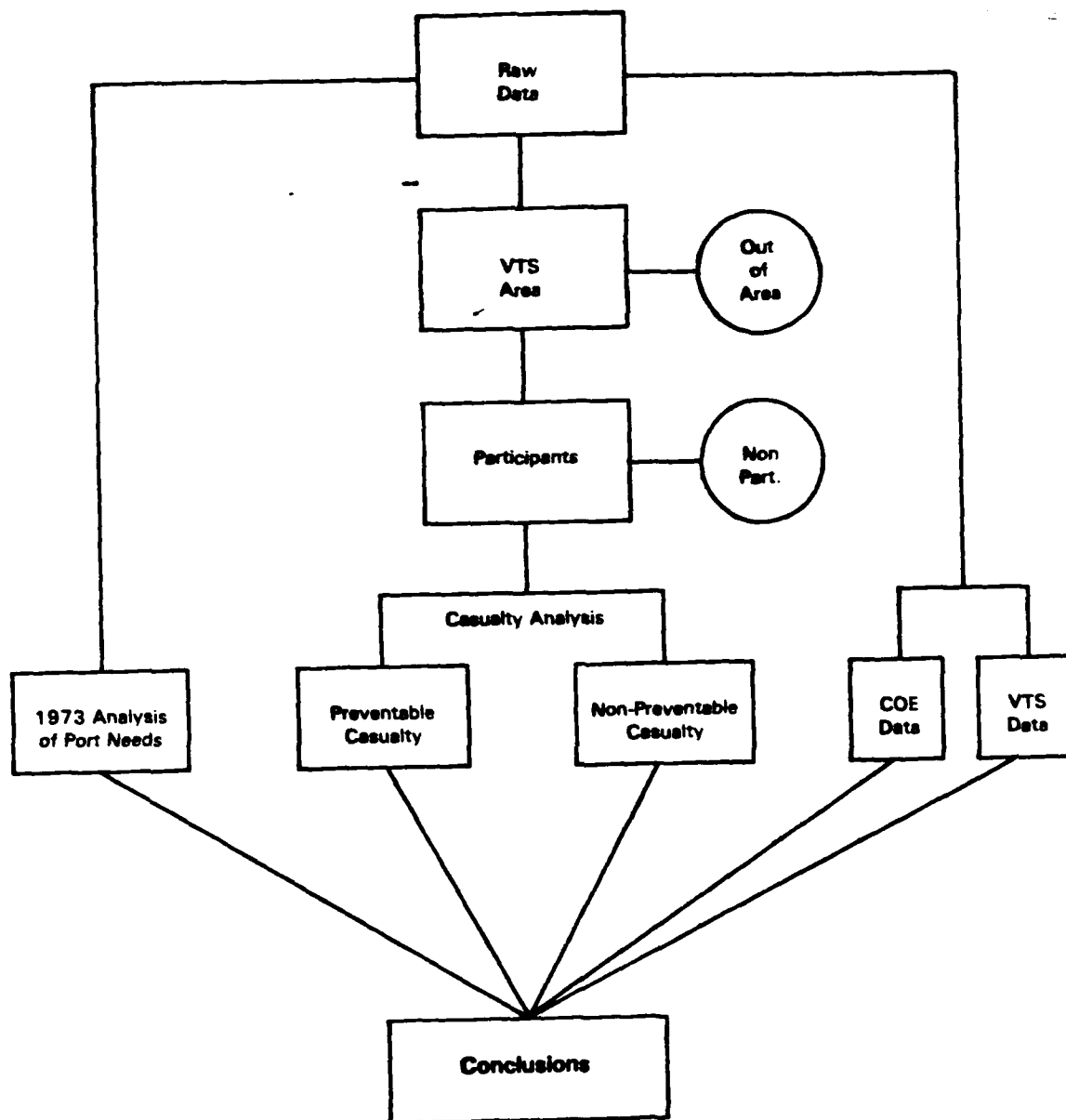


fig. 3

A. Casualty Analysis Results

The total casualty record was first examined for seasonal changes. The results, shown in fig. 4, seem to indicate that there are seasonal differences, but the fluctuations in the months from March through July make the results somewhat questionable.

Cumulative Casualties by Month CY69-77

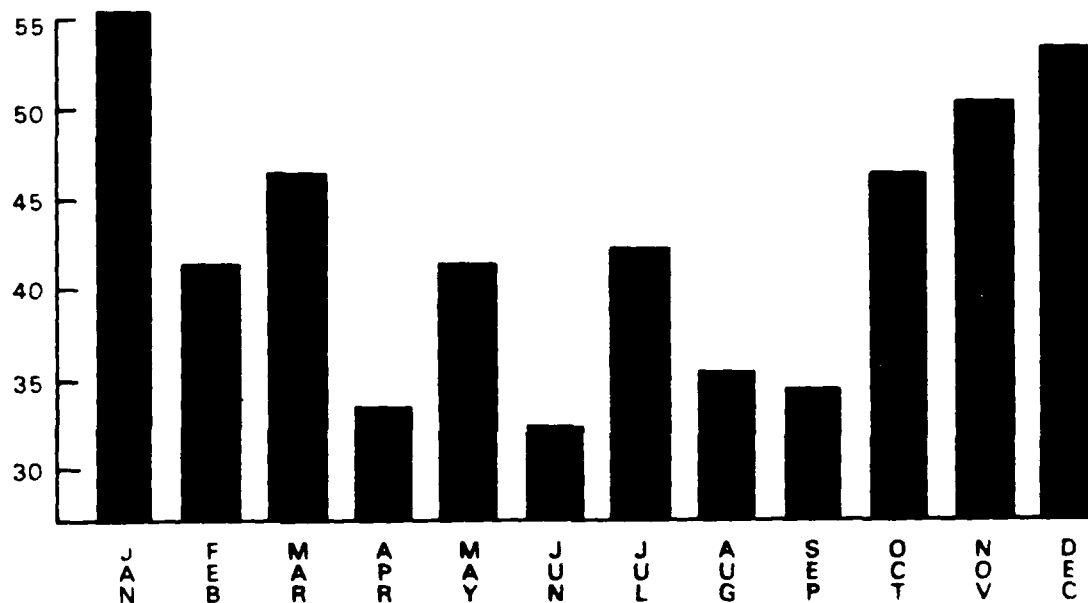


fig. 4

Figure (5) shows a breakdown of the casualty record (for all casualties) into collisions, rammings, and groundings. We found 151 collisions, 112 rammings, and 156 groundings. It should be noted that the combined totals for the three categories exceed 400 due to multiple casualty occurrences within a single casualty case. As CY78 casualty files were incomplete, the Findings and Determinations in Section IV are based on 509 casualties in CY69-77.

Houston/Galveston Casualty Analysis FY 69 to FY 78

	#	%
Total Number of Casualty Reports	583	
Total Number of Preventable Casualties	114	19.5%
FY 73 to FY 78		
*Total Number of Casualty Reports	400	
Total Number of Preventable Casualties	78	19.5%
Collisions	151	36.0%
Rammings	112	26.7%
Groundings	156	37.3%
Preventable Collision Before VTS	27	34.6%
Preventable Rammings Before VTS	4	5.1%
Preventable Groundings Before VTS	10	12.8%
Preventable Collisions After VTS	21	27.0%
Preventable Rammings After VTS	3	3.9%
Preventable Groundings After VTS	13	16.6%
Total Damages 1973-1978 (FY-81 \$)	\$21.6M	
Preventable Damages	5.8M	
Number of Deaths	2	
Number of Injuries	7	
Preventable Deaths/Injuries	0/2	

* Number of collisions, rammings, groundings exceed total number of casualty reports due to multiple types of casualties within a casualty report.

fig. 5

When we look at the preventable casualties we find that of the 78 casualties, 62% (48 casualties) were collisions, 9% (7 casualties) were rammings, and 29% (23 casualties) were groundings. Or: 32% of all collisions, 6% of all rammings, and 15% of all groundings were preventable. This shows that the VTS can have the greatest effect on the prevention of collisions and the least effect on the prevention of rammings. Preventable casualties account for about 1 out of every 5 total casualties.

When reviewing the preventable casualty cases and the level of VTS involvement required to prevent a casualty, the majority of all casualty cases (preventable by the VTS) were at the L₂ or L₃ level. Levels L₁ and L₅ were not selected for any casualties. Level L₄ was selected for only one casualty. It was found that levels L₄ & L₅ were difficult to justify for any single casualty. In general these more sophisticated levels of VTS need to be based on the overall casualty population, traffic density, traffic patterns, etc.. The present level of VTS involvement in the Houston/Galveston area, L₃ Basic Surveillance, is considered adequate based on the casualty analysis for FY73-FY78.

All of the casualties were plotted by location so as to determine areas of particular interest (Fig.6,7,8,9,9a,9b). As might be expected, the intersection at the Bay Entrance (Bolivar Roads, Galveston Channel, the GICW, the Houston Ship Channel, and the Texas City Channel) was a dense area of casualties. Figure (6) shows the VTS area below Morgans Point that includes the area of the intersections. It can be seen that this area is the major conflict area for the VTS. 39% of all casualties occur in the area below buoys "31" and "32". Other casualties are fairly well dispersed with small concentrations at the Texas City turning basin, Redfish, and Bayport precautionary areas. In looking at preventable casualties, Bolivar Roads (again) has the major concentration with Redfish and Bayport areas having only small concentrations.

A close review of the intersection area revealed, that in the Galveston Channel, many of the casualties are due to problems with strong currents (during ebbing or flooding tides), surprise encounters, or docking problems. In the area where the ICW opens into the Ship Channel and Texas City Channel, tidal currents cause problems with towboat traffic entering or exiting the ICW. This makes simple meeting or overtaking situations hazardous even where prior arrangements have been made. It is also at this junction that there are three different channel widths. The Houston Ship Channel narrows from 800' to 400', the Texas City Channel is 400', and the ICW Channel is only 125'.

One other problem was identified in the statistics provided by the Houston/Galveston VTS. Earlier in the study the voluntary participation rate was placed at about 95+% for the entire VTS system. However, the Houston/Galveston VTS unit estimates the participation rate at the junction area is substantially less, approximately 85 to 90%. This is primarily due to towboats that are only passing through the area of the ICW and may not feel it necessary to participate in the VTS. A similar problem exists with vessels that are making short trips within a port, such as a berth shift. This is a potentially serious problem in that such trips make up almost half of the transits within the VTS area. Without knowledge of a vessel's intention to move, the VTC can not give participants correct information concerning anticipated traffic, and in general the credibility and utility of VTS information to the marine community also suffers.

The Houston Ship Channel (HSC) above Morgans Point (Fig.7,9&9b) is not more casualty 'prone' than the lower hSC, although there are concentrations of casualties at barge fleeting areas such as:

- . Brays Bayou
- . Sims Bayou
- . Hunting Bayou & Cottonpatch Bayou
- . Greens Bayou
- . Tuckers Bayou, Carpenters Bayou, & Lynchburg

Preventable Casualties Before VTS 1969-1975

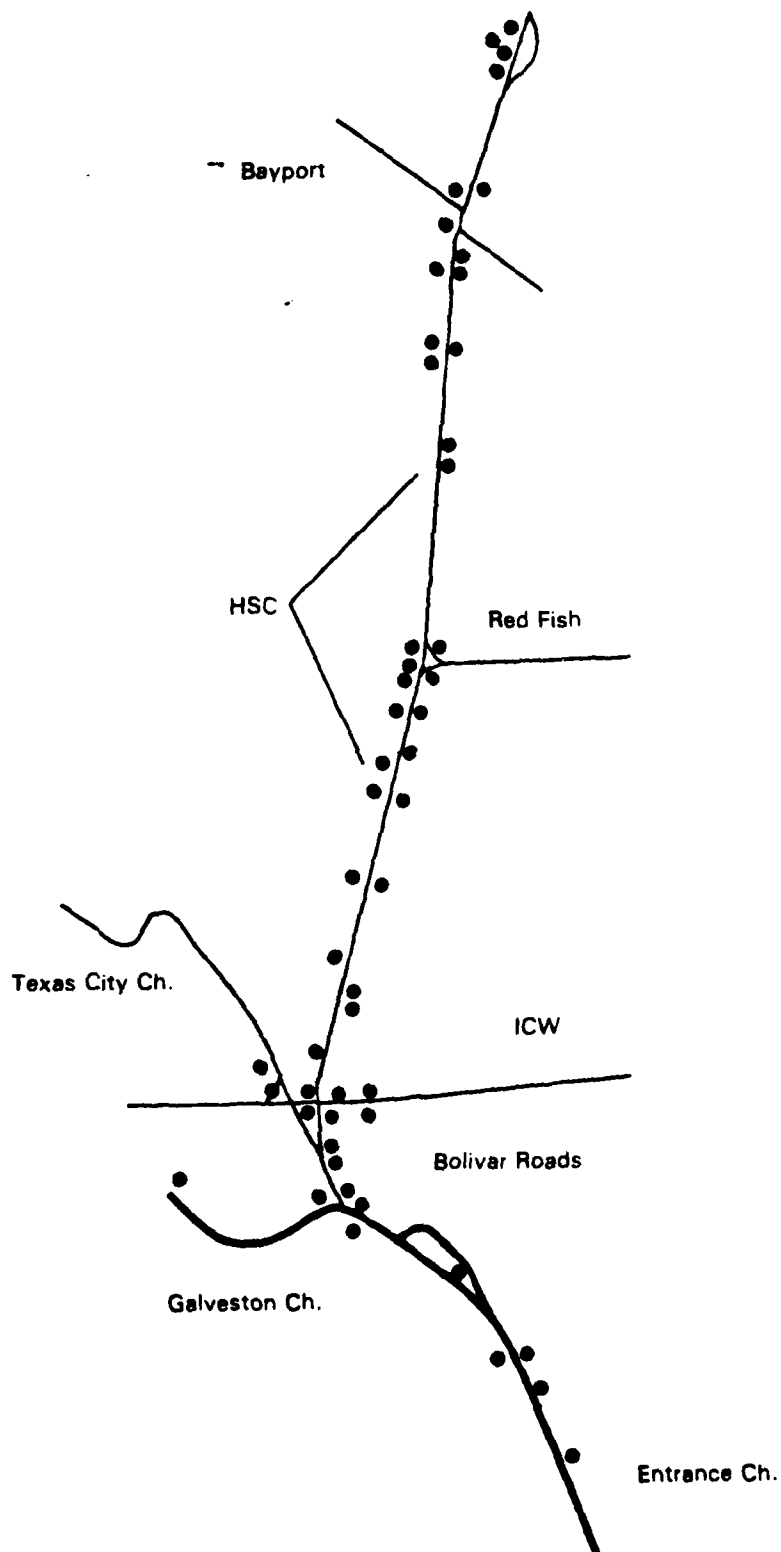


fig. 6

Preventable Casualties Before VTS 1969-1975

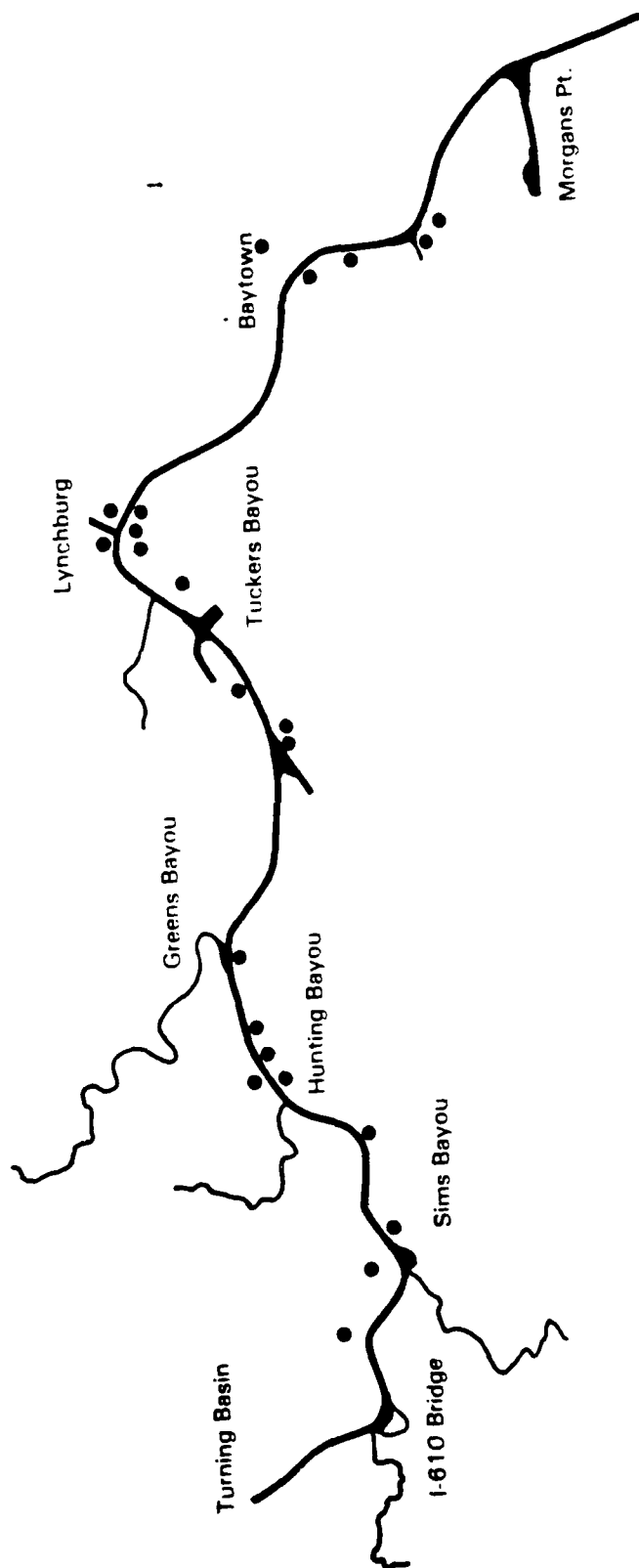


fig. 7

Preventable Casualties After VTS 1975-1978

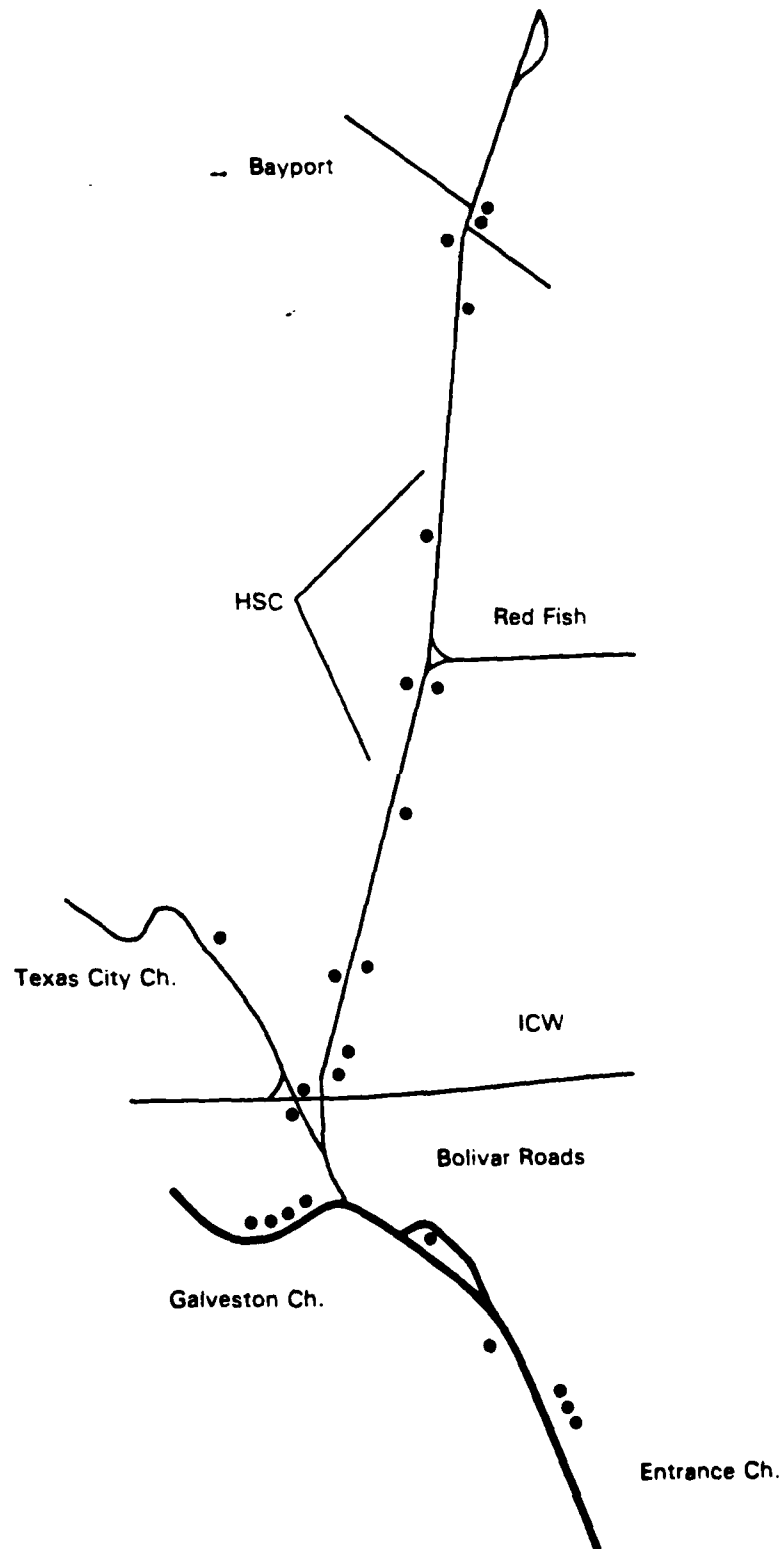


fig. 8

Preventable Casualties After VTS 1975-1978

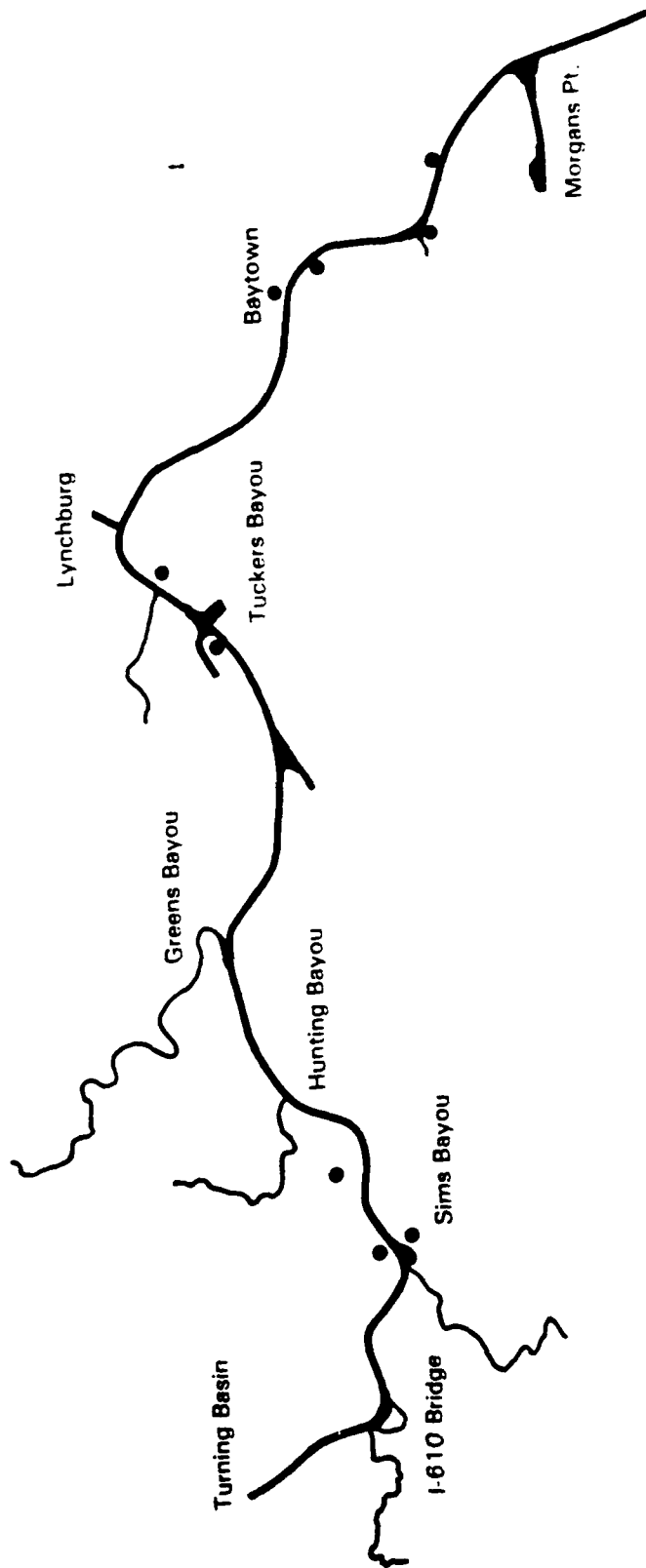


fig. 9

All Casualties

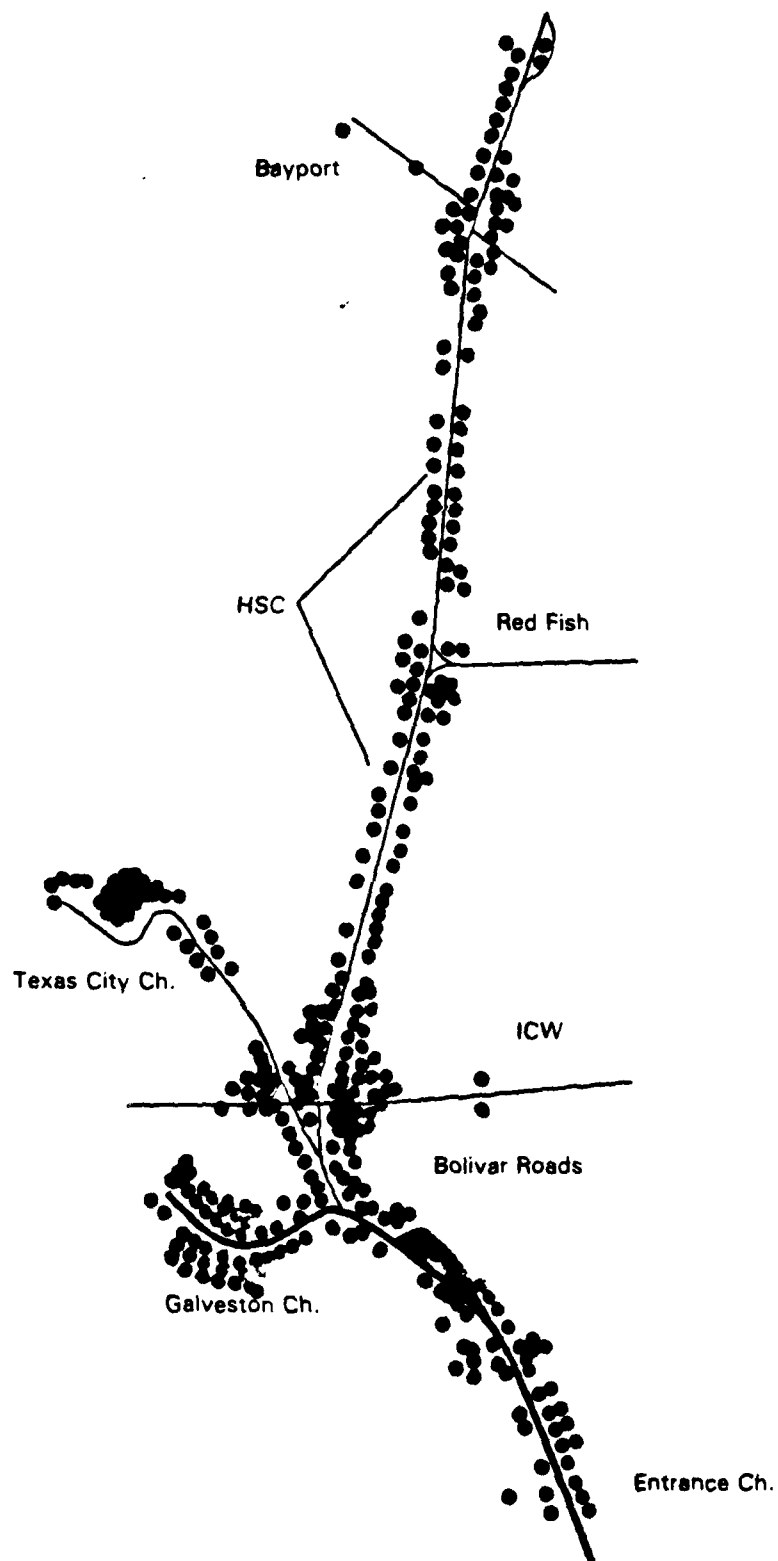


fig. 9a

All Casualties

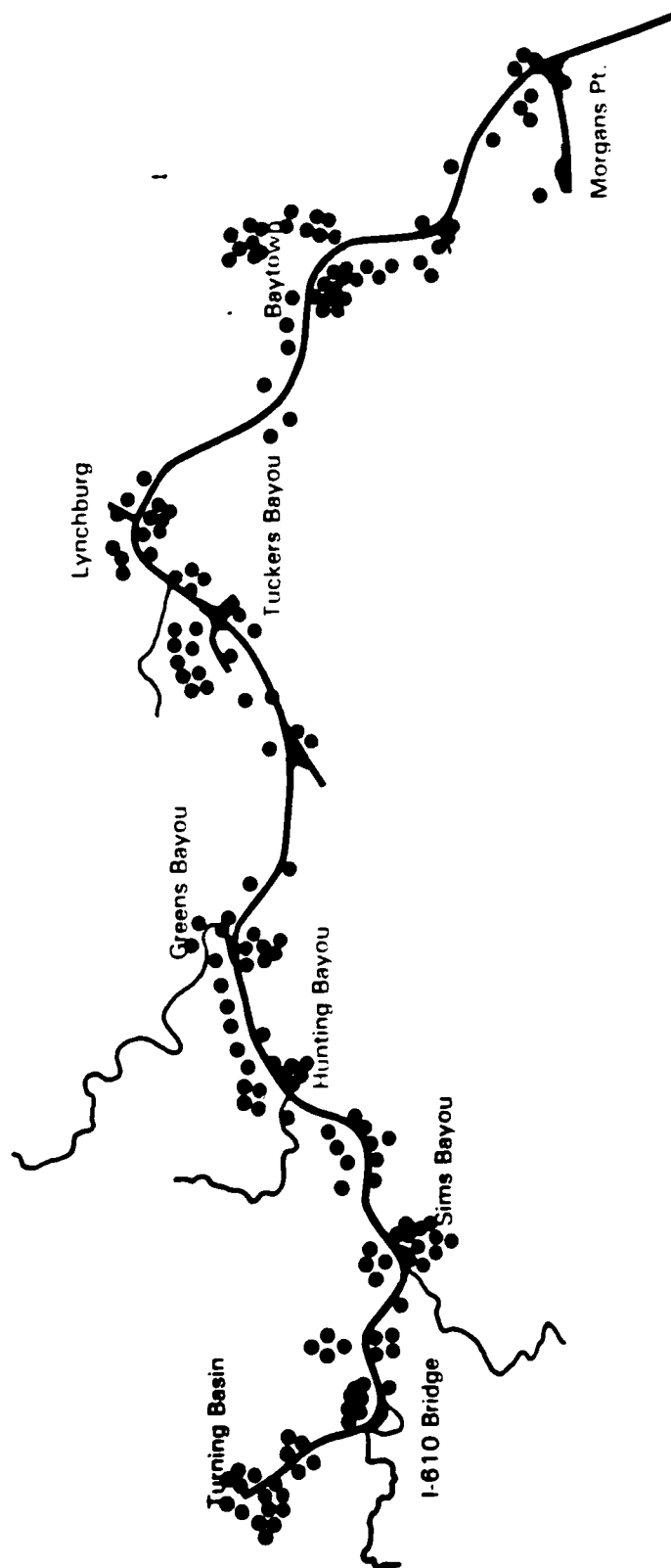


fig. 9b

Additionally, the hottest spot above Morgans Point was in the area of Baytown Bend where the Exxon docking facility is located. As well as having a bend in the channel, not to mention an Exxon facility, it is also the sight of a fixed aid-to-navigation (Range L Front Light) that has a disproportionate amount of rammings. The Range L Front Light at Baytown was involved in 6 rammings from 1976 to 1978. Its location, at the entrance to the Exxon docks in Baytown, makes it subject to numerous rammings by towboats entering and leaving the dock area. No other significant aids to navigation problem, within the VTS area of concern, was apparent from the analysis.

Casualties were also indexed according to casualty types and casualty factors, such as fog, visibility, wind, etc. This effort did not produce any significant results.

When compiling the data on dollar damages for the study, the three categories listed on the MVCR; vessel, cargo, and property damages, were combined into one single dollar figure. The total dollar damages listed for the 400 casualty cases was \$14.3 million of which \$2.95 million was preventable. When these amounts are converted into FY-81 dollars we find \$21.6(+) million in total damages and \$5.8(+) million in preventable damages, or approximately 1 in every 4 dollars of damage is preventable by VTS. Two deaths and seven injuries occurred in the 400 reported casualty cases. Of these, none of the deaths and two of the injuries could have been prevented by the VTS. The primary purpose of this effort was to estimate the value of a preventable casualty for the benefits analysis.

Any casualty that was determined to be preventable after the VTS went on line (Appendix I) was subjected to an additional review to determine whether the casualty could have been prevented at the mandatory, or traffic management level. This was undertaken in order to make a determination as to whether or not there was a need to upgrade the present VTS to a mandatory system. Out of 37 Post-VTS casualties, 17 were preventable had the VTS been mandatory, and an additional 15 could have been prevented by traffic management. Only 5 of 37 cases were preventable at the voluntary level. A mandatory system would represent an 87% improvement over a voluntary system. This, coupled with the lower voluntary participation in the Bolivar Roads area, makes mandatory participation for the Houston/Galveston VTS an apparent necessity.

Figure (10) shows the total, unpreventable, and preventable casualties in the Houston/Galveston VTS area before VTS, after VTS, and for all years combined. Most of the findings are apparent from a casual viewing of the graph. The preventable casualty population is approximately 20% of the total casualty population. The trend for total casualties and unpreventable casualties is increasing. Preventable casualties are at the same level for both 1977 and 1969 and the trend of increase--if any--is less steep. One possibility for the significant increase in total and unpreventable casualties is that commerce has almost doubled, in nine years with a corresponding trend to larger or more heavily laden vessels. This is explored in more detail later in the report.

CY 69-77 CASUALTY REPORTS

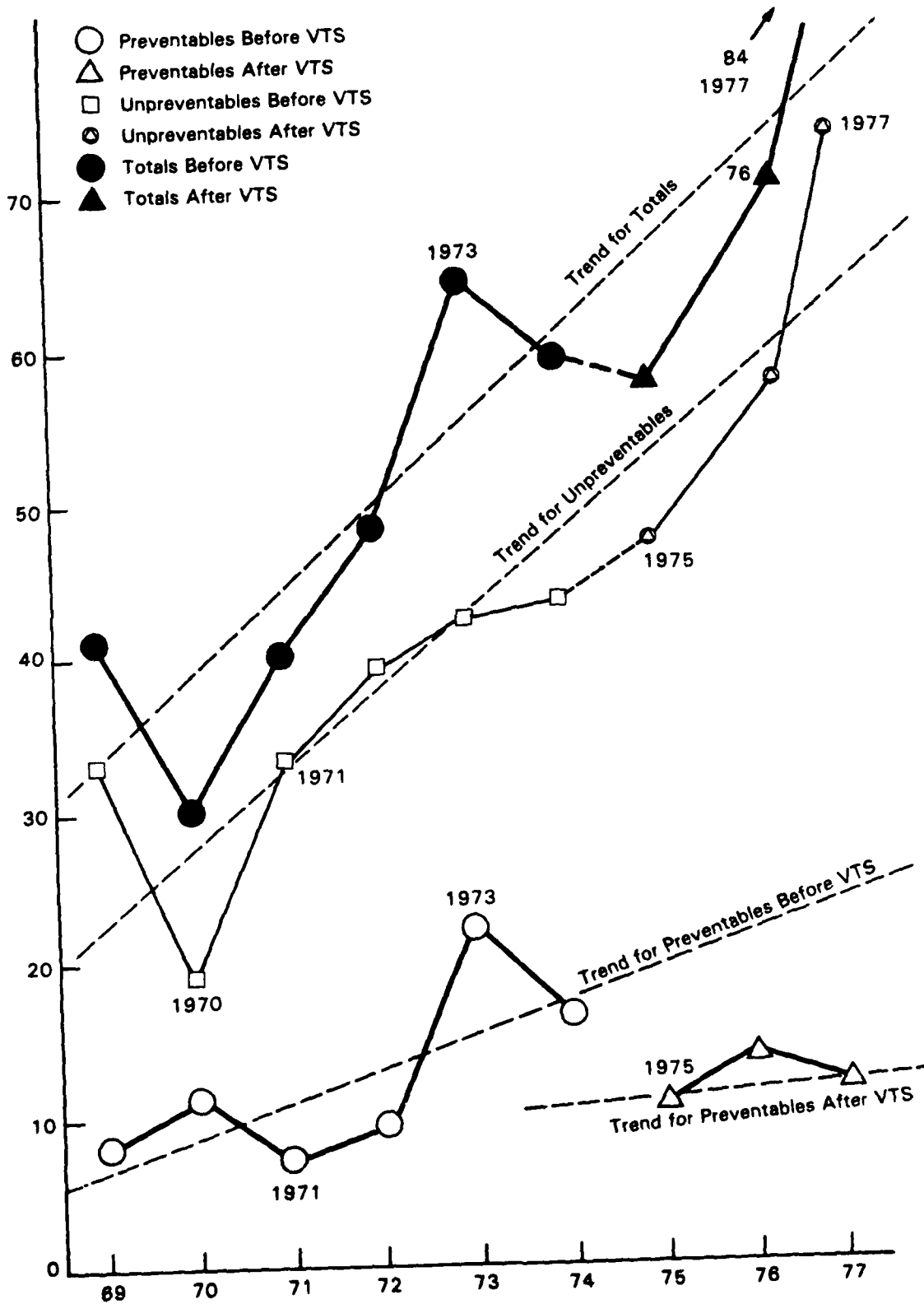


fig. 10

B. COE AND VTS DATA RESULTS

The casualty record alone is insufficient as an indicator of the VTS effectiveness. If there were less activity in the harbor system a reduction in casualties would reflect reductions in those pressures on the harbor system that might enhance hazard potential (this is in addition to a VTS affect). Conversely, when traffic pressures increase they counteract the efforts of the VTS.

In the "Sources of Data" Section VTS and COE data were compared. The two did not match well because the COE data is primarily concerned with movement of commerce, and does not take into account berth shifts, barge transfers, and other types of local transits in the VTS area--the COE has different administrative requirements for their data than the VTS. Because the VTS is primarily interested in all vessel movements (except F/V's, recreational boats, etc.) the data obtained from H/G VTS gives a more accurate account of transits in the Houston/Galveston VTS area. Figure (11) shows the distribution of vessel transits for the various ports in the Houston/Galveston VTS area (as supplied by VTS statistics). It can be seen that Houston has the largest share of the transits with 61.3% of all deep draft vessels and 20.5% of all tows calling at the port of Houston. You can also see that intraport movements, movements solely within a port complex, account for almost 50% of the VTS transits. Interport movements, movements between two different port complexes in the VTS area, account for an additional 10% of VTS transits.

**Vessel Transits to Various Ports
Houston/Galveston VTS**

Port	Ships	Tows	Ships & Tows
Houston	61.3%	20.5%	29.0%
Galveston	10.6%	1.7%	3.5%
Texas City	7.9%	6.0%	6.4%
Bayport	1.2%	1.1%	1.1%
ICW*	0.0%	5.0%	3.9%
Intraport**	13.5%	55.2%	46.6%
Interport**	5.5%	10.5%	9.5%

*Vessels transiting in the ICW but not calling at ports in the Houston/Galveston VTS area.

**Vessel movement solely within Galveston, Texas City, Bayport, or Houston.

***Vessel movement originating in one VTS area and terminating in another VTS area port.

Year	COE Data	VTS Data	% Diff
75	61,545	72,766	18.2%
76	69,940	74,819	7.0%
77	84,429	83,132	29.0%
78	66,884	88,547	32.4%

Towboat Movements = 80%

Ship Movements = 20%

fig. 11

Casualty data was only available from CY69 through CY77. COE data was collected for the years 1963 through 1970 (Fig. 12,13,14&15). COE data for the years 1963 through 1968 were added because of interest in the longer term commercial trends. For the HSC, the years before the casualty analysis (1963 through 1968) showed no real growth in either commerce (Fig.12) or transits (Fig.13). Then, from 1969 onward, commerce was steadily (with one interruption in 1975) increasing: nearly 100% in the nine year period. Transits for the HSC also showed a 'generally increasing' trend, but not one that kept pace with commerce, and not as steadily. This is in contrast with the years before 1969 where the commerce and transit curves were well matched. Figure (14) shows both the commerce and transit curves on the same scale. It can be seen that, during the pre-study years, commerce and transits paralleled each other, while after 1969 the transits did not increase proportionally with commerce. Ton-mileage was also checked. It paralleled the commerce data quite closely (Fig.15)

At this point it can already be seen that there are two areas of interest. First, the increases in commerce and transits is presumed to add some hazard potential to the harbor system. Second, the slower rate of increase for transits compared to the increases in commerce (i.e. tons/transit) is suspect. It is apparent to the study group that larger and/or more heavily laden vessels and tows is a developing trend in the H/G VTS area.

Tons of Commerce on the Houston Ship Channel

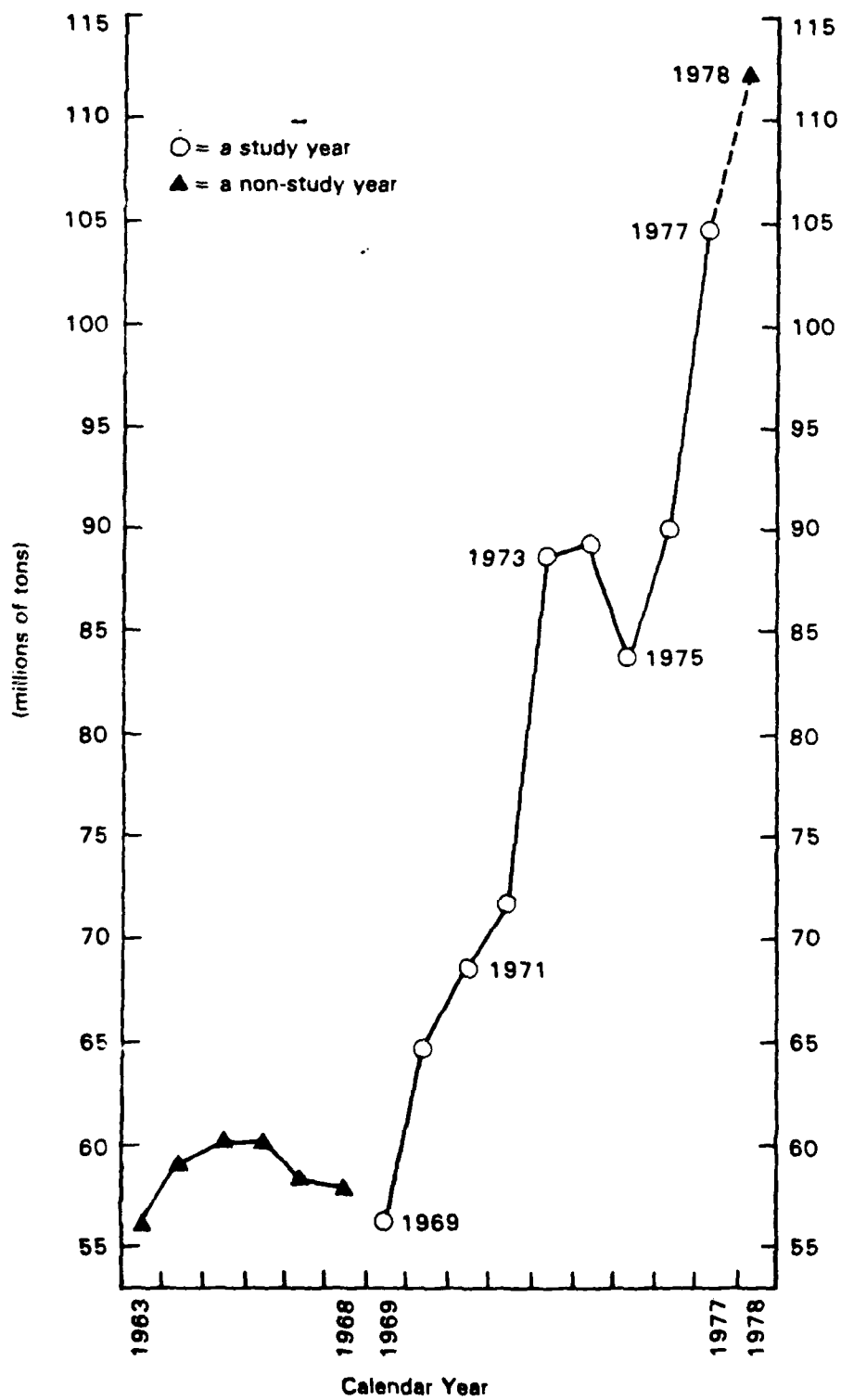


fig. 12

Transits on the Houston Ship Channel

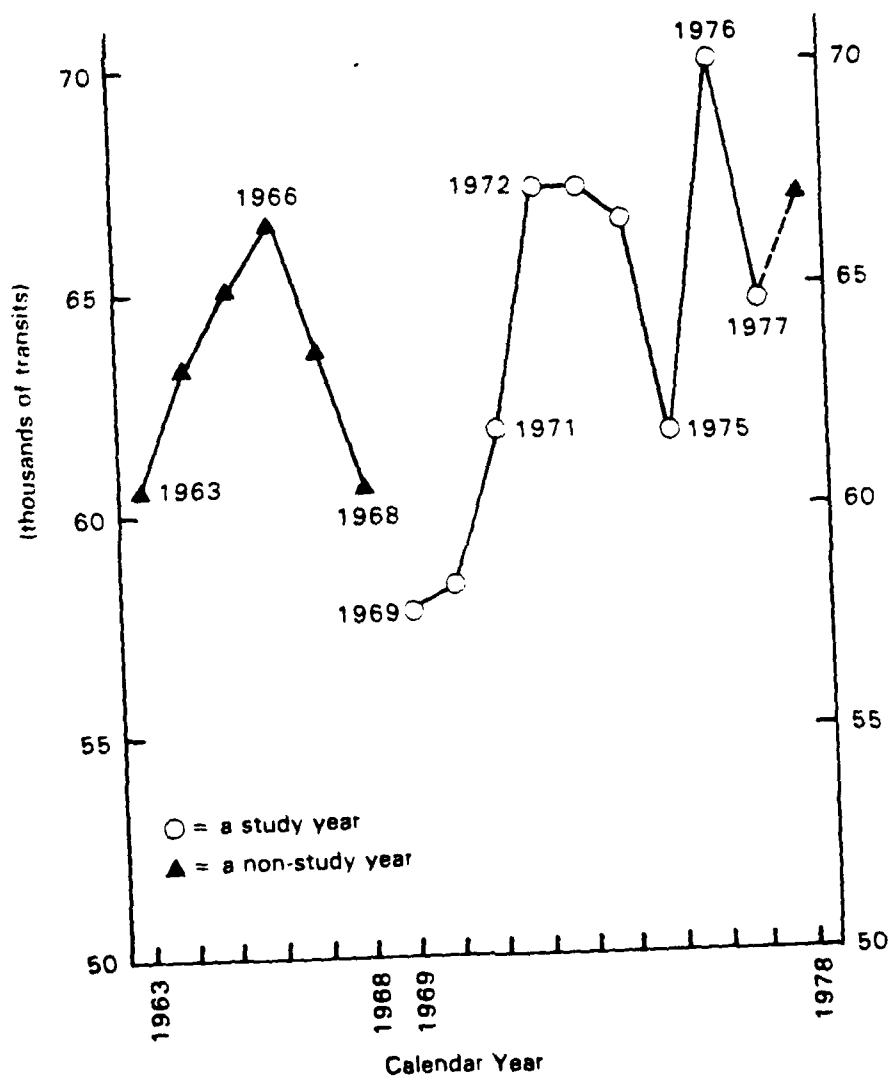


fig. 13

Commerce Versus Transits — HSC CY63-78

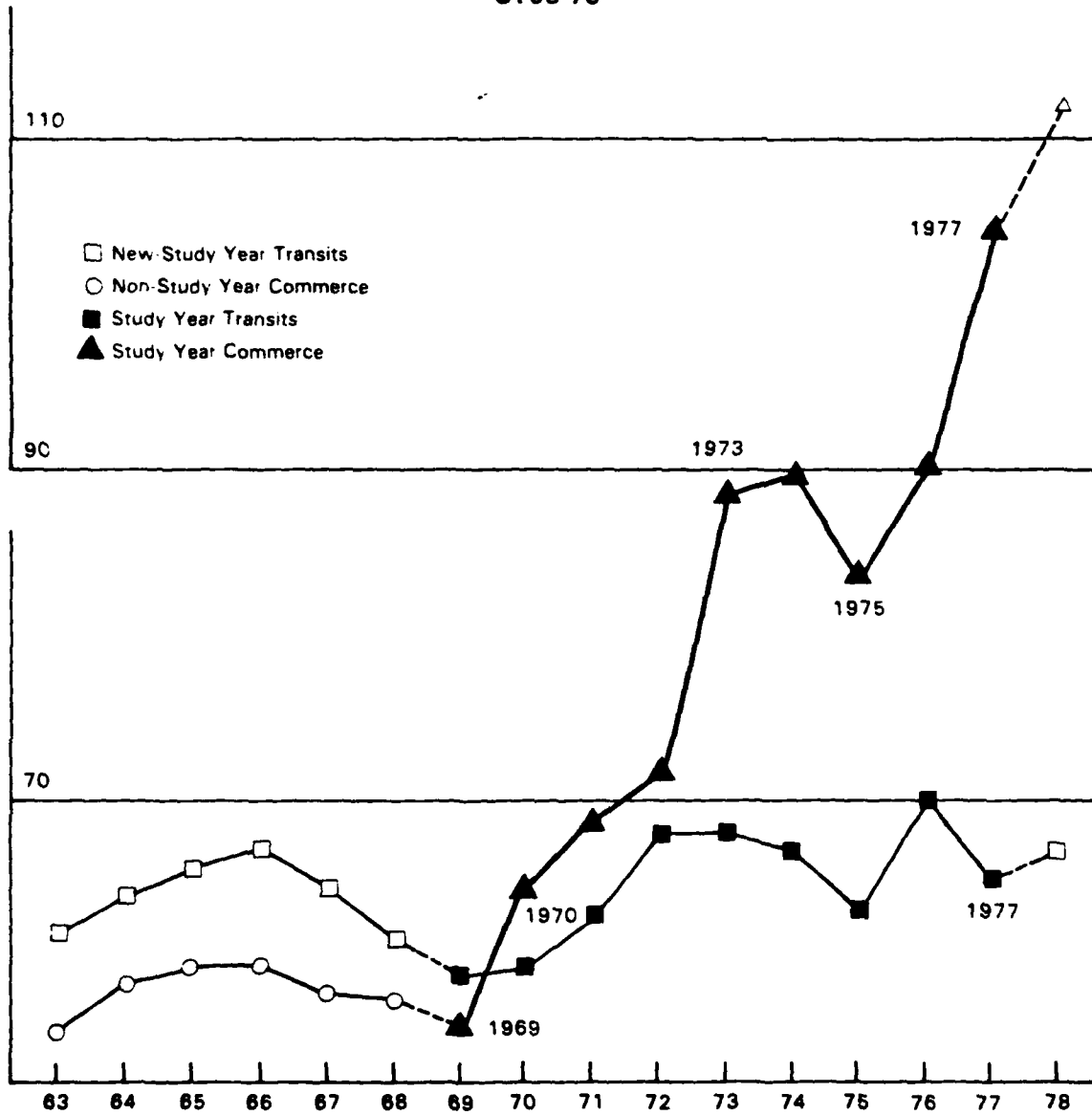


fig. 14

Ton-Miles on the Houston Ship Channel

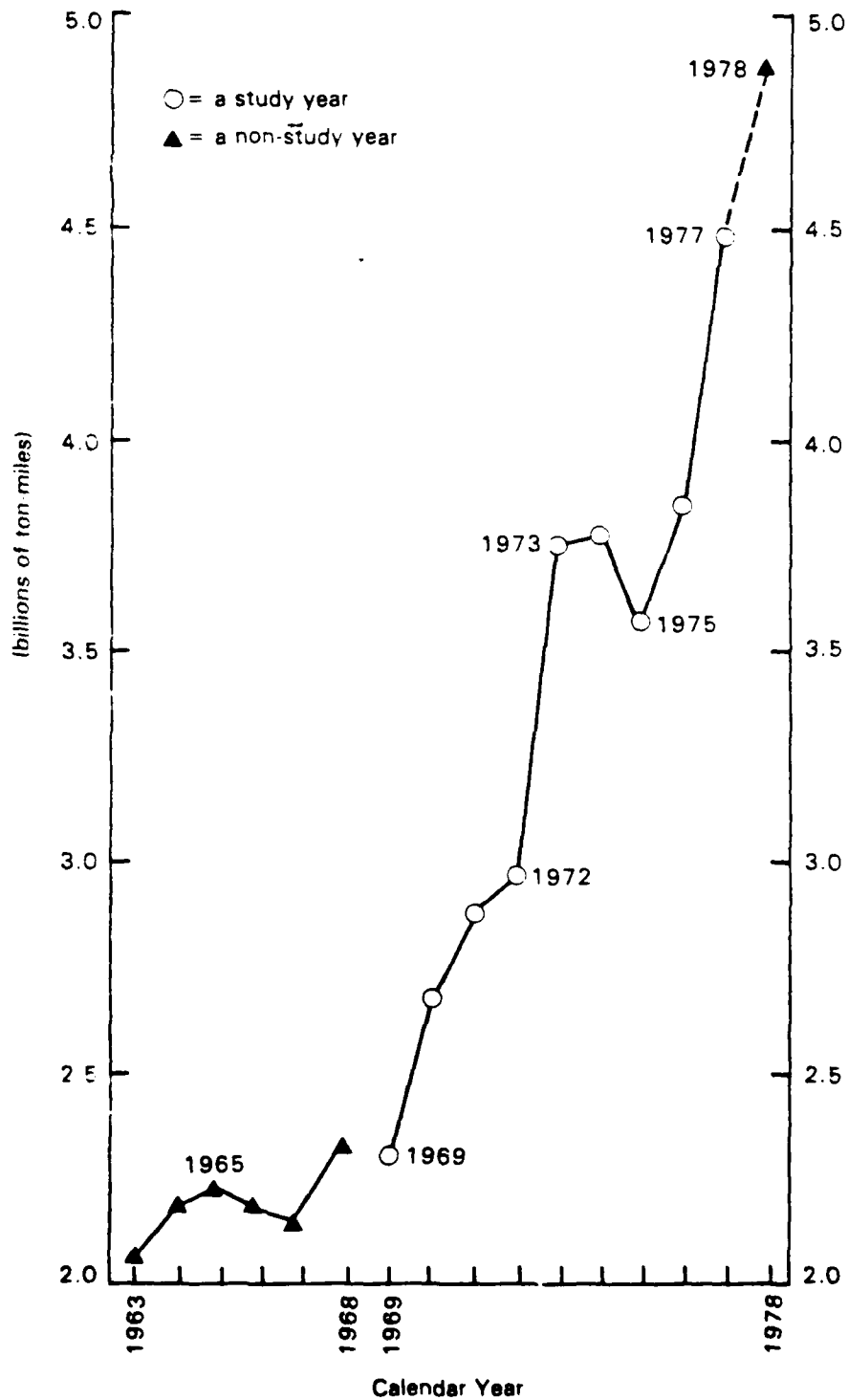


fig. 15

C. MEASURES OF RELATIVE SAFETY

Commerce and vessel transit data from the Corps of Engineers were used in developing "measures of safety" and when otherwise comparing economic trends and changes in shipping habits with the casualty record.

Measures of Relative Safety are considered important to VTS planning. These measures may indicate "harbor system saturation". It is hypothesized that an unsaturated harbor system can sustain either steady or temporary increases in activity (ie. transits, tons of commerce, etc.) while showing only slight changes in relative safety (The actual measures of relative safety presented in this report are casualties per unit of activity such as casualties per million tons of commerce moved. Since a higher value under this definition amounts to less safety; the term "relative dissafety" will be used to describe such results). If a harbor system is approaching or has reached saturation, its relative safety may begin to decrease, perhaps drastically. The consequences to harbor productivity as well as its safety might be devastating if this situation continues.

Since the Houston Ship Channel has been experiencing steady and rapid growth, measures of safety are of particular interest.

It is a goal of the VTS program to enhance good order in a VTS area. In an unsaturated system this will ideally mean an increase in relative safety. In a saturated or near-saturated system it may signify a reduced rate of decreasing safety, and that is shown in figure 10, in the trend line for preventable casualties after VTS. Another effect of good order, and this is only a suspected effect, is in the reduction of the number and/or severity of casualties which would be considered unpreventable by VTS. This study uncovered no evidence in support of this suspicion.

To generate measures of safety, COE data was divided by the data from the casualty analysis to give measures of relative dissafety; then it was presented by calendar year. Figures 16 through 24 present the results.

Figure (16) shows TOTAL CASUALTIES that occurred per ten-thousand transits. It is readily apparent that a Houston/Galveston mariner stood a more likely chance of having a casualty on a given transit as the years progressed--about twice as likely a chance in 1977 as in 1969. (In spite of the fact that 1969 had a significant amount of casualties that were due primarily to an unusually high number of unpreventable casualties. The number of casualties during 1969 was considered "unusually high" when compared with commerce and transit data, which were at the lowest level of the study. 1974 and 1975 show negative deviations from the trend upward yet correspond to reduced activity on the HSC. This is examined in detail in the following section which discusses Relationships).

Total Casualties Per 10 Thousand Transits

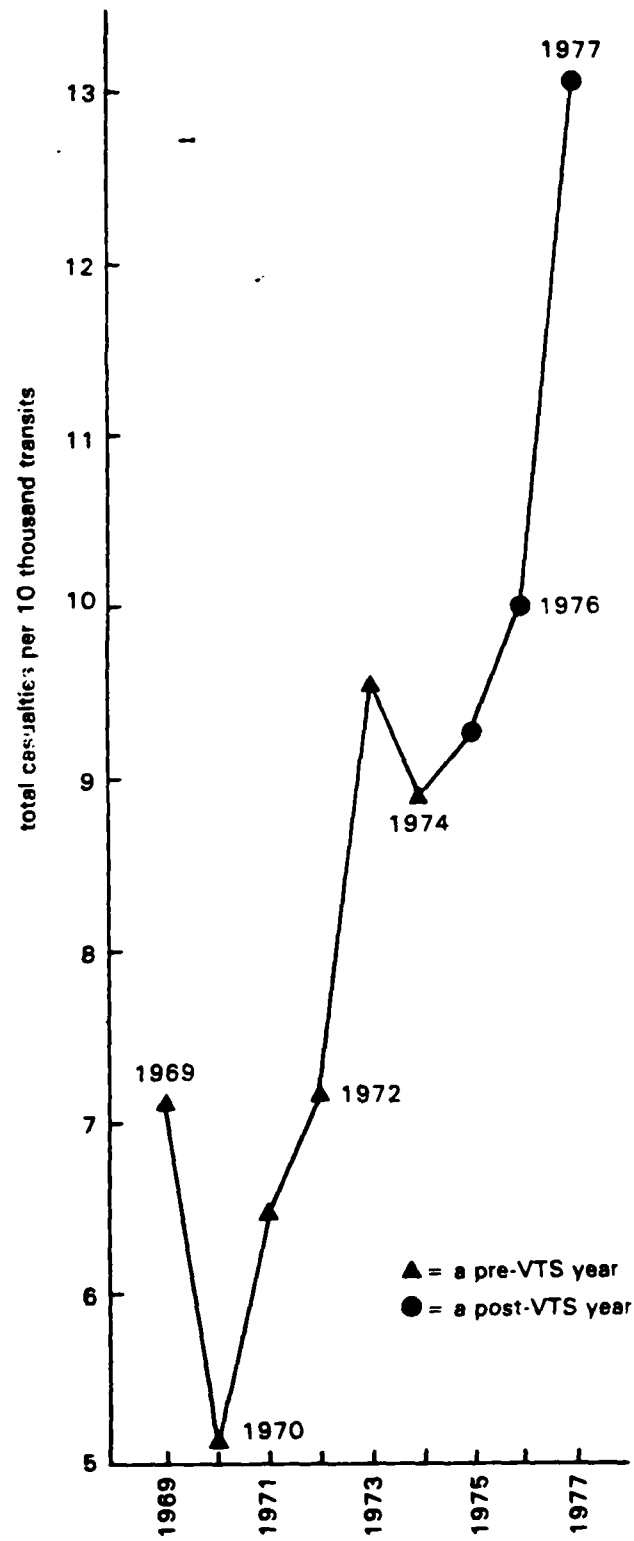


fig. 16

Figures 17 and 18 depict TOTAL CASUALTIES per ten million tons of commerce and per one billion ton-miles respectively. Again 1969 is still unusual in these measurements. While the increasing trend is less dramatic (via these measures of relative dissafety), it is still present.

Figures 19, 20, and 21, show the (same) measures of dissafety for unpreventable casualties. The results are very similar to those that are derived for total casualties. This is not surprising since the total casualty population is primarily comprised of unpreventable casualties.

Figure 22 shows the measures of relative dissafety derived from transits and preventable casualties. They are quite different from the corresponding results for the unpreventable and total casualties. Hypothetically it is expected that preventable casualties would respond to pressures on the harbor system as would unpreventable casualties. The least squares lines (trend lines, or lines that best predict the points) show that the pre-VTS trend of increasing measures of dissafety was as drastic for preventable casualties as it was for unpreventable and total casualties (the number of preventable casualties per transits had nearly doubled by 1974--whereas it took until about 1977 for the unpreventable casualties per transit to double). The post-VTS trend was notably lower.

**Total Casualties Per 10 Million Tons
of Commerce**

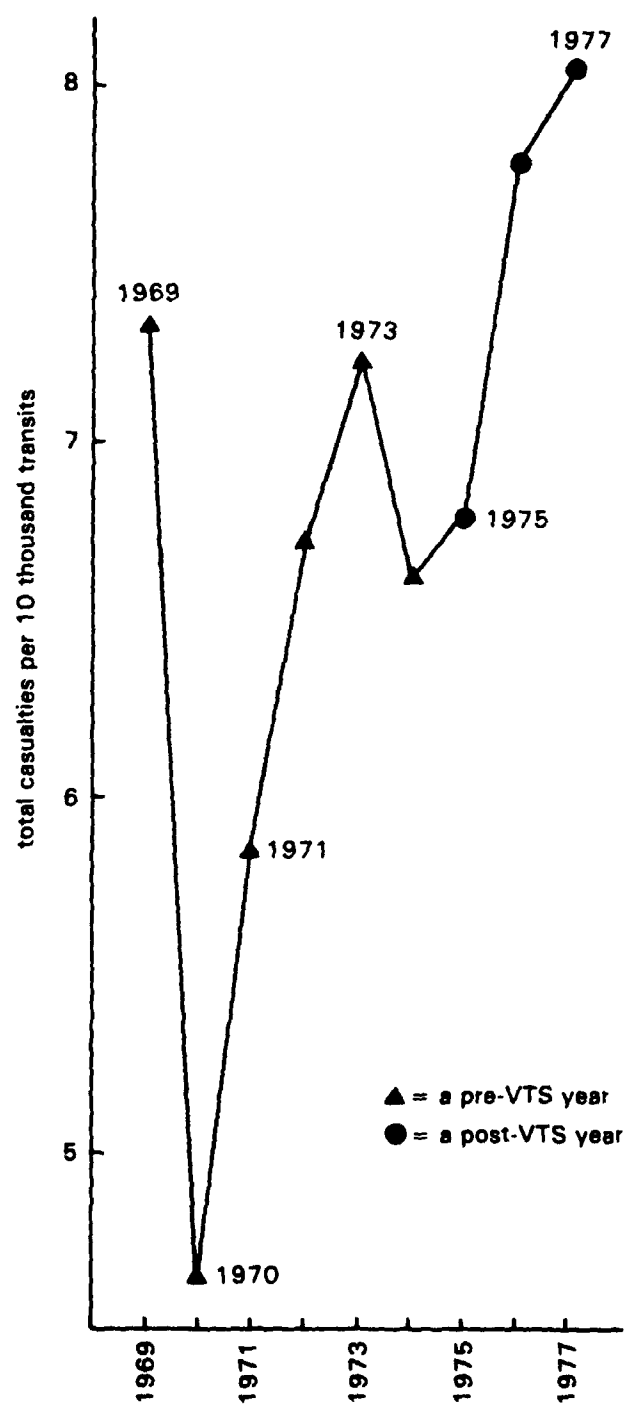


fig. 17

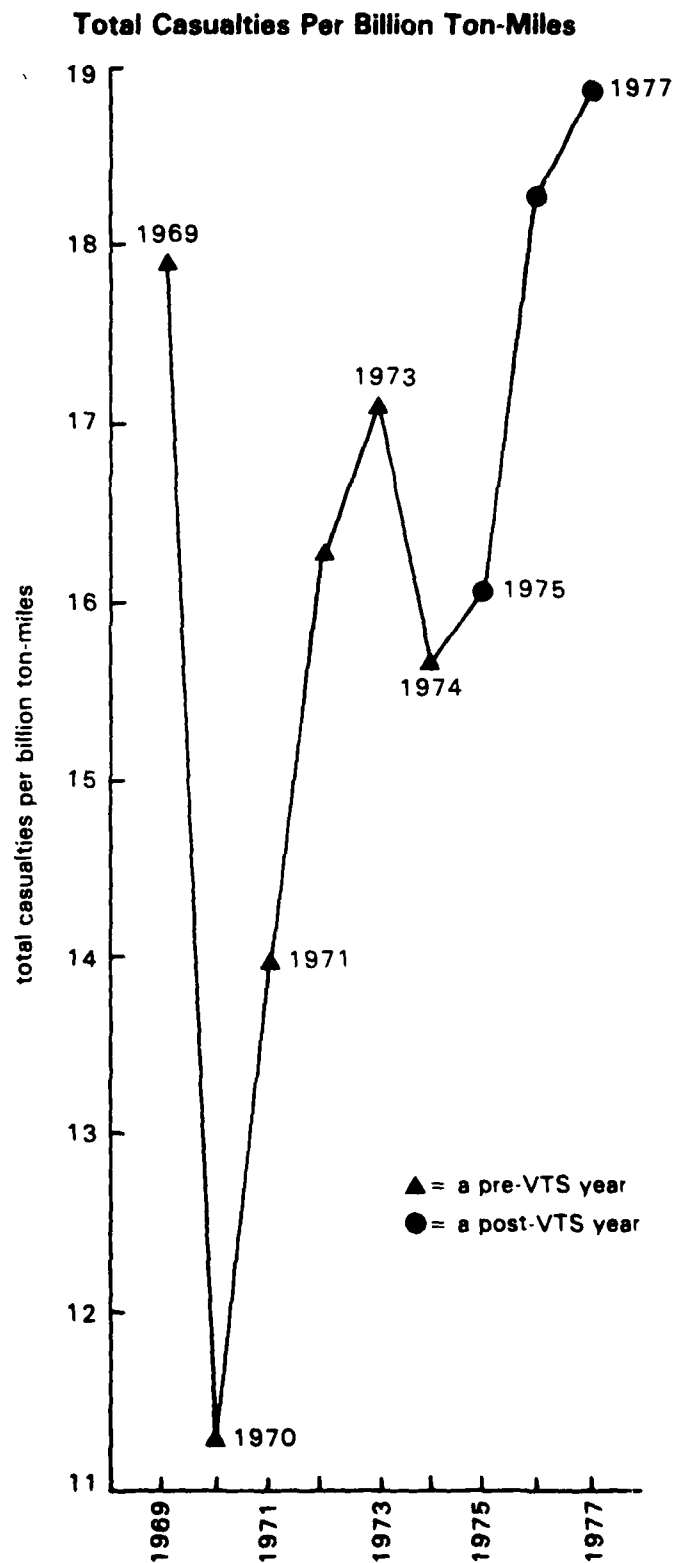


fig. 18

Unpreventable Casualties Per 10 Thousand Transits

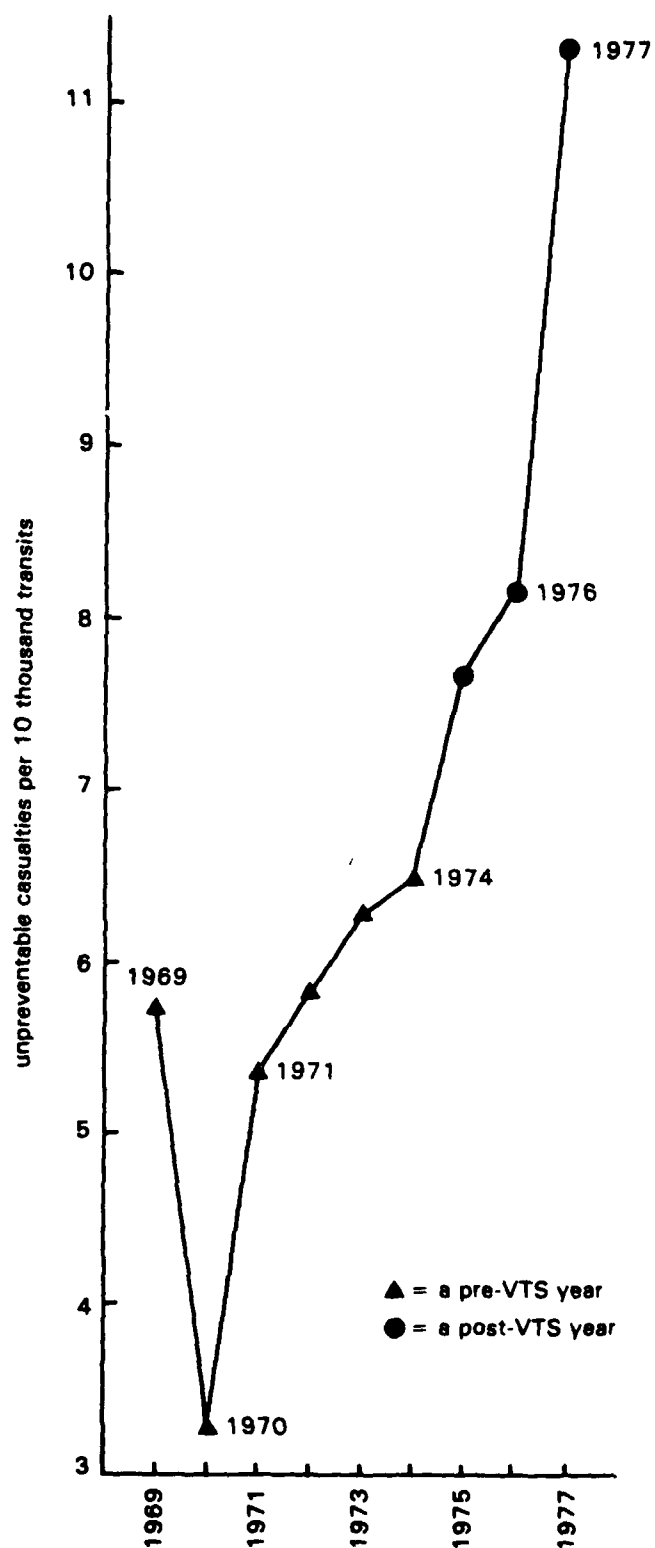


fig. 19

Unpreventable Casualties Per 10 Million Tons of Commerce

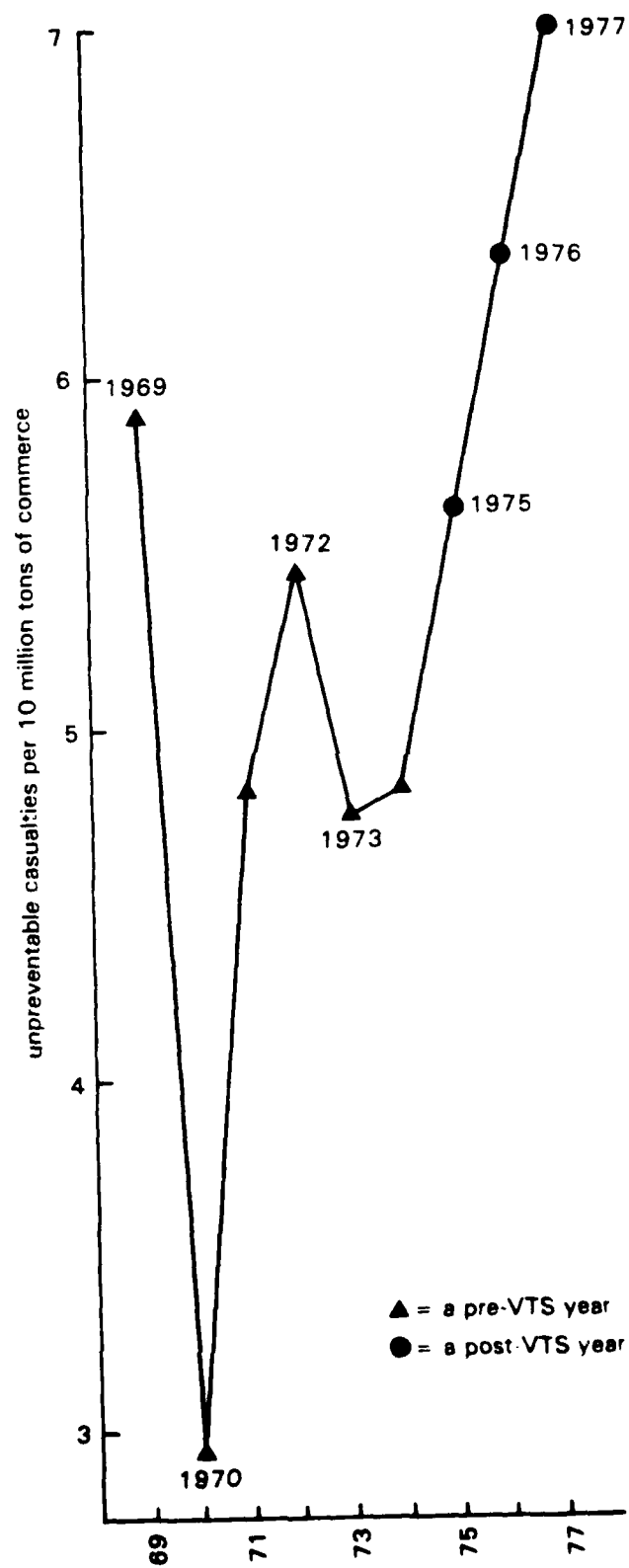


fig. 20

Unpreventable Casualties Per Billion Ton-Miles

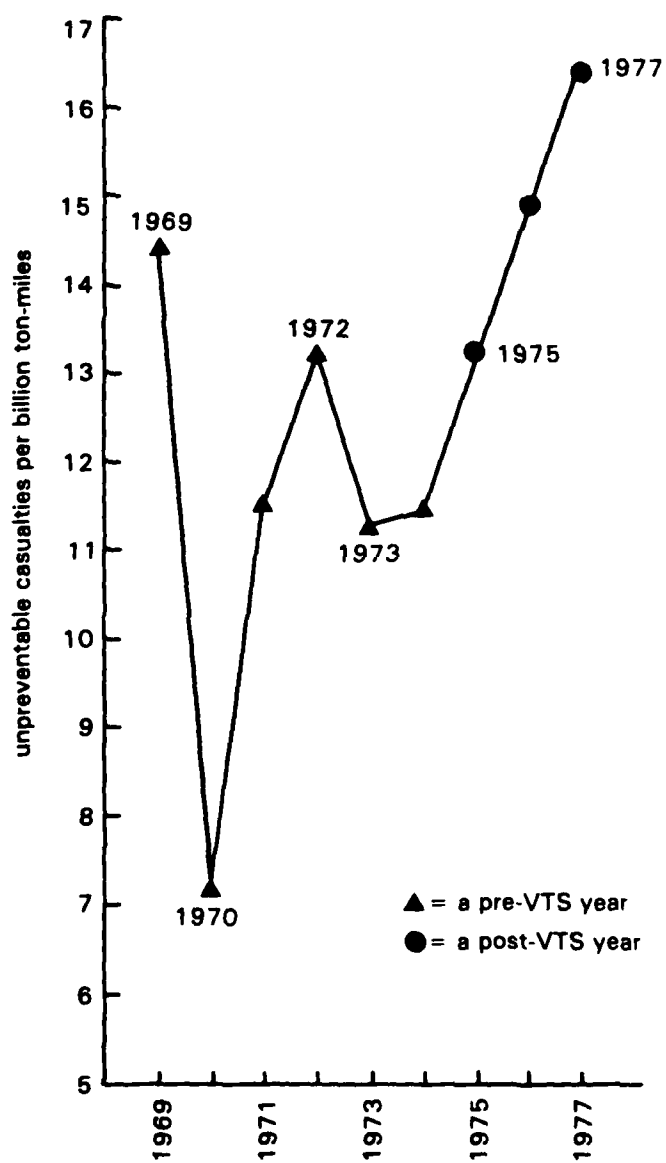


fig. 21

Preventable Casualties Per 10,000 Transits

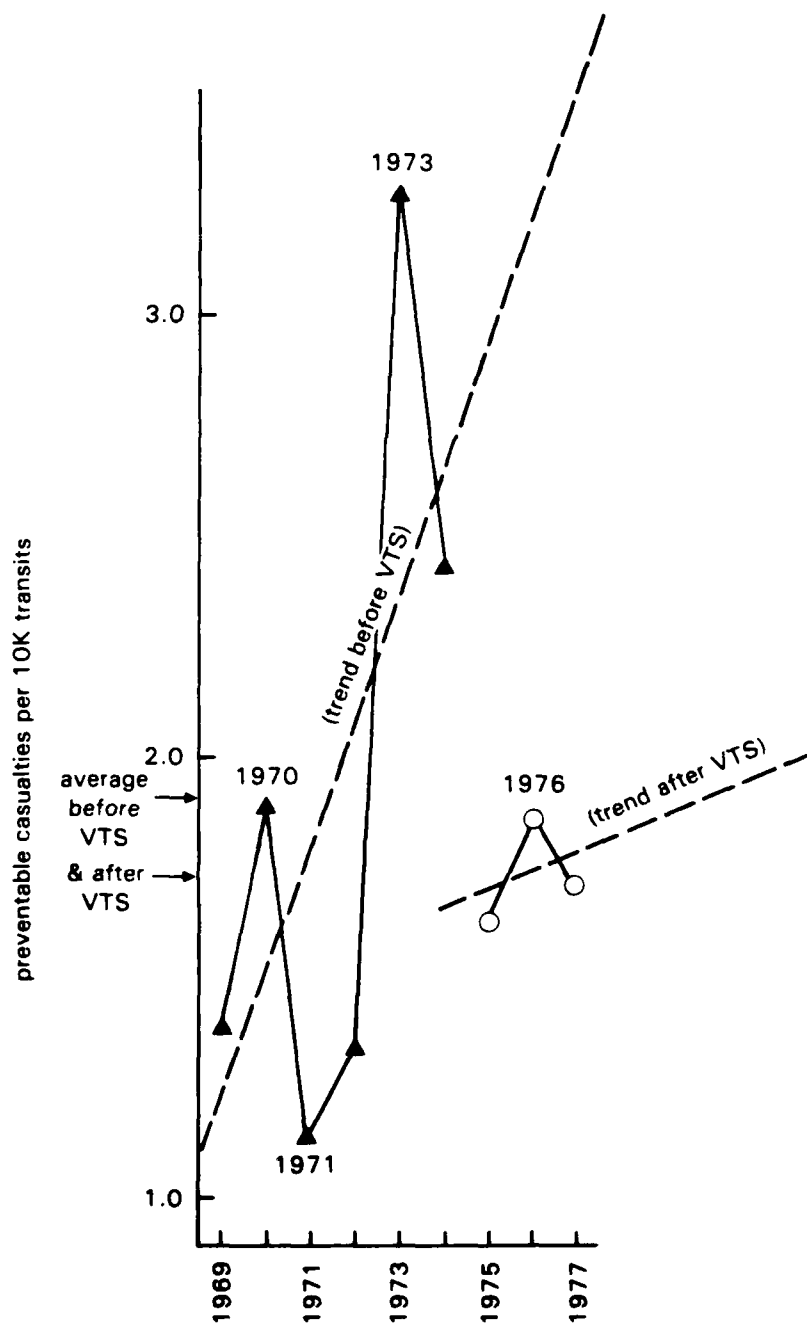


fig. 22

Figures 23 and 24 show relative dissafety as derived from preventable casualties per tons of commerce and ton-miles respectively. The results are similar to those discussed above except that the post-VTS trend shows declining dissafety (improving safety).

Looking at the various trends in measures of dissafety that were derived from preventable casualties, reveals that the actual measured values are often quite different from the values expected by the trend lines. This is due in part to the small number of preventable casualties and the few years of data available. In defense of these positive results it should be noted that the trends for pre-VTS preventable casualties are remarkably close to the results for unpreventable and total casualties which showed good correlation over the years. Conversely, the post-VTS trends were quite different and optimistic. Further, if trends are completely rejected (assumes that the measures of relative dissafety based on preventable casualties are completely insensitive to whatever forces were causing increases in unpreventable casualties) it still can be shown that the average measures of dissafety are less for the years after VTS (figures 22, 23 & 24).

Preventable Casualties Per 10 Million Tons of Commerce

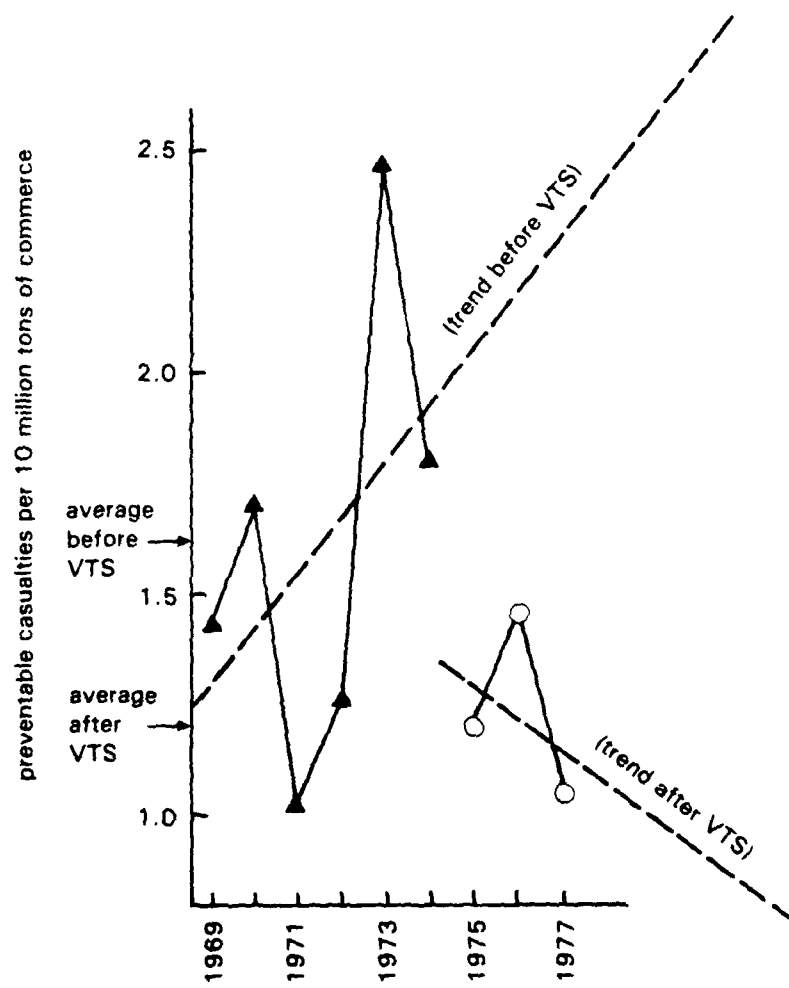


fig. 23

Preventable Casualties Per Billion Ton-Miles

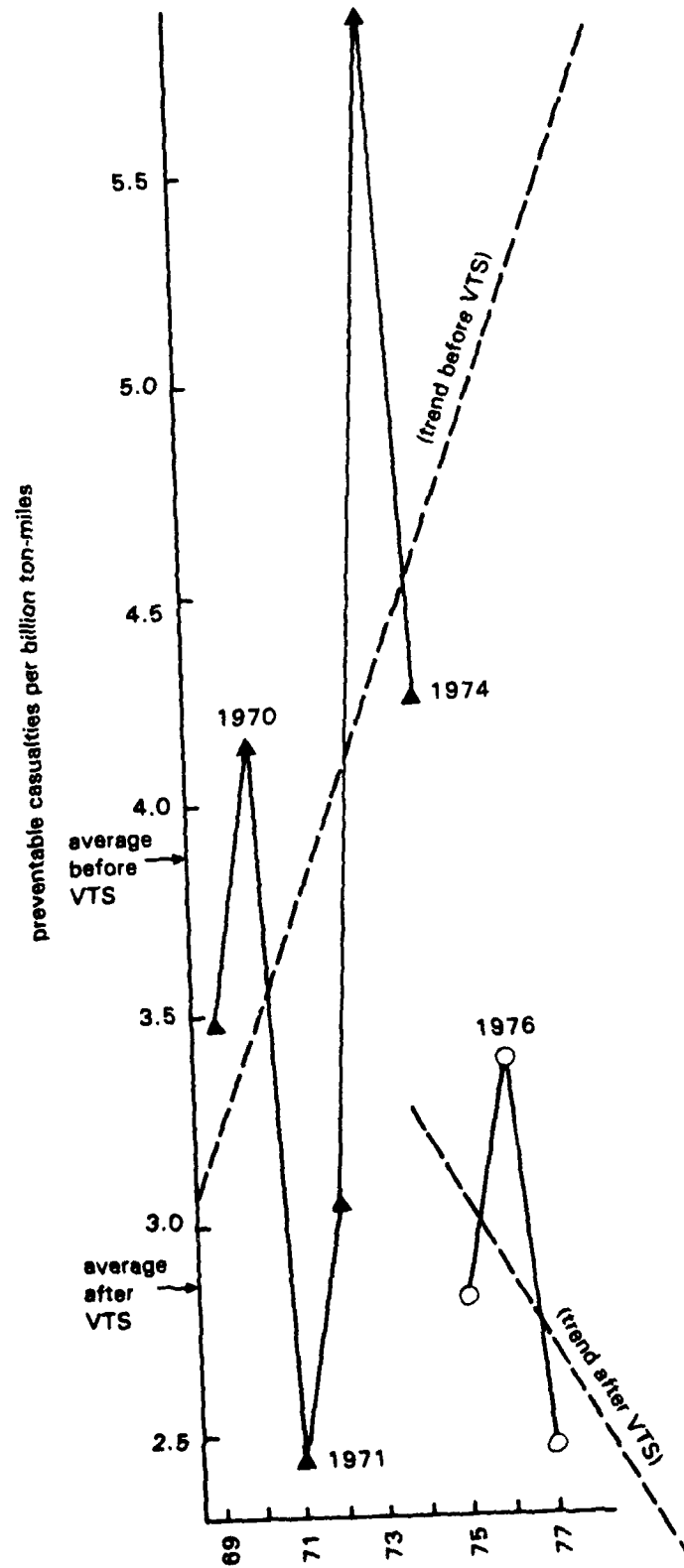


fig. 24

D. RELATIONSHIPS & PREDICTING NUMBERS OF CASUALTIES

All of the data to this point has been presented by fiscal year or calander year. While there are certain trends over the years, it is not the year itself that explains the number of casualties. An effort was made during this study to uncover relationships between the casualty figures and the COE data by using the COE data as predictors.

In the previous section measures of relative safety were explored. The investigation eventually led to the question: Is the number of casualties related to harbor activity?

By factoring out the years in the data and attempting to develop formulas which predict the number of casualties based on COE data this question can be explored.

At the outset, no such predictor was expected since the risk of casualty is generally regarded as a complex matter. On the other hand it had been noticed that the casualty trend showed some resemblance to the commerce trend, as already discussed. Further there seemed to be some relationship between casualties and, increasing commerce in conjunction with decreasing transits.

Therefore the first two relationships tried were total casualties versus:

1. $(C^2/T)^{0.5}$ where T = transits;
 and C = commerce in tons
2. (C/T)

These yielded poor results. Patterns appeared but with tightly grouped clusters of points and substantial errors of estimation. The third relationship tried was:

- ### 3. (T x C) versus total casualties

With the exception of the 1969 data this relationship yielded excellent results (fig.25). The coefficient of correlation for the data, including the 1969 results, was 0.93. Considering the number of data points, this is a strong correlation and rates some notice. Since the 1969 datum was so out of line with the other data (and since the relationship is not y essential to the VTS effectiveness question which was to be kept conservative) the 1969 data was discarded as an anomaly and the correlation recalculated as 0.98.

Transits x Commerce (Tons)
 10^{12}
Versus
Total Casualties
(Including the 1969 Data)

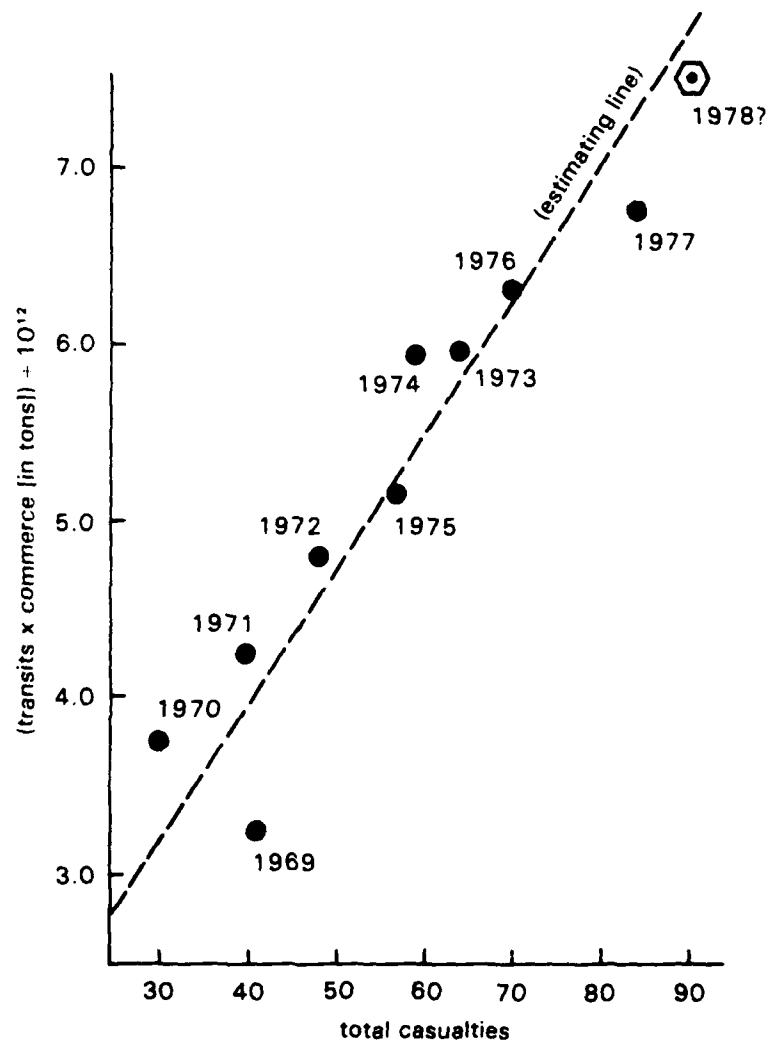


fig. 25

Next, the Least Squares Line was computed and gave a slope of 16.09 casualties per 10^{12} transit-tons. The intercept was calculated to be a negative 29.53 casualties at zero transit-tons. This intercept value indicates that the relationship being explored does not hold true for the infinite range of transit-ton figures, since a negative value for casualties is impossible even in the event of no vessel movements! While the useful range of this relationship could not be determined during this effort it could be further explored in future studies of this or other ports.

Using the slope and intercept above, the following formula was determined for predicting casualties based on transit and commerce data:

$$\text{CASUALTIES} = 16.09 [T \times C(\text{tons})/10^{12}] - 29.53$$

This formula was used to predict the measured values for the years 1970 through 1977 (fig.26). The predicted values were then used to calculate the standard error of the estimate:

= the square root of [(the sum of the squared differences between the calculated and measured values of Y) divided by (the number of data points)].

Transits x Commerce (Tons)
 10^{12}
 Versus
 Total Casualties

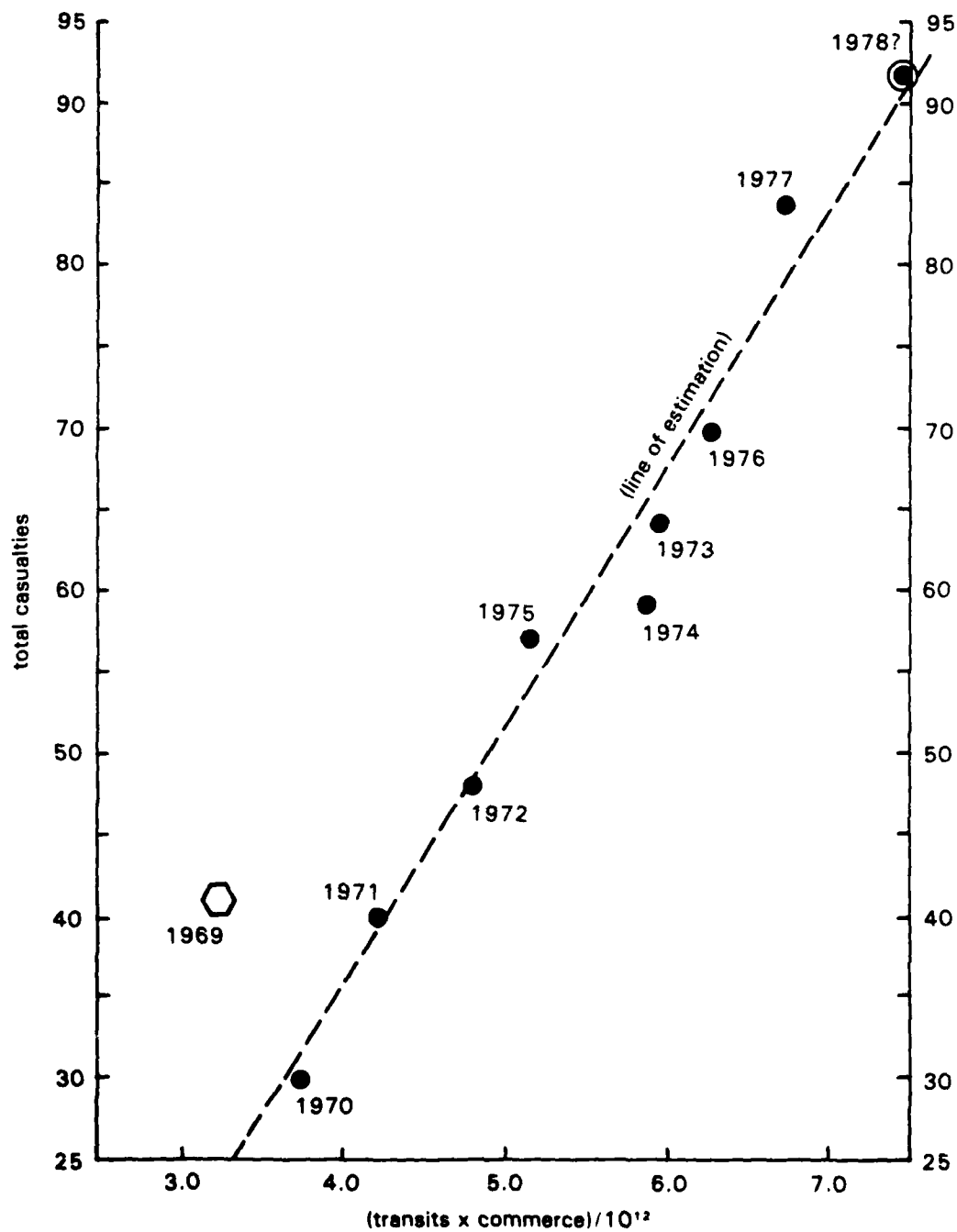


fig. 26

This yielded a value of ± 3.46 casualties. For the 95% confidence level this would be ± 6.9 casualties. A more conservative error estimate for small data populations substitutes "the number of data points - 2" for "the number of data points" in the calculation of the standard error of estimate, and yields a value of ± 8 casualties at 95% confidence.

Using the above formula to predict the number of casualties in 1978 gave a value of 91 ± 8 casualties. A preliminary review of available 1978 casualty data (which was nearly complete by the end of the study effort) indicates that this figure is approximately correct.

The importance of this formula is questionable in that it has not been established for a wide range of transit and commerce values, and it has not been evaluated in different ports. In the long-term, further examination, enhancement, or rejection of this relationship will be of interest to waterways management. The significance that is given at this time is that there does seem to be an important relationship between commerce & transits, and casualties. This helps to verify what is naturally suspected: that casualties have been on the increase in the Houston/Galveston area, and that this is largely in response to increased shipping activity.

Encouraged by these results, a number of other relationships were also explored. Figures 27 through 32 show the use of either transits, commerce tonnage, or ton-mileage, as the only independent variable used to predict total casualties (fig.27, 28 & 29) and unpreventable casualties (fig.30, 31 & 32). These also yielded good results with transits showing the weakest correlation to both unpreventable and total casualties. This is surprising if one considers the transits at a given time to be more important to safety than the loads being carried. This can be reconciled though. As was the case with total casualties, use of both transits and tonnage as independent variables (fig.33 & 34) yields excellent results in predicting unpreventable casualties (NOTE: In the formula where doubled commerce is added to transits, transits and commerce were first factored unequally to achieve relatively equal importance in the formula).

Perhaps the best relationship for predicting total casualties, unpreventable casualties, or pre-VTS preventable casualties is:

$$\text{Casualties} = \text{Commerce} \times 2 + \text{Transits}$$

This relationship can be used to generate three formulas for the three types of casualties above with correlation coefficients of 0.98, 0.92, and 0.82 respectively. (~~See appendix #VI, 14816~~)

Total Casualties Versus Ton-Miles

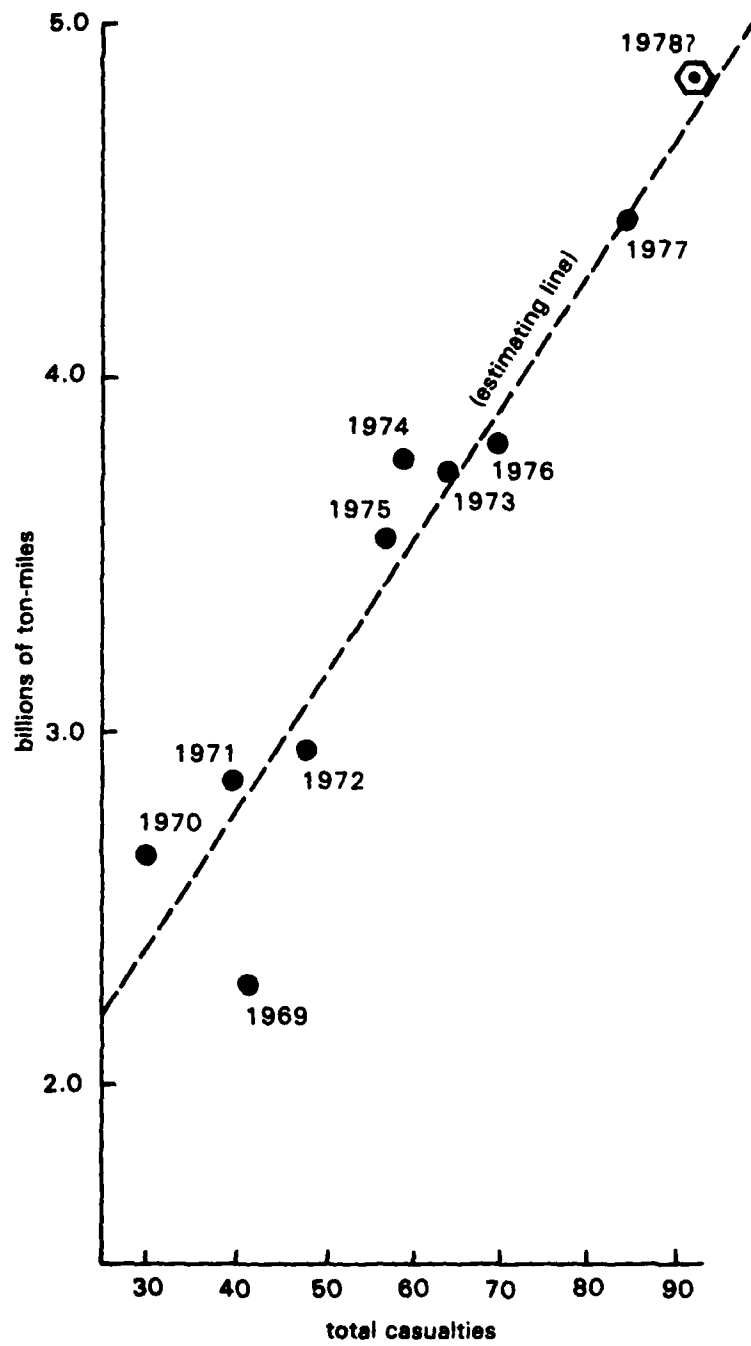
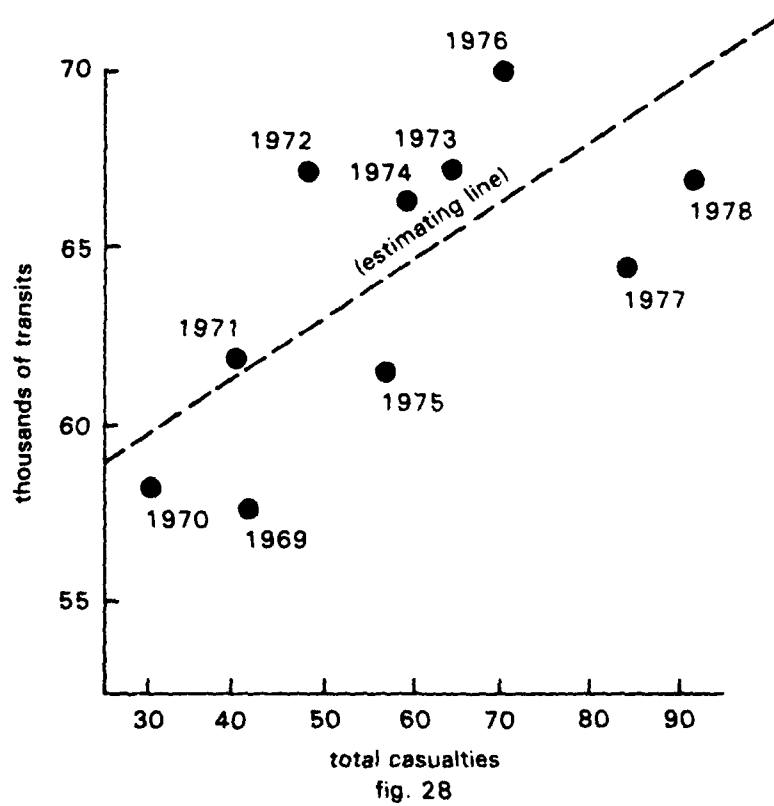


fig. 27

Total Casualties Versus Transits



Total Casualties Versus Commerce

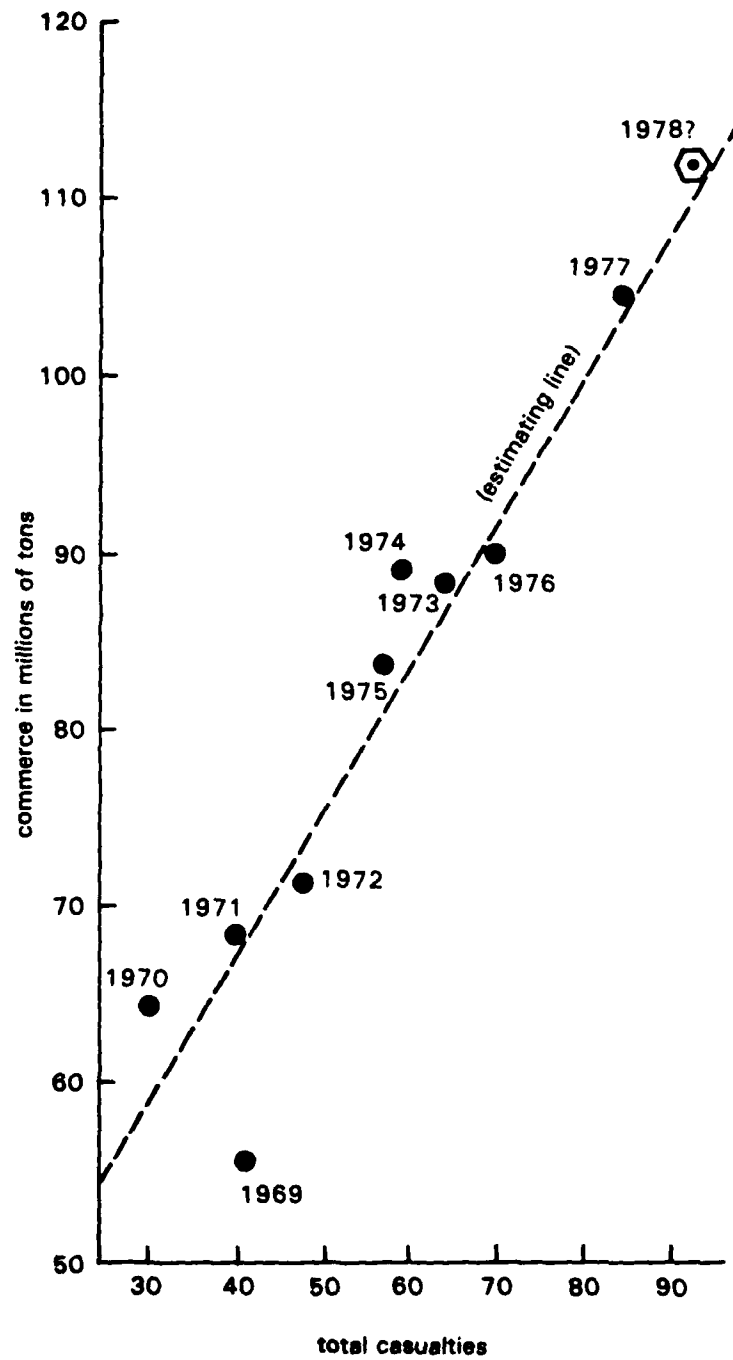
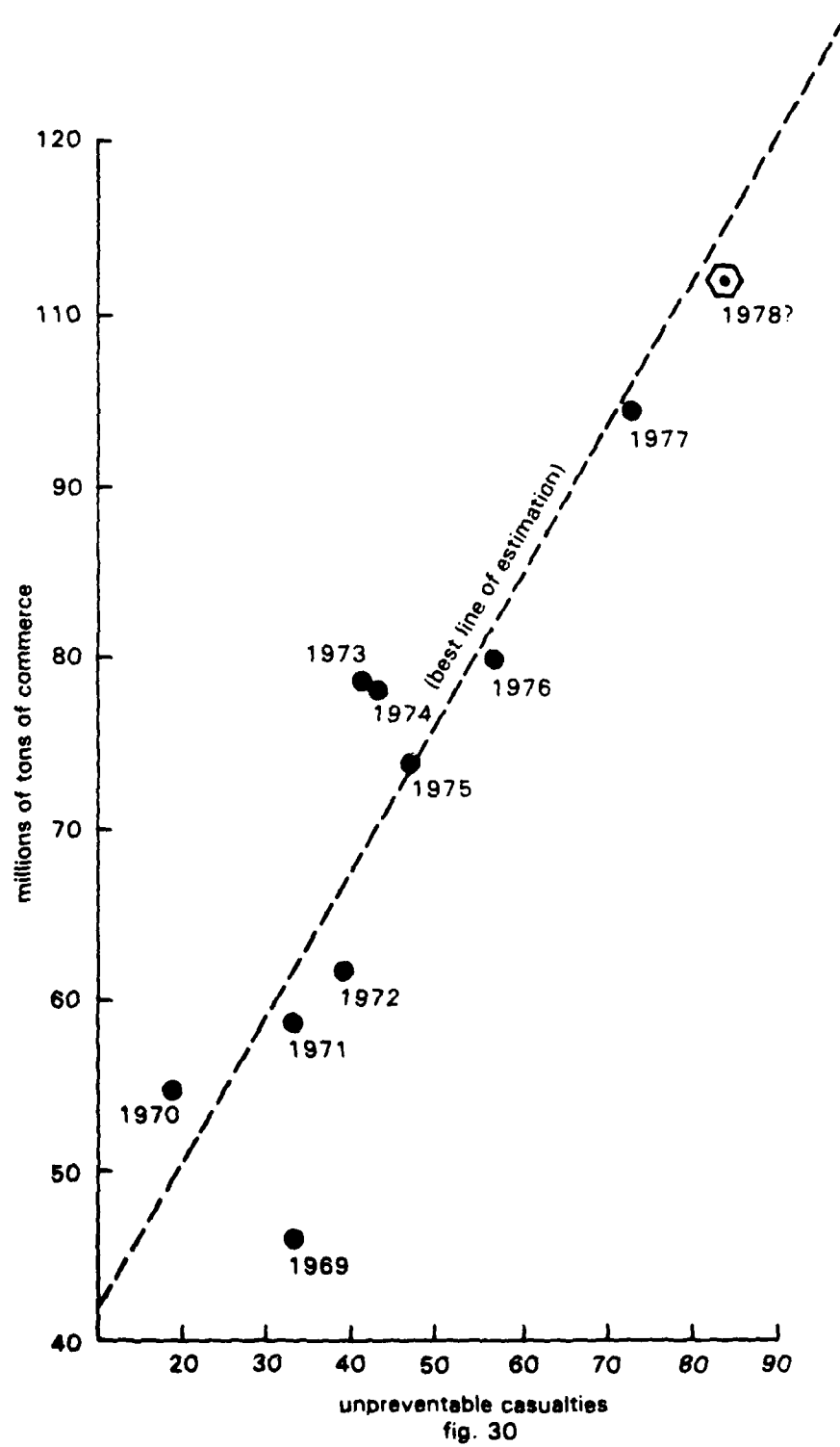


fig. 29

Commerce Versus Unpreventable Casualties



Unpreventable Casualties Versus Ton-Miles

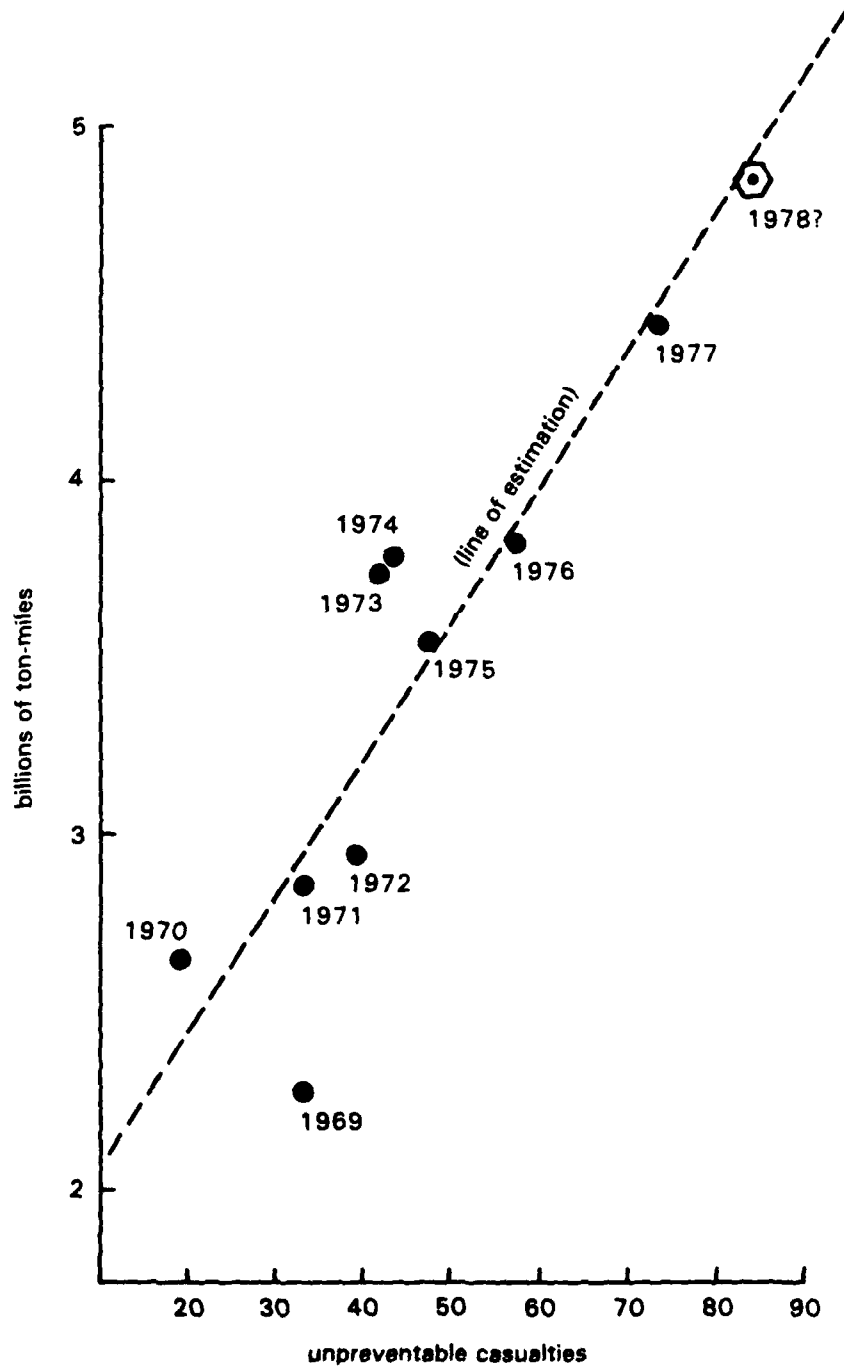


fig. 31

Transits Versus Unpreventable Casualties

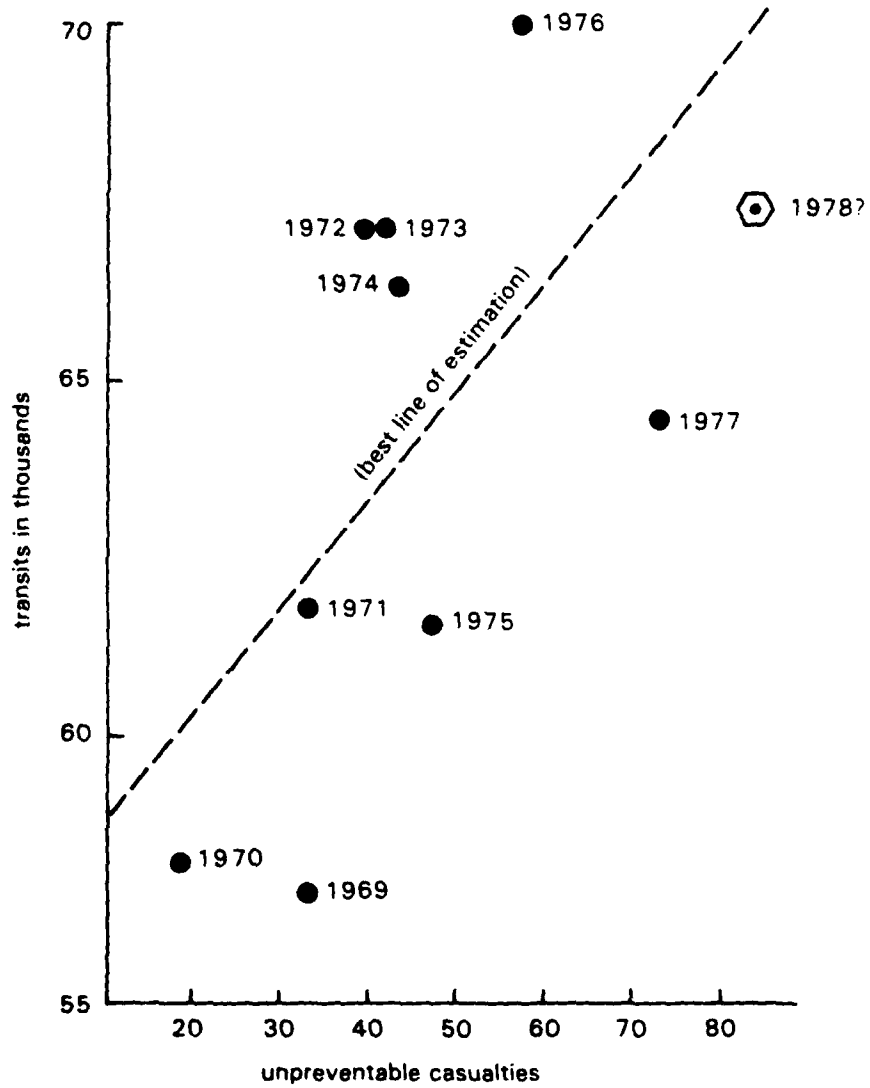


fig. 32

Transits x Commerce Versus Unpreventable Casualties

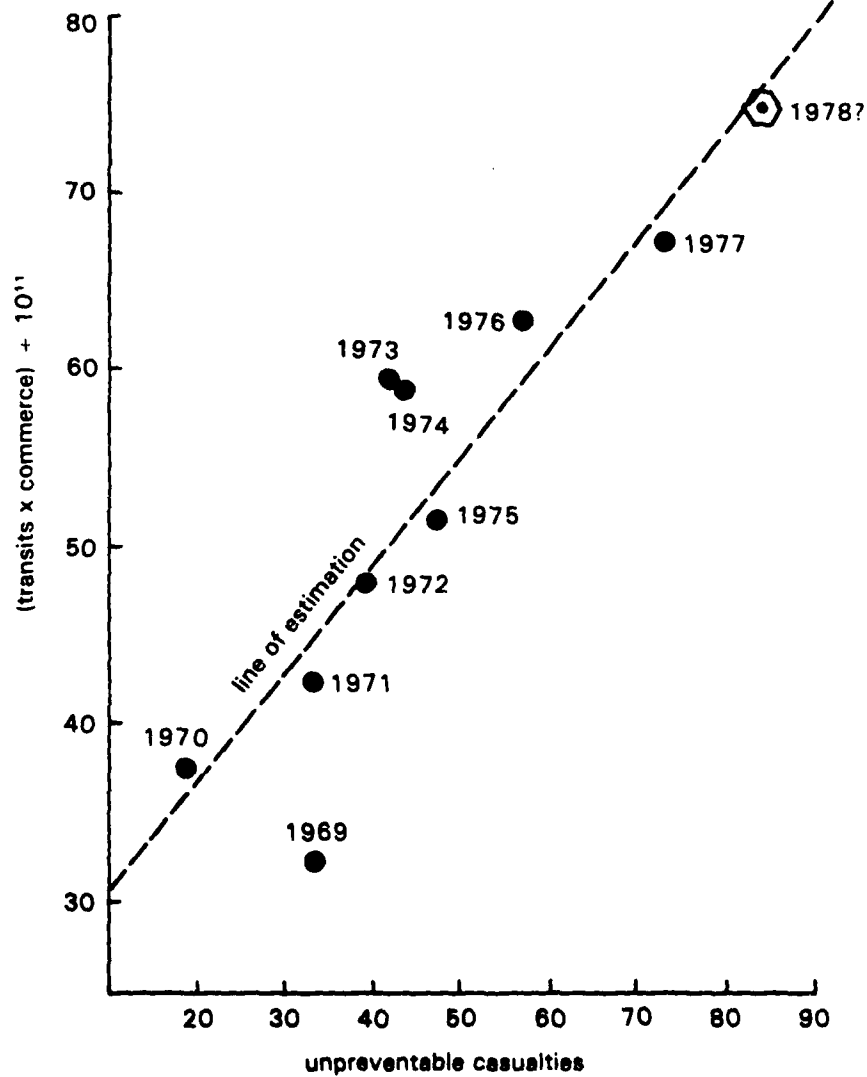


fig. 33

(2 x Commerce) + Transits Versus Unpreventable Casualties

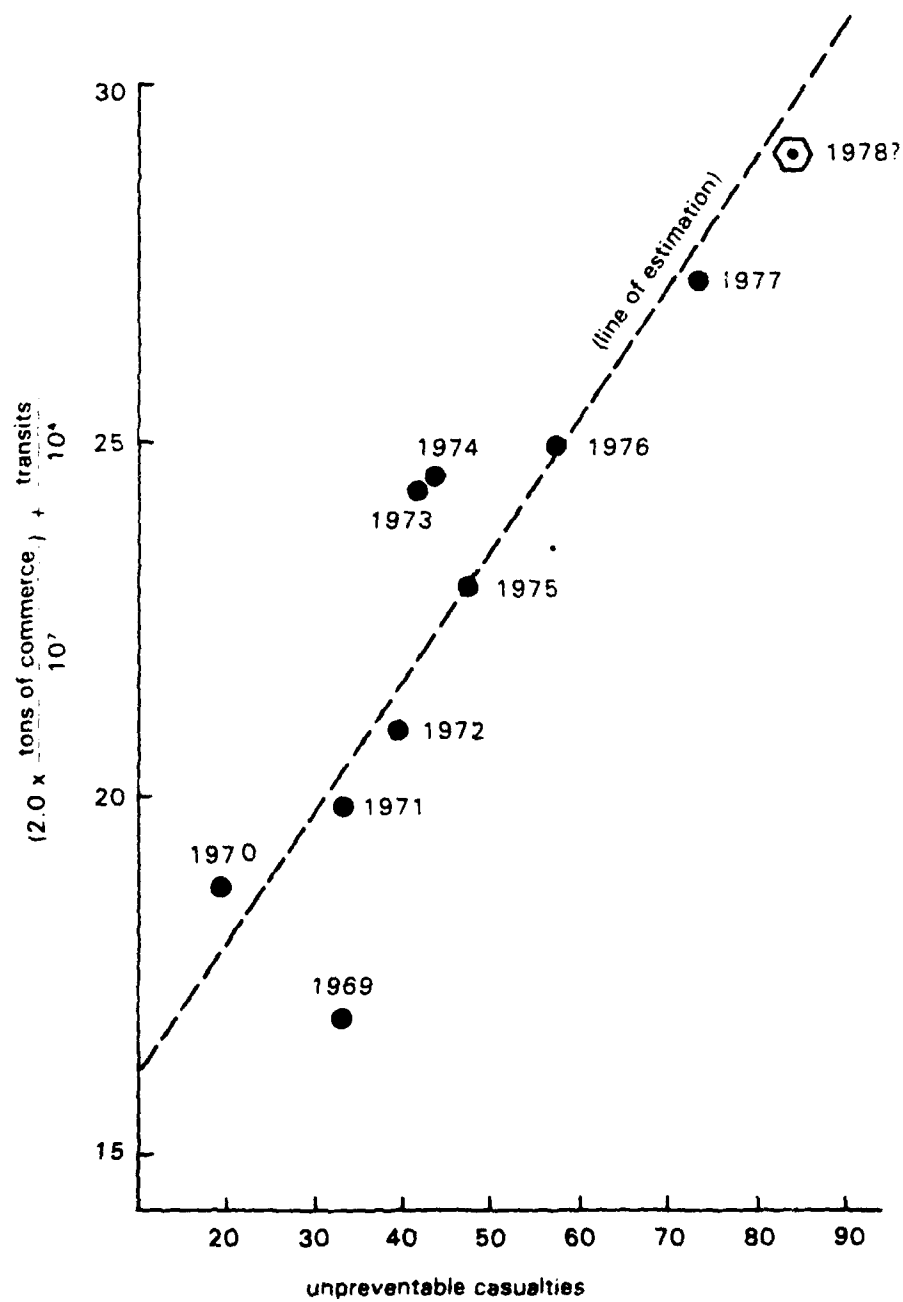


fig. 34

E. BENEFITS

Examination of the casualty record by year, makes it readily apparent that total and unpreventable casualties are on the increase. It is shown in this report that relative safety is also declining in response to these increases. Two notable exceptions are the year 1969 which has an anomalously large population of unpreventable casualties; and the year 1975/74 where a casualty decline occurred but with a corresponding decline in commercial activity. It is equally apparent that these trends must be recognized in order to estimate the benefits of the VTS.

The first step in estimating the VTS benefits was to establish the strength of the increasing trends in casualties. Figure 35 shows the values which apply to casualties versus years.

	Mean	Standard Deviation	Correlation Coefficient
preventable casualties before VTS	12.17	5.78	0.69
unpreventable casualties before VTS	34.83	8.86	0.75
total casualties before VTS	47.00	12.71	0.84
preventable casualties after VTS	11.33	1.53	0.33
unpreventable casualties af "S	59.00	13.11	0.99
total casualties after VTS	70.33	13.50	0.9999
preventable casualties for all years	11.89	4.65	0.30
unpreventable casualties for all years	42.89	15.43	0.91
total casualties for all years	54.78	16.81	0.91

fig. 35

(see also appendix VI, 1, 2 & 3)

Looking at the correlation coefficients it can be seen that:

Point #1—the strongest correlations are for unpreventable and total casualties considered for the post-VTS years (showing near perfect correlation). As might be expected, these cases showed high standard deviations from the mean (or no-trend hypothesis).

Point #2—strong (>0.9) correlations also occurred for unpreventable and total casualties considered for all years. These cases also showed high standard deviations from the mean.

Point #3—The poorest correlations, and the smallest standard deviations, are found in the post-VTS preventable casualties.

Point #4—poor correlations and small standard deviations were also found in preventable casualties considered for all years.

Point #5—The pre-VTS unpreventable, total, and preventable casualties showed some correlation and considerable standard deviation.

The points were interpreted as follows, for:

Point #1—during the post-VTS years the unpreventable and total casualties were most certainly increasing steadily.

Point #2—for all years considered there is good reason to believe that total and unpreventable casualties have been steadily increasing.

Point #3—statistically this would indicate that the mean (or no-trend hypothesis) is as good a predictor as the least square line. Therefore, after the VTS went on line the preventable casualties were stabilized at a low level with little or no tendency for increase. However, in order to give a conservative estimate of VTS benefits it was assumed that the preventable casualties were still increasing as described by the least squares line.

Point #4—either preventable casualties have been insensitive to the pressures that are increasing the total casualty population; or these pressures have been counteracted (presumably by the VTS).

Point #5—the pre-VTS years do not show as strong a correlation as would be desirable for projecting 10 year benefits. In the cases of total and unpreventable casualties before VTS this is due largely to the 1969 anomaly, and is not critical to the benefit projection. For the pre-VTS preventables it justifies the conservative estimate (the sensitivity of these measures is discussed in the text.)

To summarize the interpretations that are most important to the projection of benefit:

- Casualties steadily increased during the study years especially in the post-VTS years.
- Preventable casualties in pre-VTS years were increasing, as were all casualties during those years
- Preventable casualties in post-VTS years were still increasing, as were all casualties during those years.

ESTIMATION OF BENEFIT FROM "PREVENTABLE CASUALTIES THAT DID NOT OCCUR"

From the regression analysis a pre-VTS trend was derived that estimated an annual increase of 2.14 preventable casualties per year before VTS. The analysis also showed that in the year 1990 (Y intercept) the value for preventable casualties would have been -141.04762. (NOTE: The preventable casualty number is not "truly" dependent on the year but other factors as already demonstrated. The purpose of predicting the 10 year trend is to determine a rate of benefit accumulation for the first three years of VTS operation). The post-VTS years gave a trend of 0.5 annual increase in preventable casualties and a Y intercept of -26.6667.

Using the values stated, two formulas can be described for estimating the number of preventable casualties in a given year. They are:

$$\begin{aligned} \text{pre-VTS --- casualties} &= 2.143 (X) - 141.048 \\ \text{post-VTS -- casualties} &= 0.500 (X) - 26.66666 \end{aligned}$$

where the value for the year is designated by the variable "X". Therefore the expected total number of preventable casualties from 1975 through 1985 from the pre-VTS trend can be expressed by the first integral of the equation:

$$2.143 (X) - 141.05 \, dX;$$

or the evaluation of that integral:

$$\int_a^b 1.07 (X)^2 - 141.048 (X) \, [see \, note \, pg.44]$$

The total number of casualties from 1975 through 1985 at the post-VTS rate can be expressed by the first integral of the equation:

$$0.5 (X) - 26.6667 \, dX;$$

or the evaluation of that integral:

$$\int_a^b X^2/4 - 26.6667 (X) \, [see \, note \, pg.44]$$

NOTE: The period of the evaluation of the integrals is denoted by "a" & "b" where: a = the year CY74.5, and b = the year CY84.5. The reason these years were used in lieu of 1975.0 and 1985.0 was that the instantaneous rate at 1975 represents the years average or the rate at mid 1975. Therefore, to solve the integration from the beginning of 1975 the period of the solution must begin at the rate between 1975 and 1974... or 1974.5. Similarly for the end of the period of the solution.

The difference between the evaluations of the two integrals is then equal to the casualties which are estimated to not occur during the 10 year VTS lifecycle. The final solution then (using 8 place accuracy) is:

$$\begin{aligned} & [(1.0714286 \times 84.5^2 - 141.04762 \times 84.5) - \\ & (1.0714286 \times 74.5^2 - 141.04762 \times 74.5)] - \\ & [(0.25 \times 84.5^2 - 26.666667 \times 84.5) - \\ & (0.25 \times 74.5^2 - 26.666667 \times 74.5)] = \end{aligned}$$

162.26194 preventable casualties.

This solution was also verified by using the two trend lines to find the difference in expected casualties year-by-year and then summing them... with very nearly the same result.

The next step in estimating the benefits of the VTS was to determine the cost of a preventable casualty. For each of the update years (FY 73 - 78) the dollar damages from preventable casualties were summed and adjusted to FY 81 dollars. The results of these adjustments gave a total value of 5.80244M FY-81 dollars for all preventable casualties over the update years.

Figure 36 shows the results for predicted savings of the Houston/Galveston VTS for 10 years. Using the 5.80244 we found that the average cost of a preventable casualty was \$74K. Multiplying this amount by the potential casualties prevented by VTS, 162, and by a correction factor of three developed by this study group using information obtained from the Analysis Of Port Needs Study and other sources, the estimated total savings for the 10 year period is \$36.0M. The methodology used in determining the correction factor is discussed in the Sensitivity section.

The 10 year costs of constructing and operating the VTS are shown next with construction costs being \$4.5M and operating costs 12.0M, for a total ten year operating cost of \$16.5M. This gave an estimated benefit of \$19.5M or a Benefits to Costs Ratio of 2.2 to 1.

Predicted Savings (10 Yr Lifecycle)

$$\begin{aligned}\text{Average Cost per Casualty} &= \frac{\text{Total Damages for Preventable Casualties}}{\text{Number of Preventable Casualties}} \\ &= \frac{5.80\text{M}}{78} = 74\text{K per Casualty}\end{aligned}$$

Potential Casualties Prevented by VTS (10 ys)	162
Cost per Preventable Casualty	74K
Correction Factor*	<u>x 3</u>
Total Savings (10 yr lifecycle)	\$36.0M
AC&I Cost of Houston/Galveston VTS	\$ 4.5M
Operating Costs (1.2M per yr x 10 yrs)	<u>\$12.0M</u>
Total Operating Costs	\$16.5M
Estimated Benefits	\$19.5M
Benefits to Costs Ratio	2.2 to 1

*Correction factor developed in the *Vessel Traffic Systems Analysis of Port Needs* and modified by this study group

fig. 36

F. SENSITIVITY

In this section we will discuss the various factors used by this study group in analysing and evaluating the results of the casualty analysis.

1. Accident Prevention Determinations

To ensure that our criteria (used in making accident prevention determinations) corresponded with the criteria used in the Vessel Traffic Systems Analysis of Port Needs, the last year of the Port Needs Study (FY 72) was reviewed by this study group. Of the 36 cases reviewed, identical determinations were made in 35 cases. This represents a 97% agreement on accident prevention determinations.

2. Correction Factor

In both the previous two studies, the Vessel Traffic Systems Issue Study and the Vessel Traffic Systems Analysis of Port Needs, a correction factor was used to give a better estimate of the actual losses from a casualty. In the Issue Study a factor of five was used, and in the Port Needs Study a factor of four was used.

This study group reexamined all the data available and determined that sufficient improvements had been made in the Coast Guard's reporting system to warrant changing the correction factor to three. The basis for this conclusion is as follows:

a. Commandant Instruction 5943.7

This instruction, released on 3 April 1972, stated that the Coast Guard was receiving only 30% of the actual casualties and that there was a large discrepancy in the reported damage and the actual damage. It goes on to say that the loss/damage to the vessel is the Actual Physical Damage and does not include dry-docking, man hours loss, cost per day, etc. Vessels that are declared a total loss only show the actual damage to the original vessel, not the replacement cost of the vessel.(See Appendix II)

b. Cost of Repair Study by Coast Guard in 1971

The Vessel Traffic Systems Analysis of Port Needs indicated that the Coast Guard had undertaken a study to compare actual versus estimated damages in 1971. The study indicated the estimates were about half of the actual damage. (used in Port Needs Study to justify a factor of 4)

c. Presence of the VTC

The study group felt that the presence of the VTC and the fact that the mariner knew he was under possible surveillance encouraged the reporting of 'routine' ramming and grounding. The VTC presently has a policy of reporting to the Marine Safety Office all noted vessel casualties involving VTS participants.(Used in this update to justify a factor of 3)

As the Commandant Instruction was released only 3 months before the period of this update the information can be assumed valid for at least the first few years of the analysis. In addition the VTS was not on line during the first two years of the update and any benefit from the presence of the VTC would not be felt until 1975.

A typical example of costs not reported would be the case involving the total loss of the vessel. The Actual Damage to the vessel (as listed on the accident report) was \$1,000,000, but the replacement cost of the vessel was \$12,000,000, a difference of \$11,000,000 which was not reported. This was just one of several cases where the vessel was a total loss and only the actual damage to the original vessel was reported.

Another example of losses not reported would be the ramming and damaging of Aids to Navigation. A very low percentage of aids damaged by ramming are reported to the Coast Guard by the vessel involved. The cost to the government in replacing and repairing these damaged aids is high and yet is rarely found on a accident report.

Based on the information available to the study group the factor of three represented the best estimate of real life losses. During the first two or three years of the study (1973-1975) the factor of four was probably the correct factor to use. However, improved reporting procedures and the presence of the VTC in the later years of the study led the study group to conclude that the factor of three was the best overall factor for the study years.

3. Statistical Analysis

A number of statistical measures were used during the course of this study to evaluate such things as trends in casualties, trends in commercial activities in the area, trends in measures of safety, correlation of commercial activities with casualties, and benefits of the Houston/Galveston VTS. At the outset of the study effort it was determined by the Chief, Vessel Traffic Services Branch that benefits of the VTS were to be determined conservatively, further it is the policy of the Coast Guard to discuss possible errors related to the determination of benefit to cost ratios. In this case the preventable casualty trend was used to determine VTS benefits.

To obtain some feeling for the sensitivity of this number, the standard error of estimate was calculated for the trends before and after VTS according to the adjusted (conservative) formula for small sample sizes.

= the square root of [(the summation of the squared differences between measured and predicted values of Y) divided by (the number of samples minus two)].

The values obtained were ± 4.65 preventable casualties for the pre-VTS trend and ± 2.04 casualties for the post-VTS trend.

$\pm$ one standard error of estimate represents 68% confidence for one regression line. In this case we are interested in simultaneous (two) evaluations (a positive error for the pre-VTS trend adds to the projected benefits, and a negative error for the post-VTS trend also adds to the projected benefits). The chances of either trend line being in error beyond one standard error of estimate AND in the direction that favors the VTS benefits is equal to $(100 - 68)/2$, or 16%. The chances of BOTH lines exceeding this error in a given year is 16% of 16% (2.56%). For a given year we are 97.4% confident that our estimate has not favored the VTS benefits by the sum of the two standard errors of estimate ($4.65 + 2.04 = \pm 6.69$ preventable casualties). For a hypothetical worst case we could assume that this error was achieved in each year of the period estimated (1975-84), giving a value of 10×6.69 or 67 preventable casualties (the probability of this occurring would be very small, 0.0256^{10}). In this event the benefits of the VTS would be $162 - 67 = 95$ preventable casualties. 95 multiplied by \$74K estimated damages per preventable casualty, and the factor of 3 yields \$21.09M in benefits (compared to the 10-year VTS cost of \$16.5M).

It should be noted that the worst case error in estimated benefits is based on two conservative assumptions: first, the study team used the increasing regression line for the estimation of post-VTS preventable casualties, although the correlation coefficient for that line would ordinarily be interpreted to mean that there is no trend to increase. Further, preliminary data from 1978, when applied to the other data, shows a decreasing regression line for the post-VTS preventable casualties; second, the study team also reduced the factor of 4 for correcting estimated \$ savings to a factor of 3 as already discussed; third, benefits from sources other than vessel damages were not added (Chapter III-A.)

4. Facilitation of Commerce

In Chapter III we briefly discussed the benefit a VTS had on the facilitation of commerce. For example, a conservative estimate of transits for a given year in the HSC would be 50,000 (this is conservative by COE or VTS data). Assuming an average transit time of 2 hours (given that inter or intra-port transits are shorter and transits to sea would be longer), this 2 hour estimate can be applied to our 50,000 transits yielding 100,000 transit hours/year. Since VTS statistics have shown a 3% reduction in transit time; there occurs a 3,000 transit hours/year savings. With a 24 hour day and a \$10,000 per day average operating cost (considering all vessel types) this yields a \$1.25M/year savings due to VTS' presence.

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COAST GUARD WASHINGTON DC

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VESSEL TRAFFIC SERVICES HOUSTON/GALVESTON VTS CASUALTY ANALYSIS--ETC(U)

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V. CONCLUSIONS

The conclusions of the analysis were as follows:

- 80% of all movements in the VTS area are towboat movements, and 20% are deep draft movements.

- Data obtained from the COE is understated when compared to statistics obtained from actual transits as recorded by Houston/Galveston VTS.

- With 100% more commerce being moved in the Houston Ship Channel and only a 15% increase in transits over the nine year period CY69-77, the trend is towards larger or more heavily laden vessels and tows in the Houston/Galveston VTS area.

- Total casualties are rising in the Houston/Galveston VTS area.

- Since 1970 overall safety based on casualties versus movement of commerce and by transits has decreased.

- The number of preventable casualties per 10,000 transits and per 10 million tons of commerce has decreased since Houston/Galveston VTS went on-line (1975).

- Range L Front Light at Baytown should be re-located to a less hazardous location.

- Bolivar Roads area below Buoy 31 had 39% of all casualties since 1969. This is the major problem area in the Houston/Galveston VTS area.

- Mandatory Participation and Traffic Management Authority is required for Houston/Galveston VTS to realize the full potential of the system.

- With a predicted savings of \$36.0M in preventable casualties and a operating cost of \$16.5M for a 10 year period, the benefits to cost ratio for Houston/Galveston VTS is 2.2 to 1.

APPENDICES

HOUSTON/GALVESTON VTS CASUALTY ANALYSIS
PREVENTABLE CASUALTIES AFTER VTS ON-LINE

The following is a review of the preventable casualties after 4 February 1975.

CASE#	DATE	REMARKS
52811	4/11/75	The M/V LARRAYNE ANDRESS and tow entered the HSC in front of the SS ATLANTIC ENTERPRISE. To avoid collision the ATLANTIC ENTERPRISE had to back full and drop both anchors. On dropping anchor she swung around and collided with a tank barge in tow of the M/V V.C. SUDELA. CONCLUSION: Surprise encounter. Had the tug been a VTS participant it would have known the location of the deep draft and would not have entered the HSC.
52515	4/19/75	The M/V STELLANOVA was inbound on the HSC and entered into a starboard to starboard meeting arrangement with the outbound tug BAYOU BELLE in the vicinity of buoy 26. The tug was on the left (red) side of the channel and had slowed to avoid meeting at the bend in the HSC. The tug was approx. 100 yards north of buoy 26 when the M/V made its turn and headed directly for the tug. The tug attempted to maneuver to avoid collision but the starboard bow of the M/V struck the starboard side of the lead barge. CONCLUSION: Meeting at a bend or blind corner. Meetings, crossings and overtakings should not occur at bends or blind corners in the HSC.
53039	6/15/75	The primary cause of this casualty was the SS CONTECTICUT sailing light under adverse weather conditions CONCLUSION: Had the SS CONTECTICUT been a VTS participant it would have been advised of the weather conditions and, if necessary, been ordered by the VTC not to sail until weather conditions improved.

- 61736 11/4/75 The H/V SEBRING and tow were outbound in the HSC, overtaking the SS UNIVERSE DEFENDER. The deep draft had just met an inbound vessel and another vessel was approaching him when the SEBRING attempted to overtake him on his starboard side. During this maneuver the SEBRING came in contact with the UNIVERSE DEFENDER's starboard side. At no time were radio communications or whistle signals exchanged.
- CONCLUSION: Preventable due to lack of communications. Had both vessels been VTS participants they would have been on a common frequency for exchange of navigational information. VTC would also have informed SEBRING of the inbound vessel and, if necessary, managed traffic.
- 63031 12/11/75 This casualty was caused by the stern light of the KEMAH CLIPPER being extinguished. The SS MARYLAND TRADER did not see the KEMAH CLIPPER until it had overtaken it and collision could not be avoided. No communications were made or attempted prior to collision. PSS HOUSTON had dispatched a boat to investigate a report that the KEMAH CLIPPER had been maneuvering in an erratic manner, and arrived on scene as the accident occurred.
- CONCLUSION: Preventable casualty. Had the KEMAH CLIPPER and MARYLAND TRADER been participating in VTS both vessels would have been anticipating an overtaking situation and the MARYLAND TRADER would have been in contact with the KEMAH CLIPPER concerning her position. Had PSS HOUSTON notified VTC of the report of erratic maneuvering by the KEMAH CLIPPER VTC could have notified the MARYLAND TRADER of the situation.
- 63006 6/16/76 This casualty involves a barge breakaway at SIMS BAYOU. An abnormally fast current caused barge CC114 to break its moorings, enter the HSC and float downstream where it struck the ARCO ENTERPRISE which was loading at ARCO DOCK # 13. The barge, which was damaged during breakaway, was loaded with Butane.
- CONCLUSION: Preventable casualty if surveillance is available. Similar cases have been prevented by VTC detection.

62716

2/23/76

This casualty involved three inbound vessels in the HSC in the vicinity of buoy 100. The tug WATKINS GLEN was inbound and overtaking the tug LENNIE B just South of buoy 100 on a two whistle passing agreement. During this maneuver the M/V KOREAN WINNER contacted the WATKINS GLEN and requested a two whistle passage which the WATKINS GLEN consented to. At this point the WATKINS GLEN experienced some difficulty in his overtaking of the LENNIE B and called the KOREAN WINNER and requested him to slow to allow him to complete his maneuver prior to the KOREAN WINNER overtaking him. At no time during numerous calls from the WATKINS GLEN to the KOREAN WINNER did he correctly identify himself or to whom he was calling. The KOREAN WINNER did not acknowledge these calls and did not reduce speed until 'in extremis' and collision could not be avoided.

CONCLUSION: The KOREAN WINNER was a VTS participant but upon checking at check point 6 was advised only of the inbound tug JOAN and recieved no information of the other two tugs. This was only 15 minutes prior to collision. Primary cause of this casualty was the WATKINS GLEN entering into a passing agreement while engaged in overtaking another vessel. Had the tug advised the KOREAN WINNER to slow and wait until he completed his maneuver the casualty would have been prevented. This is a case where traffic management may have been necessary to ensure safe passage.

63578

6/6/76

The tug MARLIN, inbound Galveston Channel, overtaking another vessel and preparing to dock at G & H Towing when it cut across the bow of the inbound vessel and collided with the M/V MIDNIGHT FLASH which was entering the channel after departing her berth. No communications or whistle signals were exchanged.

CONCLUSION: Had both vessels been participating in VTS both would have been aware of the others location and the maneuver executed by the MARLIN probably would not have occurred.

- 63568 6/24/76 This casualty was caused by the tug MINI I not responding to calls by the tug CHARLIE C until the two vessels were 'in extremis'. When communication were finally established the CHARLIE C, the privileged vessel, could not stop in time and the MINI I was unable to alter course in a crossing situation.
CONCLUSION: Had each vessel been aware of the other's position and intentions this collision could have been avoided.
- 71661 10/28/76 The SS AMOCO DELAWARE was outbound in Galveston Bay Entrance Channel in heavy weather, 30-35 kt winds, when it observed the M/V ANDIE, a 59' exploration vessel, inbound approximately 1 mile away. The pilot sounded two blasts for a starboard to starboard passage and when he recieved no response sounded the danger signal. After again sounding the danger signal followed another two blasts the AMOCO DELAWARE came back full and hard right to avoid collsion. The M/V ANDIE did not respond to any whistle signals and did not see the AMOCO DELAWARE until 50 yards away. The ANDIE would not be required to participate in the VTS and was not doing so at the time of collision.
CONCLUSION: Had VTC been monitoring the entrance to Galveston Bay by radar it would have been able to detect the ANDIE inbound and could have advised the AMOCO DELAWARE of its location and direction of travel. This may have assisted the pilot in determining his course of action in sufficient time to prevent the collision.
- 72292 1/27/77 This casualty was a result of the tug MARY E mooring to HSC buoy 45 in dense fog and drifting into the channel in the path of the tug CHRISTINE M. Neither vessel communicated prior to the collision.
CONCLUSION: Had the MARY E been participating in the VTS she would not have been allowed to moor to a Aid to Navigation and both vessels would have been aware of each others location.

- 71356 3/26/77 Lack of communications was the primary cause of this casualty. Both vessels, the M/V SAM HOUSTON and the M/V CHARLES E. ANKELE, had held up to allow the MARINE CHEMIST to finish docking. Then seeing the other had held up each proceeded. The channel is only 300 ft wide at this point and was considerably narrower due to the assist tugs. The operator of the SAM HOUSTON also failed to take into account the wheel wash from one of the assist tugs. CONCLUSION: Had each vessel communicated its intentions to the other this casualty would not have occurred. VTC should have ensured safe passage by traffic management if necessary.
- 72280 3/39/77 The M/V BILLY JAY was outbound Galveston Bay when the vessel experienced a complete power failure. The vessel drifted with the wind and current with only the running lights on battery power. No emergency signals were utilized. The SS DEL ORO was outbound in reduced visibility of approximately 1/2 mile at 14 knots. At a range of one mile the BILLY JAY was observed on radar and the vessels white lights were observed at 1/2 mile away. Attempts to communicate by the DEL ORO were not successful: then the DEL ORO backed down full and came hard right in an attempt to avoid collision. The DEL ORO collided with the BILLY JAY at a speed of approximately 3 to 5 knots. CONCLUSION: Had the BILLY JAY and the DEL ORO been participating in the VTS the DEL ORO would have been advised that the BILLY JAY was in its vicinity and would have been on the lookout for the vessel. If VTC was also monitoring the area on radar it would have detected that the BILLY JAY had stopped and being unable to contact the vessel could have advised the DEL ORO of possible problems.
- 80781 3/23/77 Communications failure again was the primary cause. The SS BOSTON attempted to overtake the tug WINFRED W while the WINFRED W was itself meeting another vessel. The BOSTON did not attempt communications or sound any whistle signals to indicate its intention to pass.

CONCLUSION: Had VTC advised the BOSTON that he would overtake the WINFRED W at the same time he would meet the outbound vessel he may have slowed until the other vessel cleared. Traffic management could have been imposed to ensure safe passage.

83489 9/1/78 This casualty occurred when the tug NEWPARK SUNRISE stopped in Galveston Channel to lengthen his tow and his barge drifted into the path of the SS HAITI MARU which was attempting to pass starboard to starboard. The operator of the tug did not respond to calls by the HAITI MARU to make passing arrangements and was not in the wheel house at the time of the collision.

CONCLUSION: Had both vessels been maintaining a listening watch on the VTS frequency or channel 13 this casualty could have been avoided. Again knowledge of the other vessels intentions would have prevented the casualty.

80802 10/1/77 The outbound LUDWIG CANDIES was meeting an inbound tow which was being overtaken by the SS LINNET. As the LUDWIG CANDIES moved to starboard to give the LINNET more room she encountered bank suction and her bow sheered to port. LUDWIG CANDIES put her rudder hard right and started to back full when she loss power to both of her engines. With no power she collided with the LINNET. No communications were made prior to the collision.

CONCLUSION: Three vessels attempting to meet and overtake each other with no formal agreement by radio or whistle. VTC should have advised LINNET to slow and not overtake the other inbound vessel until clear of LUDWIG CANDIES.

80049 10/18/77 The tug DUROC (with tow) was being overtaken by the deep ladened M/S ALGOL when the DUROC collided with the side of the ALGOL due to suction from the ALGOL. The ALGOL passed close aboard to the DUROC as he was setting up to meet another vessel.

CONCLUSION: This case was very hard to call as both vessels were aware of the others intentions but were unable to complete the maneuver safely. It is possible that the VTC would have wanted to impose traffic management if it felt that the ALGOL could not make a safe passage before meeting the next vessel. This is the type of casualty we would like to prevent but may have been unable to, due to traffic conditions.

- 80644 10/ /77 Surprise meeting resulting in collision. Case file not available at this time to provide details of case.
- 80333 11/ /77 One vessel backed out of slip to change berths and backed into underway vessel. Case file not available at this time to provide details of case.
- 81479 1/ /78 This casualty involved the M/V HARDANGER and the ESSO BARCELONA as the primary vessels. The ESSO BARCELONA was in the process of tying up to the dock with four tugs assisting and was blocking the HSC. The pilot on the tanker called the HARDANGER and informed him of his situation and requested that he hold up to allow him to clear the channel into his berth. This was agreed to by the HARDANGER and the BARCELONA started his berthing. As soon it became apparent to the pilot of the BARCELONA that the HARDANGER had not in fact slowed but was proceeding directly towards his position. The BARCELONA pilot again called the HARDANGER and asked his intentions. The pilot on the HARDANGER when he saw that there was not enough room to get by attempted to stop his vessel but was unable to in time to prevent a collision with the assisting tug MARS.

CONCLUSION: This casualty occurred in a precautionary area and both vessels had ample time in which to avoid collision. In this case the VTC could have prevented this casualty only by active traffic management, in other words stepping in and ordering the HARDANCER not to proceed beyond a specific point until the BARCELONA was cleared. (This might not have been appropriate as from all appearances the vessels involved had made and understood passing arrangements).

83484 7/6/78 The M/V SERGEY YESENIN was outbound in the HSC approaching Bolivar Roads when it was observed by the M/V FURGO TEXAS SEAL which was outbound the Galveston Channel at a slow rate of speed. It appeared to the FURGO TEXAS SEAL that the SERGEY YESENIN was going to sea due to his fast rate of speed and no communications to indicate he was going to enter Galveston Channel. Suddenly the vessel turned into the Galveston Channel crossing over to the starboard side of the channel and colliding with the FURGO TEXAS SEAL. No whistle signals or radio communications were exchanged prior to collision.

CONCLUSION: Had the vessels been VTS participants the intentions and positions of both vessels would have been known to each other. The FURGO TEXAS SEAL would not have had to guess the intentions of the SERGEY YESENIN.

The following casualties involved vessels in groundings or wake damage situations.

52543 2/26/75 This case involved a deep draft vessel passing ahead of a tug and tow at a excessive speed which caused a large wake that damaged the tug's barges. The tug MARY E. STAPP had requested a slow down from the ANCO STANE which was not executed. As a result the tug's barges broke the connecting wires, dived, and struck bottom. The tug then attempted to contact the ANCO STANE by radio with no response.

CONCLUSION: Preventable casualty. The fact that a VTC has the monitoring capability to measure a ships speed and monitor a vessels communications would increase the compliance to requests of this type. Had the tug advised VTC prior to departing the ICW of a need for slow downs from deep draft vessels VTC could have relayed this request to other vessels in sufficient time to ensure compliance.

- 52568 2/11/75 This grounding involved the M/V ALVEGA which was transiting Bolivar Roads in reduced visibilty when a fishing vessel crossed his bow and forced the pilot to run the vessel aground to avoid collision.
CONCLUSION: Had VTC been monitoring the area with radar it would have detected the presence of the F/V and its intended course and advised the M/V accordingly.
- 61120 10/18/75 This casualty occurred as a result of extinguished aids to navigation in the area. The M/V STOLT CROWN misjudged his location and turned early; going aground outside the channel.
CONCLUSION: Had VTC advised the pilot of the extinguished aids the he would have been anticipating the problem and could have relied on other aids or landmarks in the area. As the aids are privately maintained, it was unclear from the report if VTC was aware of the outages.
- 63489 7/14/76 The M/V NOPAL VEGA was inbound the HSC when it passed the Steel Enterprises Inc. dock where the barge UMC 730 was moored. The speed at which the NOPAL VEGA was traveling caused the UMC 730 to break its moorings, strike the dock and cause damage to the barge and the dock. From the bell book of the NOPAL VEGA its speed was approximately 12.2 knots.
CONCLUSION: If VTS had regulations regarding speed limits or no wake areas this casualty could have been prevented.
- 63485 8/17/76 This casualty involved the EXXON BATON ROUGE grounding to avoid a collision with the M/V HOWARD EYMARD. After passing arrangements were made by radio the EXXON BATON ROUGE attempted to overtake the HOWARD EYMARD at the bend in the HSC by light 75. The HOWARD EYMARD did not turn at the bend and forced the EXXON BATON ROUGE out of the channel.

CONCLUSION: Communication between the two vessels was not made until just prior to the overtaking situation although the EXXON BATON ROUGE had made several attempts to raise the HOWARD EYMARD earlier. This caused the EXXON BATON ROUGE to overtake at a bend in the HSC. If more timely communications been established or had the vessels been participating in the VTS the casualty could have been avoided.

63192 2/26/76 The primary cause of this casualty was excessive draft of the SS PRINCESS ANNE MARIE which caused it to ground in the vicinity of Galveston Bay Entrance Channel Buoy 6. VTC advised the vessel after it was in the channel to turn around and return to sea. While attempting to turn with the assistance of tugs the vessel went hard aground. Fog was also setting in at this time.

CONCLUSION: Had the VTC noted that the vessels draft equalled the published depth of the channel it should have advised the vessel not to enter until he had a reasonable under keel clearance. If VTC did not have the authority to issue such an order, the COTP should have been advised of the situation.

80011 This casualty involved a deep draft vessel in the HSC which advised a tug coming out of the ICW that his vessel was throwing up a large wake and the tug should hold in the ICW until his vessel had cleared. The tug recieved this information but did not slow up and his tow suffered damage.

CONCLUSION: Had the vessel held up, this casualty would not have occurred. Had the vessels been participating, the VTC might have had to intervene with traffic management to ensure that the tug remained in the ICW.

63304 4/30/76 The M/V CITATION and tow grounded in Galveston-Freeport Cut-Off Channel due to buoy #2 being off station. After the grounding the vessel checked in with VTC to advise him of his situation and was informed that VTC was aware of the buoy being off station. There is no indication in the report to show that the vessel was participating in the VTS prior to the casualty.

CONCLUSION: If the vessel been a VTS participant prior to the casualty VTC would have informed him of the buoy being off station, thus preventing the casualty.

- 71004 12/15/76 Adverse weather conditions caused the tug BILLY WALKER to pass on the wrong side of a red buoy in the Texas City Channel.
CONCLUSION: Had the tug been a VTS participant he would have been advised in advance of the adverse weather and could have taken timely action to anchor or request the VTC assist him with the VTC radar.
- 70932 01/16/77 The primary cause of this casualty was the operator of the M/V MARK SHURDEN and tow entered Galveston Bay from the ICW and was not aware of the adverse weather conditions in the bay until it was too late.
CONCLUSION: Had the M/V been a VTS participant VTC would have advised him of the weather conditions, swells 20ft. or more and winds greater than 40 kts, and advised him not to leave the ICW until weather conditions improved.
- 82191 2/16/78 This casualty involved the M/V PALMA, whose wake caused the tow of the tug LADY ALICE to break up, resulting in the barge ATC 1212 going aground.
CONCLUSION: Had the tug and the M/V PALMA been VTS participants the VTC could have advised the PALMA of the tug's position and that the tug was requesting a slow down if the vessel was throwing a large wake.

The following cases involve preventable rammings.

- 52594 04/20/75 The primary cause of this casualty was heavy weather which caused the tow of the M/V MISS LOU to break up and while attempting to regroup his tow the tug struck HSC light 31. CONCLUSION: Had the tug been participating VTC could have advised the vessel of the weather conditions in advance and the operator could have delayed his sailing or anchored his vessel until such time as weather conditions improved.
- 63115 10/25/75 Heavy weather (winds 60+) were the primary cause of this casualty. The results were the same as 52594 above. CONCLUSION: Same as 52594 above.
- 63119 7/9/76 This casualty involved the small passenger vessel M/V SEA QUEEN whose operator failed to correctly determine his position while approaching the Galveston Bay Entrance at night and collided with the South Jetty. CONCLUSION: Had the vessel checked in with VTC and advised them of his position the radar operator would have been able to determine if his reported position was correct and then been able to advise the vessel of his position with respect to the South Jetty.
- 63564 9/13/76 This casualty involved the small passenger vessel M/V CHIP VII and is identical to the above.
- 73149 9/18/76 The Tug JACK FISHER was transiting the HSC near Baytown when he moved to the extreme right side of the channel to allow two vessels meeting port to port additional room. At this point the tug was forced farther to the right by the two vessels and rammed HSC Light III. CONCLUSION: Another situation where three vessels were involved in meeting and overtaking situations at the same time in a narrow channel. Traffic management should have been initiated.



DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to
COMMANDANT (MVI-3)
U.S. COAST GUARD
WASHINGTON, D.C. 20590

• COMDTINST 5943.7
3 APR 1972

• COMMANDANT INSTRUCTION 5943.7

Subj: Marine Casualty Report; improvements in obtaining

1. Purpose. The purpose of this Instruction is to emphasize the continuing need for reports of all marine casualties. It also contains some guidelines to assist in establishing total casualty dollar figures.

2. Background. 46 CFR 136.05-1 sets forth the requirement for the notice by the owner, agent, master, or person in charge of a vessel to the nearest Coast Guard Marine Inspection Office whenever a casualty occurs resulting in actual physical damage in excess of \$1500; material damage affecting the seaworthiness or efficiency of a vessel; stranding or grounding; loss of life; or injury causing anyone to be incapacitated for a period in excess of 72 hours (except injury to harbor workers not resulting from vessel or vessel equipment casualty). Since the establishment of the Information and Analysis Staff in the Office of Merchant Marine Safety, a detailed study utilizing sources in addition to the normal Coast Guard inputs has indicated that our reports of casualties occurring is only approximately 30%. In addition there is a large discrepancy in total dollar value of casualties reported to truer casualty costs.

3. Discussion. While it is considered likely that we are receiving reports of most significant marine casualties, it is desirable to increase our total casualty knowledge to include a higher percentage of those incidents not presently reported. Some types of casualties lend themselves to this unreported group. The particular class of casualties that may be presently ignored by those personnel responsible includes, but is not limited to: (1) Machinery casualties that are in the "material damage affecting the seaworthiness or efficiency of a vessel" category; (2) Heavy weather plate or rolling chock damage that might fall in the "actual physical damage to property in excess of \$1500 or "seaworthiness or efficiency" category; (3) Damage due to docking or undocking; (4) Grounding where vessel bottom is not inspected until a later "routine" dry-dock exam. These represent only a selected few of the potential types that account for the estimated 70% of the reportable casualties not included in casualty reports received at Coast Guard Headquarters. A renewed interest and cooperation at the local contact level should improve the record in these areas.

4. Action. OCMI's shall take necessary action to improve the ratio of reports received to casualties occurring. This action should include a renewed interest and cooperation on the part of each inspector toward

COMDTINST 5943.7

3 APR 1972

achieving a more meaningful total casualty picture of his zone. Many times the materiel inspector, in the normal performance of his duties, will be in a position to observe repairs being made and can ascertain that the required report has been submitted.

a. Inspectors should review deck and machinery logs when aboard a vessel for an inspection. This review should include the period of the current voyage. From this review the inspector should ascertain that appropriate casualty reports have been or will be submitted.

b. The space provided on the Form CG-2692, Report of Vessel Casualty or Accident, for "estimated loss/damage to your vessel", "estimated loss/damage to your cargo" and "estimated loss/damage to other property" (space 25) is an important input in the statistical information and analysis coding and should be as accurate and complete as possible. The dollar figure to be entered here is the ACTUAL PHYSICAL DAMAGE to property and DOES NOT INCLUDE associated expenses in returning the vessel or property to service (dry-docking - man hours lost - cost per day lost etc.) Try to avoid entering "unknown" or "in excess of \$1500". Investigation will normally disclose the dollar figure to be inserted, and this can be done either by returning the form to the person who submitted the report or by the Investigating Officer adding or amending the entry as appropriate. If possible, amending the entry should be done upon receipt of the report, ideally by the inspector who has knowledge of the damage and can make an accurate estimate based either upon repair facility records or his own experience.

c. Form CG-2752, Report of Structural Failure, Collision Damage or Fire Damage to Inspected Vessel is not being submitted with any regularity as required on the occurrence of these incidents. This form is an important input into total vessel record and submission in every applicable case is required. OCMI's will insure compliance and complete reporting on this form in every instance.

Distribution: (SDL No. 94)

A: None

B: n(45); c(20); f(15); g(11); e(10); r(7); h(6); b(3); j(2); dpq(1)

C: m(5)

D: i(2)

E: None

List CG-10, T2

4771