(NASA-CR-148502) SEASAT ECONOMIC ASSESSMENT. VOLUME 9: PORTS AND HARBORS CASE STUDY AND GENERALIZATION Final Report, Feb. 1974 - Aug. 1975 (ECON, Inc., Princeton, N.J.) 201 p HC $7.75 CSCL 05C G3/43

N76-28622

Unclas 15364

VOLUME IX

SEASAT ECONOMIC ASSESSMENT

PORTS AND HARBORS

CASE STUDY AND GENERALIZATION

ECON INCORPORATED
Report No. 75-125-9B
NINE HUNDRED STATE ROAD
PRINCETON, NEW JERSEY 08540
609 924-8778

FINAL

VOLUME IX

SEASAT ECONOMIC ASSESSMENT

PORTS AND HARBORS

CASE STUDY AND GENERALIZATION

Prepared for

The National Aeronautics and Space Administration
Office of Applications
Washington, D.C.

Contract No. NASW-2558

August 31, 1975

ECONOMICS OPERATIONS RESEARCH SYSTEMS ANALYSIS POLICY STUDIES TECHNOLOGY ASSESSMENT

NOTE OF TRANSMITTAL

The SEASAT Economic Assessment was performed for the Special Programs Division, Office of Applications, National Aeronautics and Space Administration, under Contract NASW-2558. The work described in this report began in February 1974 and was completed in August 1975.

The economic studies were performed by a team consisting of Battelle Memorial Institute; the Canada Centre for Remote Sensing; ECON, Inc.; the Jet Propulsion Laboratory; and Ocean Data Systems, Inc. ECON, Inc. was responsible for the planning and management of the economic studies and for the development of the models used in the generalization of the results.

This volume presents a case study and its generalization concerning the economic benefits of improved local weather forecasting to the dockside activities of ships in ports and harbors. The study was performed by Kenneth Hicks of ECON, Inc.

The SEASAT Users Working Group (now Ocean Dynamics Subcommittee) chaired by John Apel of the National Oceanographic and Atmospheric Administration, served as a valuable source of information and a forum for the review of these studies. Mr. S. W. McCandless, the SEASAT Program Manager, coordinated the activities of the many organizations that participated in these studies into the effective team that obtained the results described in this report.

B. P. Miller

TABLE OF CONTENTS

		Page
	Note of Transmittal	ii
	List of Figures	v
	List of Tables	vii
1.	Overview of the Assessment	1
2.	Introduction	9
3.	Summary and Conclusions	10
	3.1 Summary	10
	3.2 Conclusions	23
4.	Ports and Harbors Case Study	30
	4.1 Introduction and General Discussion	30
	4.1.1 Introduction	30
	4.1.2 General Discussion	31
	4.2 Case Study Methodology	37
	4.3 The Ports of Philadelphia	38
	4.3.1 Introduction	38
	4.3.2 Sources of Weather Related Economic Loss	42
	4.3.3 Weather Related Economic Losses to Ship Owners	44
	4.3.4 Derivation of the Maximum Labor Related Economic Loss	50
	4.3.5 The Variability in Labor Related Annual Losses	63
	4.3.6 The Growth in the Economic Loss	72
	4.3.7 The Expected Economic Losses to a Ship Owner	76
	4.3.8 The Influence of Weather Forecasting Quality	79
	4.3.9 Estimation of Benefits	99
5.	Estimation of National Benefits	112
	5.1 Introduction	112
	5.2 Development of the National Benefit	115
	5.2.1 Vessel Arrivals at Major U.S. Ports	115
	5.2.2 Port Climatological Precipitation	119
	5.2.3 Port Shipping Breakdown for 1974	119
	5.2.4 Climatology and Shipping Breakdown Equivalences	121
	5.2.5 1974 Benefits Exclusive to SEASAT	126
	5.2.6 General National Annual Losses and Benefits	128

TABLE OF CONTENTS
(Continued)

		Page
5.3	Generalization of the Ports and Harbors Case Study	131
	5.3.1 Introduction	131
	5.3.2 The Generalization Procedure	137
	5.3.3 The Benefits to Shipping in Ports and Harbors from SEASAT and Weather Forecasting	143
Appendix A		153
A.1	Source Data	153
A.2	Data and Information Sources and Data Derivations	155

LIST OF FIGURES

Figure		Page
1.1	SEASAT Net Benefits, 1975-2000	7
1.2	SEASAT Net Benefits, Inset	8
4.1	The Ports of Philadelphia	39
4.2	Central Harbor Area of Ports of Philadelphia	41
4.3	Longshoremen Wage Rates	46
4.4	Longshoremen Wage Rates	47
4.5	Longshoremen Hiring and Guarantees	48
4.6	Longshoremen Hiring and Guarantees	49
4.7	Memorandum of Agreement	51
4.8	Net Registered Tonnage Statistics - 1973	52
4.9	Typical Weather Station Reporting	55
4.10	Precipitation Days Compilation for the Port of Philadelphia 1974 at Philadelphia and Marcus Hook	56
4.11	Precipitation Loss Days in the Ports of Philadelphia 1974	60
4.12	Nonproductive Labor Related Costs or Losses to Breakbulk Ship Owners Using the Ports of Philadelphia in 1974	62
4.13	Local Climatological Data, Annual Summary with Comparative Data	64
4.14	Ameriport Tonnage Projections	74
4.15	Net Registered Tonnage Statistics - 1973 and Averages	78
4.16	Comparison of NMC and WSFOs (193 stations) total precipitation and no precipitation forecasts correct nationally 1966-1973. Morning (0600 GMT) and afternoon (1800 GMT) forecasts for all three periods were averaged over the conterminous United States	93

LIST OF FIGURES
(Continued)

Figure		Page
4.17	Forecasting Quality Precipitation and No Precipitation	95
5.1	Vessels Entered and Cleared in Foreign Trade	118
5.2	Port of Boston	134
5.3	Port Capital Expenditure	136

LIST OF TABLES

Table		Page
1.1	Content and Organization of the Final Report	2
3.1	Realizable Incremental Benefit Exclusive to SEASAT 1985-2000 Ports of Philadelphia - Combining Breakbulk, Bulk, and Container Shipping U.S. and Foreign Flag	13
3.2	Annual Benefits from Appropriately Applied Weather Forecasting. Ports of Philadelphia - Breakbulk, Bulk, Container Shipping Combined U.S. and Foreign Flag	14
3.3	1974 National Annual Maximum Avoidable Losses from Precipitation in Ports and Harbors	16
3.4	1974 Estimated National Annual Benefit from Appropriately Applied Weather Forecasting, from all Sources, to Ports and Harbors	17
3.5	1974 Annual Benefits to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration	18
3.6	1985-2000 National Annual Maximum Avoidable Losses from Precipitation in Ports and Harbors (U.S. and Foreign Flag)	19
3.7	Estimated National Annual Benefit from Appropriately Applied Weather Forecasting, from all Sources, to Ports and Harbors (U.S. and Foreign Flag)	20
3.8	1985-2000 Annual National Benefit to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration. (U.S. and Foreign Flag)	21
3.9	Allocation of 1985-2000 Annual Benefit from SEASAT or Appropriate Weather Forecasting Among Ports (operating costs $10,000/day, working status)	22
3.10	1974 SEASAT Exclusive National Benefits With Labor Losses Excluded. (U.S. and Foreign Flag)	24
3.11	1985-2000 SEASAT Exclusive National Benefits With Labor Loss Excluded. (U.S. and Foreign Flag)	25

LIST OF TABLES
(Continued)

Tables		Page
3.12	1985-2000 Estimated National Annual Benefit from Appropriately Applied Weather Forecasting, With Labor Losses Excluded. (U.S. and Foreign Flag)	26
4.1	ILA Labor Hiring Rules	70
4.2	Prediction Intervals for Hiring ILA Labor	71
4.3	Dockage Charge Estimates	77
4.4	Costs and Prediction Quality	80
4.5	Equations of Expected Loss Per Ship Type	85
4.6	Avoidable Nonproductive Losses and Savings Per Ship as a Consequence of Correct Weather Forecasting Probability. Ports of Philadelphia - Breakbulk Shipping	103
4.7	Avoidable Nonproductive Costs and Savings Per Ship as a Consequence of Correct Weather Forecasting Probability. Ports of Philadelphia - Dry Bulk Shipping	104
4.8	Avoidable Nonproductive Costs and Savings Per Ship as a Consequence of Correct Weather Forecasting Probability. Ports of Philadelphia - Container Shipping	105
4.9	Annual Benefits, Ports of Philadelphia - Breakbulk Shipping	106
4.10	Annual Benefits, Ports of Philadelphia - Dry Bulk Shipping	107
4.11	Annual Benefits, Ports of Philadelphia - Container Shipping	108
4.12	Realizable Incremental Annual Benefit Exclusive to SEASAT 1985-2000 Ports of Philadelphia - Combining Breakbulk, Bulk, and Container Shipping	110

LIST OF TABLES
(Continued)

Tables		Page
4.13	Annual Benefits from Appropriately Applied Weather Forecasting. Ports of Philadelphia Breakbulk, Bulk, Container Shipping Combined	111
5.1	Vessel Arrivals of Major U.S. Ports	116
5.2	Major U.S. Port Climatological Precipitation	120
5.3	Major U.S. Port 1974 Breakdown	121
5.4	East Coast Ports Equivalences (5 Ports)	123
5.5	Gulf Coast Ports Equivalences (2 Ports)	124
5.6	West Coast Ports Equivalences (4 Ports)	125
5.7	1974 Benefit Multipliers	127
5.8	1974 Annual National Benefits to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration	127
5.9	1974 National Annual Maximum Avoidable Losses to Ship Owners from Precipitation in Ports and Harbors	129
5.10	1974 Estimated National Annual Benefit to Ship Owners from Appropriately Applied Weather Forecasting, from all Sources, to Ports and Harbors	130
5.11	Port Capital Expenditures ($ million)	139
5.12	Adjusted Capital Expenditures ($ million)	139
5.13	Normalized Port Growth Estimators	140
5.14	Estimated Growth Factors (1985-2000)	140
5.15	1985-2000 Benefit Multipliers	143
5.16	1985-2000 Annual National Benefit to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration	144
5.17	1985-2000 National Annual Maximum Avoidable Losses to Ship Owners from Precipitation in Ports and Harbors	144

LIST OF TABLES
(Continued)

Tables		Page
5.18	1985-2000 Estimated National Annual Benefit to Ship Owners from Appropriately Applied Weather Forecasting from all Sources, to Ports and Harbors	145
5.19	The Values of E_{uL}/E_u	148
5.20	SEASAT Exclusive National Benefits with Labor Losses Excluded	149
5.21	1985-2000 SEASAT Exclusive National Benefits with Labor Loss Excluded	149
5.22	1985-2000 Estimated National Annual Benefits to Ship Owners from Appropriately Applied Weather Forecasting, with Labor Losses Excluded	150
5.23	Benefit Distribution Among Ports	150
5.24	1985-2000 Annual National Benefit Distribution to Ports and Harbors	152

1. OVERVIEW OF THE ASSESSMENT

This report, consisting of ten volumes, represents the results of the SEASAT Economic Assessment, as completed through August 31, 1975. The individual volumes in this report are:

- Volume I - Summary and Conclusions
- Volume II - The SEASAT System Description and Performance
- Volume III - Offshore Oil and Natural Gas Industry - Case Study and Generalization
- Volume IV - Ocean Mining - Case Study and Generalization
- Volume V - Coastal Zones - Case Study and Generalization
- Volume VI - Arctic Operations - Case Study and Generalization
- Volume VII - Marine Transportation - Case Study and Generalization
- Volume VIII - Ocean Fishing - Case Study and Generalization
- Volume IX - Ports and Harbors - Case Study and Generalization
- Volume X - A Program for the Evaluation of Operational SEASAT System Costs.

Each volume is self-contained and fully documents the results in the study area corresponding to the title. Table 1.1 describes the content of each volume to aid readers in the selection of material that is of specific interest.

The SEASAT Economic Assessment began during Fiscal Year 1975. The objectives of the preliminary economic assessment, conducted during Fiscal Year 1975, were to identify the uses and users of the data that could be produced by an operational SEASAT system and to provide preliminary estimates of the benefits produced by the applications of this data.*

---

*SEASAT Economic Assessment, ECON, Inc., October 1974.

Table 1.1: Content and Organization of the Final Report

Volume No.	Title	Content
I	Summary and Conclusions	A summary of benefits and costs, and a statement of the major findings of the assessment.
II	The SEASAT System Description and Performance	A discussion of user requirements, and the system concepts to satisfy these requirements are presented along with a preliminary analysis of the costs of those systems. A description of the plan for the SEASAT data utility studies and a discussion of the preliminary results of the simulation experiments conducted with the objective of quantifying the effects of SEASAT data on numerical forecasting.
III	Offshore Oil and Natural Gas Industry-Case Study and Generalization	The results of case studies which investigate the effects of forecast accuracy on offshore operations in the North Sea, the Celtic Sea, and the Gulf of Mexico are reported. A methodology for generalizing the results to other geographic regions of offshore oil and natural gas exploration and development is described along with an estimate of the world-wide benefits.
IV	Ocean Mining - Case Study and Generalization	The results of a study of the weather sensitive features of the near shore and deep water ocean mining industries are described. Problems with the evaluation of economic benefits for the deep water ocean mining industry are attributed to the relative immaturity and highly proprietary nature of the industry.

Table 1.1: Content and Organization of the Final Report
(continued)

Volume No.	Title	Content
V	Coastal Zones - Case Study and Generalization	The study and generalization deal with the economic losses sustained in the U.S. coastal zones for the purpose of quantitatively establishing economic benefits as a consequence of improving the predictive quality of destructive phenomena in U.S. coastal zones. Improved prediction of hurricane landfall and improved experimental knowledge of hurricane seeding are discussed.
VI	Arctic Operations - Case Study and Generalization	The hypothetical development and transportation of Arctic oil and other resources by ice breaking super tanker to the continental East Coast are discussed. SEASAT data will contribute to a more effective transportation operation through the Arctic ice by reducing transportation costs as a consequence of reduced transit time per voyage.
VII	Marine Transportation-Case Study and Generalization	A discussion of the case studies of the potential use of SEASAT ocean condition data in the improved routing of dry cargo ships and tankers. Resulting forecasts could be useful in routing ships around storms, thereby reducing adverse weather damage, time loss, related operations costs, and occasional catastrophic losses.
VIII	Ocean Fishing - Case Study and Generalization	The potential application of SEASAT data with regard to ocean fisheries is discussed in this case study. Tracking fish populations, indirect assistance in forecasting expected populations and assistance to fishing fleets in avoiding costs incurred due to adverse weather through improved ocean conditions forecasts were investigated.
IX	Ports and Harbors - Case Study and Generalization	The case study and generalization quantify benefits made possible through improved weather forecasting resulting from the integration of SEASAT data into local weather forecasts. The major source of avoidable economic losses from inadequate weather forecasting data was shown to be dependent on local precipitation forecasting.
X	A Program for the Evaluation of Operational SEASAT System Costs	A discussion of the SATIL 2 Program which was developed to assist in the evaluation of the costs of operational SEASAT system alternatives. SATIL 2 enables the assessment of the effects of operational requirements, reliability, and time-phased costs of alternative approaches.

The preliminary economic assessment identified large potential benefits from the use of SEASAT-produced data in the areas of Arctic operations, marine transportation and offshore oil and natural gas exploration and development.

During Fiscal Year 1976, the effort was directed toward the confirmation of the benefit estimates in the three previously identified major areas of use of SEASAT data, as well as the estimation of benefits in additional application areas. The confirmation of the benefit estimates in the three major areas of application was accomplished by increasing both the extent of user involvement and the depth of each of the studies. Upon completion of this process of estimation, we have concluded that substantial, firm benefits from the use of operational SEASAT data can be obtained in areas that are extensions of current operations such as marine transportation and offshore oil and natural gas exploration and development. Very large potential benefits from the use of SEASAT data are possible in an area of operations that is now in the planning or conceptual stage, namely the transportation of oil, natural gas and other resources by surface ship in the Arctic regions. In this case, the benefits are dependent upon the rate of development of the resources that are believed to be in the Arctic regions, and also dependent upon the choice of surface transportation over pipelines as the means of moving these resources to the lower latitudes. Our studies have also identified that large potential benefits may be possible from the use of SEASAT data in support of ocean fishing operations. However, in this case, the size of the sustainable yield of the ocean remains an unanswered question; thus, a conservative viewpoint concerning the size of the benefit should be adopted until the process of biological replenishment is more completely understood.

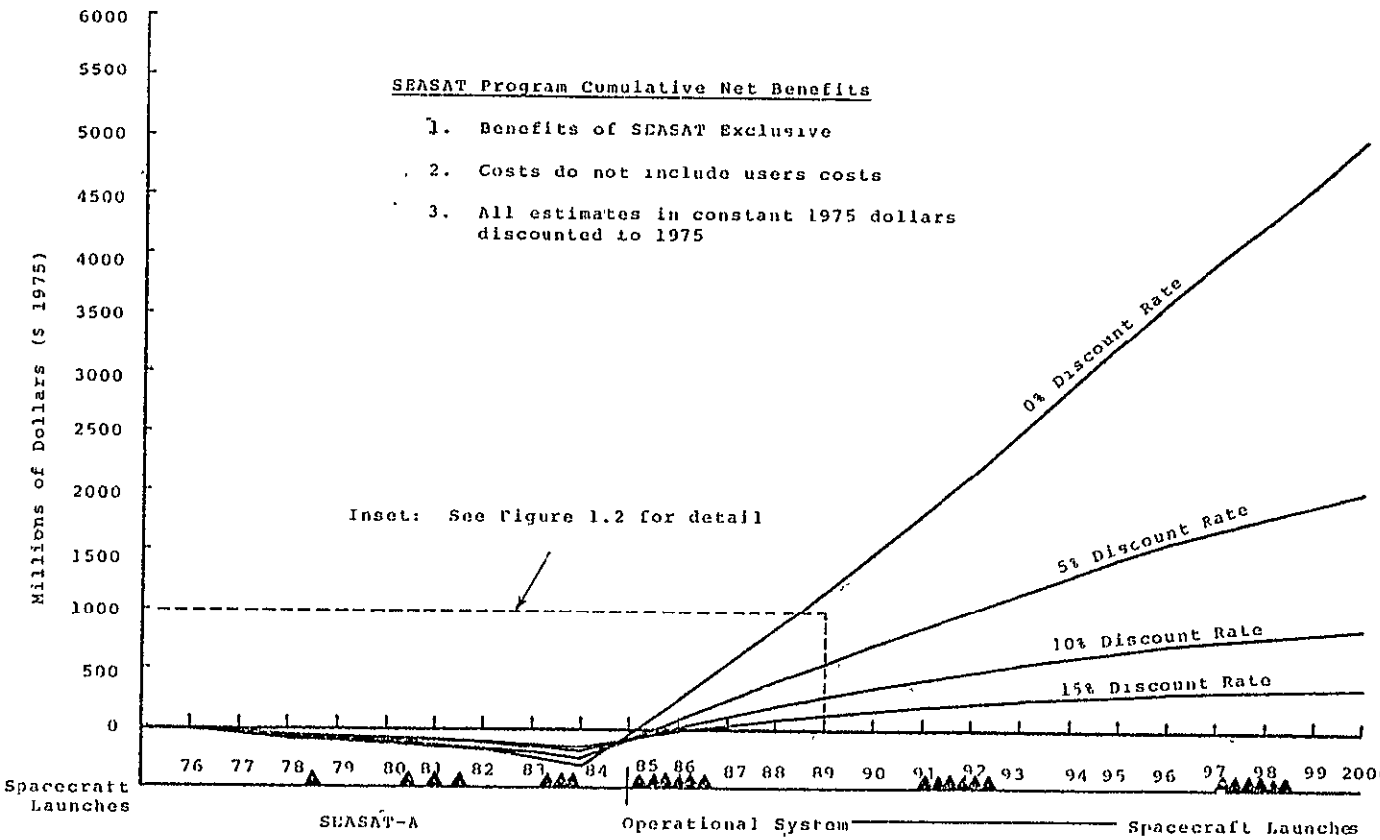
With the completion of this second year of the SEASAT Economic Assessment, we conclude that the cumulative gross benefits that may be obtained through the use of data from an operational SEASAT system, to provide improved ocean condition and weather forecasts is in the range of \$859 million to \$2,709 million (\$1975 at a 10 percent discount rate) from civilian activities. These are gross benefits that are attributable exclusively to the use of SEASAT data products and do not include potential benefits from other possible sources of weather and ocean forecasting that may occur in the same period of time. The economic benefits to U.S. military activities from an operational SEASAT system are not included in these estimates. A separate study of U.S. Navy applications has been conducted under the sponsorship of the Navy Environmental Remote Sensing Coordinating and Advisory Committee. The purpose of this Navy study was to determine the stringency of satellite oceanographic measurements necessary to achieve improvements in military mission effectiveness in areas where benefits are known to exist.* It is currently planned that the Navy will use SEASAT-A data to quantify benefits in military applications areas. A one-time military benefit of approximately \$30 million will be obtained

*"Specifications of Stringency of Satellite Oceanographic Measurements for Improvement of Navy Mission Effectiveness." (Draft Report.) Navy Remote Sensing Coordinating and Advisory Committee, May 1975.

by SEASAT-A, by providing a measurement capability in support of the Department of Defense Mapping, Charting and Geodesy Program.

Preliminary estimates have been made of the costs of an operational SEASAT program that would be capable of producing the data needed to obtain these benefits. The hypothetical operational program used to model the costs of an operational SEASAT system includes SEASAT-A, followed by a number of developmental and operational demonstration flights, with full operational capability commencing in 1985. The cost of the operational SEASAT system through 2000 is estimated to be about $753 million ($1975, 0 percent discount rate) which is the equivalent of $272 million ($1975) at a 10 percent discount rate. It should be noted that this cost does not include the costs of the program's unique ground data handling equipment needed to process, disseminate or utilize the information produced from SEASAT data. Figures 1.1 and 1.2 illustrate the net cumulative SEASAT exclusive benefit stream (benefits less costs) as a function of the discount rate.

This volume describes the results of a case study and its generalization concerning the economic benefits of improved local weather forecasts to the dockside activities of ships in ports and harbors.



Costs*	19	49	78	100	123	151	184	239	307	352	368	373	375	393	437	503	546	566	568	587	629	695	738	753
Benefits*										311	622	933	1244	1555	1937	2319	2701	3083	3465	3847	4229	4611	5375	5757

*Cumulative Costs and Benefits at 0% Discount Rate (millions, $ 1975)

Figure 1.1 SEASAT Net Benefits, 1975-2000

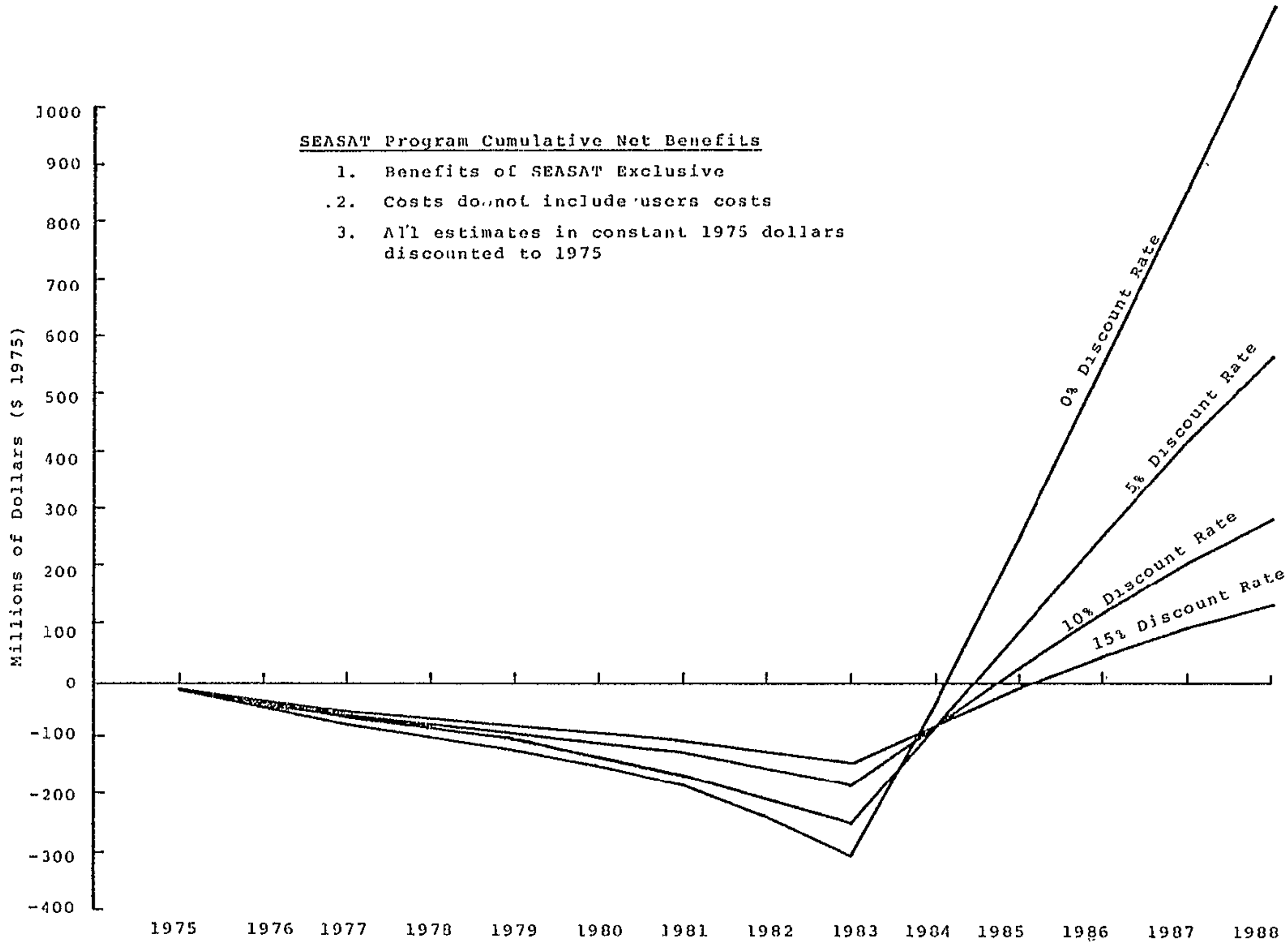


Figure 1.2 SEASAT Net Benefits, Inset

2. INTRODUCTION

In ports and harbors some services to shipping are weather dependent. This weather dependence results in avoidable incremental costs directly to ship owners, the magnitude of which is dependent on the quality of weather forecasting of the specialized meteorological events associated with the weather dependence.

A case study has been undertaken to determine the avoidable costs and their weather dependence in the ports of Philadelphia in 1974. The case study was then extended to the eleven major U.S. ports specifically and to the 106 minor U.S. ports generally.

The case study and its extension quantify the benefits or savings of avoidable costs that are exclusive to the integration of data collected by SEASAT and for appropriate application of the improvements in normal weather forecasting quality.

The investigation was further generalized to quantify similar benefits for the time interval 1985-2000. This generalization defined the growth of shipping arrivals in U.S. ports in terms of proposed capital investment in port facilities.

3. SUMMARY AND CONCLUSIONS

3.1 Summary

Consultation with the shipping fraternity in the ports of Philadelphia clearly identified the major source of avoidable economic losses from inadequate weather forecasting knowledge, to be dependent on the local forecasting of the occurrence of precipitation.

If no precipitation is predicted but precipitation is observed then contracted longshore labor must be paid guaranteed wages. If precipitation is predicted but no precipitation occurs then shipping is idled because service labor is not available and nonproductive ship operating costs and dockage fees must be paid.

Precipitation days, when it rained continuously between 8 a.m. and 12 noon, were identified for 1974 from data in the ports of Philadelphia for breakbulk shipping. These days were transformed into an annual avoidable labor loss from the number of labor gangs called on the precipitation days and from the rates charged for the labor by the stevedoring companies. Labor related avoidance losses were then extended to both container and dry bulk shipping.

The resulting estimated 1974 labor related avoidable losses were in 1974 dollars:

From breakbulk shipping	$ 900,000
From container shipping	73,800
From dry bulk shipping	34,200
	$1,008,000

This was adjusted for any year by adding a range +31%,-22% based on relative annual precipitation climatology in Philadelphia. This loss is associated with the specific weather prediction error (NP:P) where no precipitation is predicted but precipitation is observed. A generalized expected economic loss equation which incorporates the error (NP:P) and the error (P:NP) was developed which is dependent upon ship and port charges and, in particular, on the capability of precipitation prediction of the event of concern to this study.

The event of concern is that for which precipitation is continuous from 8 a.m. to 12 noon, an event not predicted under normal weather forecasting processes.

Based on normal weather forecasting, current success and judgmental evaluations of the growth of this success with time and the interrelation between normal forecasting and forecasting of the event of interest, the following forecasting success probabilities were deduced:

1974 event of interest success probability	0.35
1985 event of interest success probability	0.37
2000 event of interest success probability	0.375
Maximum event of interest success probability	0.46

The maximum event of interest probability requires a normal forecasting probability of unity. Normal forecasting is that forecasting currently provided by the National Weather Service.

The incremental success probability of the event of interest that could be contributed by SEASAT in the time interval 1985-2000 was judgmentally estimated from the influence of surface wind data (thought to be SEASAT's data major contribution) as 0.001. This is 20 percent of the event of interest success probability increase between 1985 and 2000 and about 1 percent of the maximum increment between 1974 and the maximum.

Insertion in the expected loss equation of these probabilities and incremental probabilities results in the estimation of benefits to the ports of Philadelphia from SEASAT and from appropriate application of normal weather forecasting capability. The benefits shown in Tables 3.1 and 3.2 are for the years 1985-2000 and incorporate the growth in shipping arrivals in the ports of Philadelphia by that time period. The benefits combine both United States and foreign flag vessels, the population being an undefined mix with daily operating costs not less than $1,500 and not greater than $10,000.

Philadelphia is one of eleven major U.S. ports. By evaluating the recorded ship arrivals in 1974 at the remaining ten major U.S. ports and the mean annual climatological precipitation of each relative to Philadelphia, the 1974 major

Table 3.1 Realizable Incremental Annual Benefit Exclusive to SEASAT 1985-2000 Ports of Philadelphia - Combining Breakbulk, Bulk and Container Shipping U.S. and Foreign Flag.

Ship Operating Costs $/day	Ship Berthing Status	Realizable Incremental Annual Benefit Range Exclusive to SEASAT ($)		
10000	working	7,541	9,668	12,665
10000	idle	6,970	8,936	11,706
1500	working	3,169	4,060	5,319
1500	idle	2,582	3,310	4,336

The range quoted for benefits is a result of port climatology.

All benefits are in $1974.

Table 3.2 Annual Benefits from Appropriately Applied Weather Forecasting. Ports of Philadelphia - Breakbulk, Bulk, Container Shipping Combined U.S. and Foreign Flag.

1985 Maximum Benefit	Annual Realizable Benefits ($) 1985	2000	Ship Operating Costs $/day	Ship Berthing Status
9,305,666	3,580,350	3,628,742	10000	working
8,934,376	3,305,617	3,350,406	10000	idle
4,075,509	1,507,870	1,528,802	1500	working
3,331,165	1,232,448	1,249,112	1500	idle

All benefits have a range +31%;-22% about quoted value based on port climatology.

All benefits are in $1974.

port benefits were developed. These were expanded to include the 106 minor ports by a simple multiplying factor based on relative tonnages to give the 1974 national avoidable losses and national benefits shown in Tables 3.3, 3.4 and 3.5. The Philadelphia labor rate was assumed nationwide.

Shipping arrivals at each U.S. port are expected to grow in magnitude and to change throughout shipping categories by 1985-2000. In general ship tonnages are expected to increase and ports will vigorously compete for container ship traffic while technology will be a significant factor in containerizing cargo and in handling cargo.

Growth in shipping arrivals and shifts in categories of shipping was developed from published regional capital spending on port facilities which it is estimated will have a major influence on shipping handling capacity in 1985-2000. Factors for port growth were then related to the activity and results in the ports of Philadelphia in 1974.

The results of this generalization in time are shown in Tables 3.6, 3.7 and 3.8. No attempt was made to generalize this case study to the ports of the world.

The annual national benefits during the time period 1985-2000, as calculated, are distributed throughout the ports and are accumulated from different categories of shipping according to percentages shown in Table 3.9. These percentages pertain either to benefits exclusively from SEASAT or from appropriate application of weather forecasting. The

Table 3.3 1974 National Annual Maximum Avoidable Losses from Precipitation in Ports and Harbors

Ship Daily Operating Costs ($)	Ship Berthing Status	TYPE OF SHIPPING			National Total Annual Maximum $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	42,009,569	24,759,889	12,169,216	78,938,674
10000	idle	39,943,796	22,078,488	11,082,308	73,104,542
1500	working	19,567,006	8,984,601	5,101,710	33,653,317
1500	idle	17,484,706	6,303,151	4,014,801	27,802,658

Losses have a range $^{+42.42}_{-37.5\%}$ due to climatology.

U.S. and Foreign Flag.

Table 3.4 1974 Estimated National Annual Benefit from Appropriately Applied Weather Forecasting, from all Sources, to Ports and Harbors

Ship Daily Operating Costs ($)	Ship Berthing Status	TYPE OF SHIPPING			National Annual Benefit $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	15,539,348	9,161,895	4,504,225	29,206,468
10000	idle	14,775,221	8,169,680	4,101,930	27,046,831
1500	working	7,237,843	3,324,572	1,888,309	12,450,724
1500	idle	6,467,594	2,332,351	1,486,015	10,285,960

Assumptions

- National Shipping Arrival Distribution for 1974
- 1985-2000 Weather Forecasting Capability
- Implemented Weather Forecasting Quality for Use in Ports and Harbors
- U.S. and Foreign Flag

Benefits have a range $^{+42.4\%}_{-37.5\%}$ due to climatology.

Table 3.5 1974 Annual Benefits to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration.

Ship Operating Costs $/day	Ship Berthing Status	BREAKBULK		DRY BULK		CONTAINER		Range of 1974 National Benefit $		
		Phila $	National $	Phila $	National $	Phila $	National $			
10000	working	3,418	41,966	2,509	24,724	609	12,181	49,294	88,871	112,312
10000	idle	3,256	39,977	2,239	22,063	554	11,081	45,101	73,121	104,124
1500	working	1,588	19,491	907	8,938	255	5,101	20,960	33,536	47,755
1500	idle	1,413	17,349	636	6,267	200	4,000	17,260	27,616	39,325

The 1974 National Benefit has an associated range based on climatological precipitation of $^{+42.4\%}_{-37.5\%}$.

U.S. and Foreign Flag.

Table 3.6 1985-2000 National Annual Maximum Avoidable Losses from Precipitation in Ports and Harbors (U.S. and Foreign Flag)

Ship Daily Operating Costs ($)	Ship Berthing Status	TYPE OF SHIPPING			National Total Annual Maximum $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	74,319,096	33,642,192	25,505,953	133,467,241
10000	idle	70,664,538	29,998,804	23,227,857	123,891,199
1500	working	34,615,975	12,207,715	10,692,880	57,516,570
1500	idle	30,932,181	8,564,327	8,414,785	47,911,293

Losses have a range $^{+42.4\%}_{-37.5\%}$ due to port climatology.

$ are $1974.

Table 3.7 Estimated National Annual Benefit from Appropriately Applied Weather Forecasting, from all Sources, to Ports and Harbors (U.S. and Foreign Flag)

Ship Daily Operating Costs ($)	Ship Berthing Status	TYPE OF SHIPPING			National Annual Benefit $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	27,489,106	12,451,015	9,440,856	49,380,977
10000	idle	26,137,365	11,102,595	8,597,645	45,837,605
1500	working	12,803,744	4,518,093	3,958,990	21,280,827
1500	idle	11,491,173	3,169,665	3,114,687	17,725,525

Benefits have a range $^{+42.4\%}_{-37.5\%}$ due to port climatology.

$ are $1974.

Table 3.8 1985-2000 Annual National Benefit to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration. (U.S. and Foreign Flag)

Ship Operating Costs $/day	Ship Berthing Status	BREAKBULK		DRY BULK		CONTAINER		Range of National Benefit $		
		Phila $	National $	Phila $	National $	Phila $	National $			
10000	working	3,418	74,243	2,509	33,593	609	25,531	83,354	133,367	189,915
10000	idle	3,256	70,724	2,239	29,978	554	23,225	77,454	123,927	176,472
1500	working	1,588	34,492	907	12,144	255	10,690	35,829	57,327	81,634
1500	idle	1,413	30,692	636	8,515	200	8,385	29,745	47,592	67,771

National Benefit Range due to port climatology variation, +42.4% / -37.5%.

$ are $1974.

Table 3.9 Allocation of 1985-2000 Annual Benefit from SEASAT or Appropriate Weather Forecasting Amongst Ports (operating costs $10,000/day, working status)

Port	SHIPPING TYPE BENEFIT			Total Benefit %
	Breakbulk %	Container %	Dry Bulk %	
Philadelphia	4.64	0.92	2.00	7.56
Boston	0.68	0.99	0.23	1.90
New York/New Jersey	4.47	4.99	4.73	14.19
Baltimore	4.06	2.75	3.01	9.82
Hampton Roads	5.04	2.58	0.86	8.48
Houston	5.41	0.90	3.96	10.27
New Orleans	16.18	1.03	3.34	20.55
San Francisco	2.56	0.20	1.06	3.82
Los Angeles/Long Beach	2.13	0.48	0.37	2.98
Seattle	3.31	1.86	0.90	6.07
Portland	1.95	0.64	2.37	4.96
Minor Ports	5.24	1.80	2.36	9.40
Total	55.67	19.14	25.19	100.00

percentages shown are for working ships and for daily operating costs of $10,000. Shipping with either different daily operating costs or with different berthing status would produce different percentage allocations of benefits. It can be reasonably argued that increasing success in weather forecasting in ports and harbors will result in an effective reduction of labor's wages. It is then also reasonable to assume that labor will contractually seek to eliminate this condition by requiring a fixed annual wage. Avoidable losses to labor will then become unavoidable losses, with a consequent reduction in benefits. The resulting adjustment to benefits from SEASAT exclusively and from appropriately applied weather forecasting are shown in Tables 3.10, 3.11 and 3.12.

3.2 Conclusions

The national realizable incremental annual benefit exclusive to the integration of SEASAT derived data into the weather forecasting process is quite modest. Its extreme maximum value is $190,000 (1974) as shown in Table 3.8 of the summary. Between January 1, 1985, the time when SEASAT will become operational, and December 31, 2000, the end of the planning horizon, the integrated undiscounted benefit is $3,040,000 (1974). The present value at January 1, 1975 of this annual benefit at different discount rates is tabulated below.

Discount rate	0%	5%	10%	15%
Present value ($ 1974)	3,040,000	1,210,699	557,137	233,757

Table 3.10 1974 SEASAT Exclusive National Benefits With Labor Losses Excluded. (U.S. and Foreign Flag)

Ship Operating Costs $/day	Ship Berthing Status	SHIPPING TYPE BENEFIT			National Annual Benefit $	Benefit % Reduction
		Breakbulk $	Dry Bulk $	Container $		
10000	working	30,921	24,388	10,702	66,011	16.3
10000	idle	28,911	21,728	9,604	60,243	17.6
1500	working	8,481	8,603	4,910	21,994	34.4
1500	idle	6,247	5,932	3,979	16,158	41.4

Benefits have a range $^{+42.4\%}_{-37.5\%}$ based on ports climatology.

All benefits are in $1974.

Table 3.11 1985-2000 SEASAT Exclusive National Benefits With Labor Loss Excluded. (U.S. and Foreign Flag)

Ship Operating Costs $/day	Ship Berthing Status	SHIPPING TYPE BENEFIT			National Annual Benefit $	Benefit % Reduction
		Breakbulk $	Dry Bulk $	Container $		
10000	working	54,702	33,136	22,432	110,270	17.32
10000	idle	51,148	29,522	20,129	100,799	18.67
1500	working	15,004	11,689	7,595	34,285	40.19
1500	idle	11,052	8,060	5,300	24,412	48.71

Benefits have a range $^{+42.4\%}_{-37.5\%}$ based on ports climatology.

All benefits are in $1974.

Table 3.12 1985-2000 Estimated National Annual Benefit from Appropriately Applied Weather Forecasting, With Labor Losses Excluded. (U.S. and Foreign Flag)

Ship Operating Costs $/day	Ship Berthing Status	SHIPPING TYPE BENEFIT			National Annual Benefit $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	20,253,973	12,281,681	8,294,736	40,830,390
10000	idle	18,902,542	10,933,835	7,451,579	37,287,956
1500	working	5,569,629	4,348,665	2,812,863	12,731,157
1500	idle	4,119,966	3,000,404	1,968,794	9,089,164

Benefits have a range $^{+42.4\%}_{-37.5\%}$ based on ports climatology.

All benefits are in $1974.

The magnitude of the estimated benefit is directly related to the small influence that SEASAT data is judged to have on the general growth of the normal local weather forecasting procedures and to the complexity of prediction of the meteorological event of interest to this application. Should the judgmental influences estimated prove to be in error, or should meteorological factors other than surface wind measurements be significant, then the expected benefits will change.

From Table 3.9 of the summary, the port of New Orleans is allocated the maximum amount of national benefit at 20.55 percent. This port services at least 50 different shipping lines or owners so that the expected benefit per shipping line from SEASAT is negligibly small.

From Table 3.7, the estimated national maximum annual benefit from appropriately applied weather forecasting, will range about the estimated value of $49,380,977 ($1974), from $30,863,111 ($1974) to $70,318,511 ($1974). Appropriately applied weather forecasting requires the specific procedure to apply the normally available meteorological data to the forecasting of the precipitation and the dissementation of the resulting information to the ship owners. The information can then be sufficiently reliable so that ship owners will act upon it.

Working with the lower bound of the climatology range or $30,863,111 ($1974) implies that the annual implementation and operating costs of this new forecasting system if a net benefit exists, in the port of Boston for example, should not exceed $586,399 ($1974). In the port of New Orleans the local forecasting system annual implementation and operating costs should not exceed $6,342,369 ($1974). These quantitative estimates identify therefore the incentives for the implementation and operation of local forecasting systems, specific to this application.

Table 3.6 which tabulates the maximum benefits in ports and harbors identifies the quantitative incentives for eliminating the influence of precipitation forecasting in the nation's ports and harbors. These are the incentives for the construction of coverage in the loading and unloading areas of the nation's port and harbors.

Working again with the lower bound of the climatological range or $83,417,026 per annum, the annual costs for such protective coverage in the port of Boston should not exceed $1,584,923 ($1974) while in the port of New Orleans similar annual costs should not exceed $17,142,199 ($1974). With this protective coverage labor would not be prevented by precipitation from working every day, and therefore should not contractually seek precipitation compensation.

The case study and its generalization has demonstrated that benefits exclusively from SEASAT to port and harbor operations are likely to be extremely small. The study results further demonstrate the economic incentives in each major U.S. port to implement and operate a precipitation prediction system useful to shipping concerns in reducing avoidable cost losses. In addition it demonstrates for each port the economic incentives for protecting against precipitation in the loading/unloading areas of the port.

The avoidable cost loss savings or benefits from improved weather forecasting result from cost loss savings for nonproductive labor and from cost loss savings for ship operating and dockage costs. It is suggested that the labor related cost savings will not really materialize because the union will seek compensation to offset any resulting decrease in longshore labor take home pay. If this occurs any described benefits will be reduced as discussed on pages 147-150 of this report. The remaining cost loss savings reduce the cost to the shipowners for transferring cargoes, thus reducing overhead. This reduction could be applied to a reduction in shipping costs for goods moved domestically and in the import-export trade. This portion of the avoidable cost savings would then be a social benefit, small in magnitude.

4. PORTS AND HARBORS CASE STUDY

4.1 Introduction and General Discussion

4.1.1 Introduction

Activities and operations of shipping are frequently disrupted by weather and sea state conditions prevailing in a port.

In general, the disruptions interrupt the orderly integrated working of the port and the port services so that, as a consequence, an economic loss is sustained by ship owners.

In theory, these economic losses are a result of inadequate prediction of local weather and sea state conditions which SEASAT data, in its operational form, may be able to alleviate. This alleviation, should it occur, will arise because improved large area weather forecasting will be of significance to local weather forecasting, a condition not clearly identifiable because of the distinctive modeling necessary to precise local weather forecasting.

In a well established commercial activity such as shipping it is necessary to accept that practical forms of optimization have been achieved by ship owners who construct operations in keeping with their risk characteristics and with their generalized interests. This is particularly true today when a ship owner is very much directly involved with the exercise of control of his ships. This implies that even with perfect local weather forecasting a ship owner may continue to operate as before for reasons that are not immediately apparent, because of his particular personality and commercial interests. The objective of this case study is to identify, however, those activities and operations of shipping in a port which present opportunity for economic loss and to derive the magnitude of this loss and the degree of loss saving that an operational SEASAT may provide.

The case study investigation will concentrate on the economic loss opportunities in one selected U.S. east coast port, although, evidently, the case study quantification should extend to all U.S. ports as an aggregate. The representative port will be that of Philadelphia. All other major U.S. ports will be categorized in terms of the ports of Philadelphia with respect to shipping traffic and precipitation to generate appropriate national economic losses.

4.1.2 General Discussion

4.1.2.1 The General Sources of Economic Losses

The ship owner either contracts or charters his vessel to carry cargo from a port of origin to a port of destination. Most generally, a vessel's cargo may be collected from a sequence of ports before the vessel leaves its port of clearance, and the cargo is delivered to a sequence of ports after the vessel reaches its port of arrival.

Each port makes available a variety of services and support which are indispensable to the transfer of cargo between the vessel and the shore and to the sustenance and maintenance of the vessel itself. All such services are paid for by the ship owner.

To be available to the ship at the proper time, most services must be arranged and contracted for ahead of time by the ship's agent at the port. If then, for any reason, the ship does not avail itself of the services contracted for, the contracts must be honored, thus incurring an economic loss to the ship owner.

For the port to function effectively for all shipping, the port establishes operating rules to which ship owners and consignees of cargo must adhere. If there is noncompliance to these rules for any reason, penalties are incurred which must be payed for by either the shipper or the consignee. Penalty payments are, therefore, also an economic loss.

Some of these economic losses can result from inclement weather in the port, and it is these that SEASAT's data contribution may specifically help to alleviate by appropriate weather prediction.

Weather-associated economic losses will be discussed as either delays or penalties. Delays will be classed as either scheduling delays or ship service safety delays.

A scheduling delay results when a vessel does not arrive at its scheduled time at its port of termination. The vessel may then lose its berth and all contracted services. The services must then be paid for and the ship will spend more time at anchorage, requiring nonproductive ship operating costs. The cost of the contracted services and the incremental ship anchorage operating costs constitute the economic loss from scheduling delay. Berthing is a problem when the demand for berths in a port exceeds the supply of berths, a condition that does not prevail in every port.

A service safety delay can result from inclement weather in a port while the ship is on its way to berth or is berthed. These delays are of three major types:

1. Those resulting from service labor which berths vessels, deciding that weather and sea conditions make it unsafe to operate. The labor involved is that of the pilots and tugboat operators. The general safety problem is then one of navigational constraint due to fog, heavy seas, or unusual tides.

2. Those resulting from service labor which transfers cargo between ship and shore and from service labor operating at the shore cargo terminals. This particular labor force belongs either to the International Longshoremen's Association (ILA) and operates under the practical implementation of a negotiated agreement, particularized to the port, or they are railroad personnel for coal cargoes and roll on, roll off, vessels.

3. Those resulting from risk averse decisions taken by the ship's master or ship owners. These decisions prevent cargo from being transferred from the ship to the pier or deny entry to the vessel's hatches because the cargo is susceptible to weather damage.

Penalties result from infringement of port operating rules or from infringement of owner-charterer contracts. These are various forms of demurrage, ship or wharf; cargo storage costs, ground transportation costs, and dispatching or demurrage between an owner and a charterer. Penalties are related to a particular port through tariffs established in the port, or they are determined by specific contractual arrangements for each individual chartering agreement.

Scheduling delays, ship service safety delays or detentions, and penalties appear to be the general sources of potential economic loss to ship owners as a result of inadequate weather prediction. The implication is that the currently available weather prediction quality is not adequate for firm decisions to be made by the ship owners or their representatives, so that these economic losses can be reduced or eliminated.

4.1.2.2 Weather Prediction Requirements

The weather at a port must be predicted sufficiently ahead of time and with an assured quality that ship owner action could be expected to ensue. If ship owner action is to result, the ship owner must be assured of a profitable return as a consequence of action resulting from the predictions, and the ship owner must also have available alternate courses of action which can still promise profit.

Prediction of weather at a port is a local weather prediction process. In general, local weather vagaries require a comprehensive local model interpreting the appropriate topographic influences on the broad weather parameters (air pressure, winds, temperature differences) and which incorporates a time structuring. Currently, it is difficult to predict the time of occurrence of weather phenomena accurately because of dynamic energy transport modelling inadequacies. It is not clear that SEASAT's global weather information, even provided on a smaller grid, will appreciably influence the quality of local weather prediction. That is, it is much more a question of accurate local influence modelling than of data initialization, although accurate wind information seems to be beneficial.

Shipping is a constrained commerce. Cargoes are contracted for at particular port locations and, for the contract to be fulfilled, a ship must enter the particular port irrespective of the prevailing weather. Certain cargoes can only be handled in certain ports, thus constraining options. In addition, the tendency is to consider that a ship is being properly utilized if it is in motion, in spite of the weather particularly with the current trend to larger, more expensive ships. To some unknown extent, shipping rates assume certain weather delays in transit based on observational experience so that incremental profit is always a possibility, with associated risk, if current inclement weather does not persist for the duration of the ship transit.

Incremental improvement in local weather prediction requires, therefore, careful association with the SEASAT program technical objectives, and the benefits that can result to the ship owners require careful selection if they are to be realistic.

4.1.2.3 The Values of the General Sources of Economic Losses

The values of the economic losses are related to port charges, labor charges, and ship operating costs. Port charges, such as those for penalties or berthing, are established at each port and depend on the cargoes involved. Labor charges are established through contracts between labor unions and the users of ports with intermediate organizations that control and operate the labor and the equipment needed for moving cargo on and off ships. Labor charges are defined, in the contract according to cargoes involved. Ship owner or ship master decisions concerning the activities relating to ship operations are determined by the cargo susceptibility to weather damage.

Actual economic loss potentials are, therefore, influenced by the port being considered. New York, for example, is a sea port, congested and somewhat difficult to navigate within. Philadelphia is a river port, where a ship entering Delaware Bay en route to the port still has a maximum of

130 miles to go from entrance to the unloading port, offering the observational benefit of elapsed time in the river that does not prevail at non-river ports.

4.1.2.4 The General Nature of the Pertinent Data

The port operations and activities are generally quite fractionated. Small organizations handle the shipping of specific ship owners, developing capabilities to satisfy the changing needs of their clients.

No organization appears to be strictly concerned with the role of weather prediction in helping to reduce the economic losses to their clients. Weather is lumped together with all other problems such as labor disputes and equipment breakdown in the port.

Because of the fractionation by organizations and the lumping together of losses, it has been decided to seek to generate measures for ports as a whole, wherever possible, rather than for individual shipping lines. This approach will minimize the amount of work required to itemize and compile data.

The actual sources of weather related economic losses to shippers have been determined in most instances through discussion with the shippers themselves or with their agents.

4.2 Case Study Methodology

Data collected from the ports of Philadelphia will be employed to specifically quantify port economic losses and the dependence of those losses on weather prediction improvements.

The economic losses in these ports will be quantified for different categories of shipping viz: - breakbulk, dry bulk, and container shipping. Tankers are generally operated privately by the petroleum interests and losses are not, therefore, explicitly quantifiable.

The economic losses in the ports of Philadelphia will be used as a model from which the economic losses of the remaining ten major U.S. ports will be quantitatively related through climatological precipitation measures and shipping traffic breakdowns. Precipitation and traffic breakdowns will be used as multipliers of the model to determine national losses. The eleven U.S. ports account for over 90 percent of the ship arrivals in the United States. The arrivals in the remaining 106 ports will be treated as a multiplication factor.

Weather prediction requirements as developed in the case study will be determined and, from these requirements, appropriate weather prediction capabilities will be estimated as a function of time.

Port and harbor economic losses will then be allocated to normal weather forecasting improvements and to the incremental improvements provided by SEASAT data.

4.3 The Ports of Philadelphia

4.3.1 Introduction

The ports of Philadelphia, called Ameriport, are shown in Figure 4.1 and are strung out along the Delaware River at Wilmington, Marcus Hook, Chester, Paulsboro, Gloucester City,

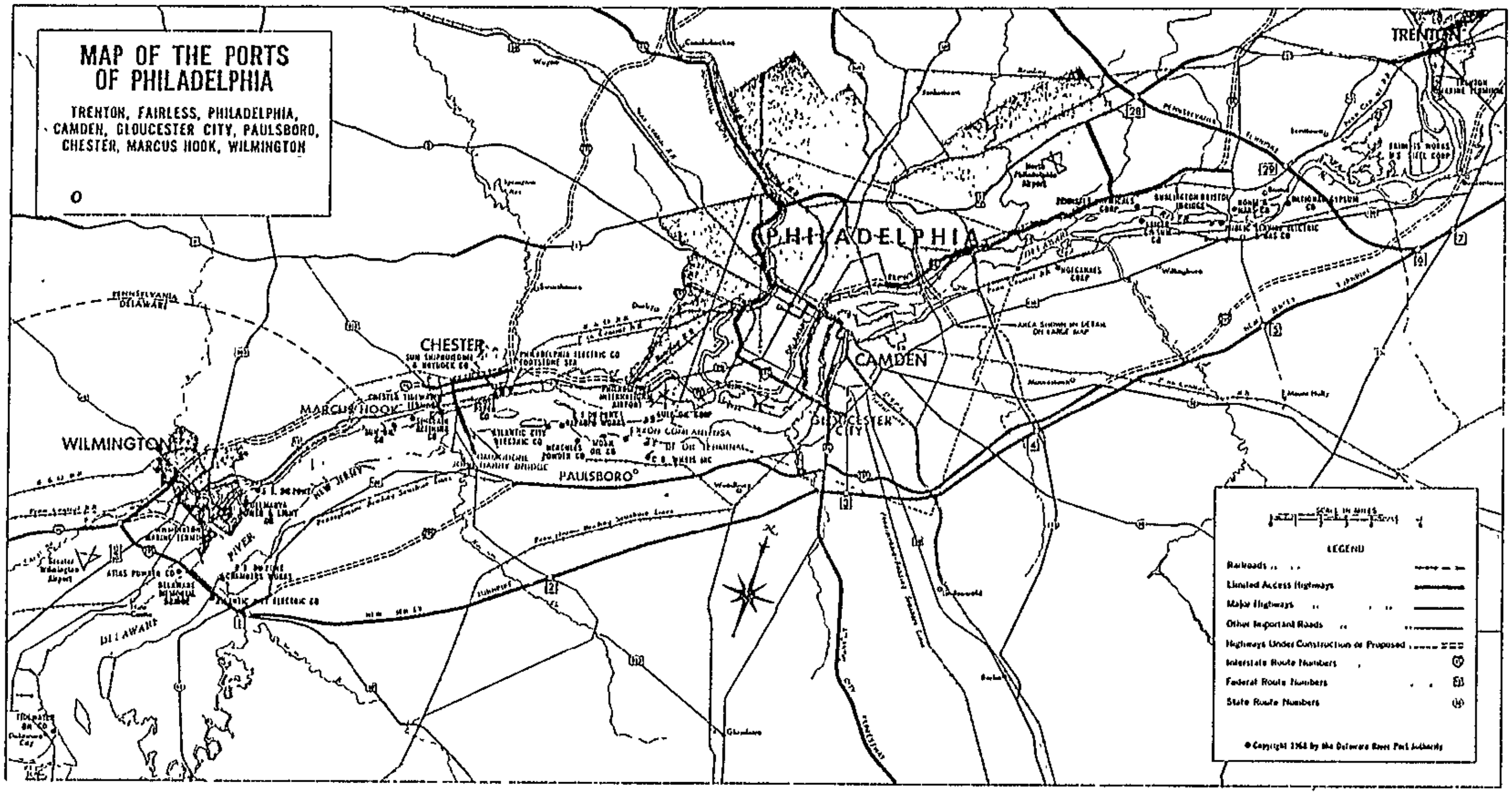


Figure 4.1 The Ports of Philadelphia

Camden, Philadelphia, Fairless and Trenton. Shipping entering Delaware Bay at Cape Henlopen must travel 90 miles to the central port of Philadelphia.

Numerous terminals, piers and wharves are distributed along the length of the river as shown in Figure 4.2 which is actually navigable for 130 miles from the Delaware Bay entrance. Terminals and piers are operated by a wide variety of organizations called stevedoring companies or terminal operators. About 17 different such organizations exist in the port of Philadelphia.

Approximately 200 steamship companies operate in the port and they are represented by about 23 steamship agents.

Construction and engineering services, including port equipment for the port, is undertaken by the Philadelphia Port Corporation. Advertising, publicity, and marketing of the ports' assets is presented worldwide by the Delaware River Port Authority. The Philadelphia Marine Trade Association (PMTA) contracts for its members with the International Longshoremen Association and provides the labor needed for the shipping and solves the majority of labor disputes for its members. Tariffs for penalties exercised by the port on cargo movement infractions are determined by the port of Philadelphia Marine Terminal Association. The Philadelphia Maritime Exchange, (PME) a private nonprofit organization, sustained by the fees of its membership, is a collection, storage and distribution center for maritime information and acts as liaison between the port

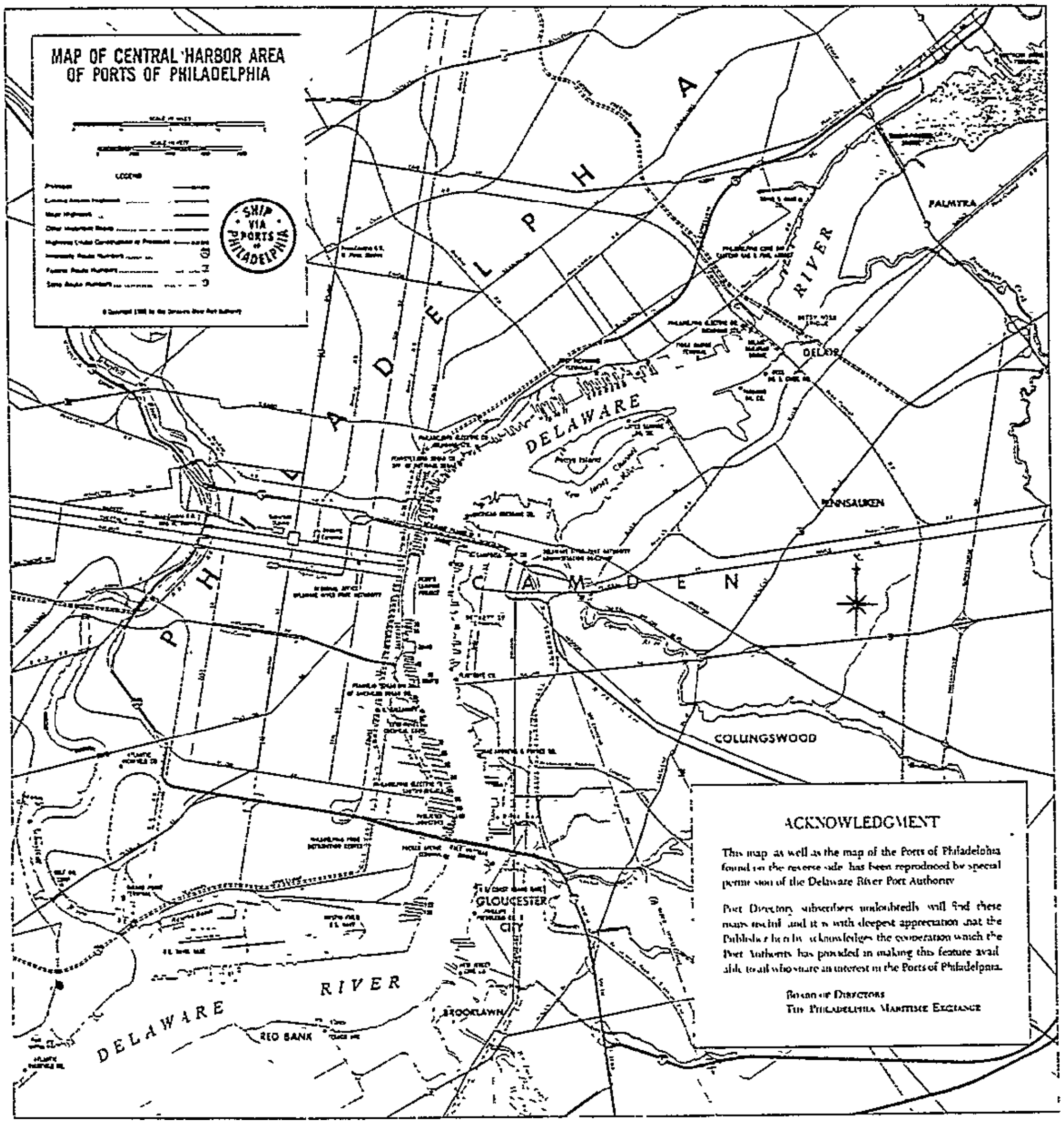


Figure 4.2 Central Harbor Area of Ports of Philadelphia

community and those federal, state and municipal organizations and agencies with responsibility for helping to keep the port and harbor complex operating. In addition, the Maritime Exchange documents events and happenings in the port as a reference for any research on port practices. The pilots of the port are members of the Pilot's Association for the Bay and River Delaware.

The organizations mentioned in this introduction have, through their cooperation and time, contributed to understanding the port operations and to selecting data pertinent to SEASAT's potential for reducing the losses to ship owners using the port.

Various organizations have or are involved in providing weather prediction data and information to users of the port. These include the Franklin Institute of Philadelphia, Accuweather of State College, Pennsylvania and the corporations RCA and ITT who supply various forms of marine equipment to shipping in the Delaware River. As a general statement, the weather prediction quality, made available by these organizations, has been insufficient for profitable action by the ship owners.

4.3.2 Sources of Weather Related Economic Loss

Various general sources of weather-related economic loss to ship owners have been previously discussed. It is now necessary to distinguish those which are of practical significance in the port of Philadelphia.

The consensus of opinion of those solicited was that the practically significant, weather related economic losses were those resulting from the guaranteed wages which must be paid to cargo movement labor.

Scheduling delays, as a result of inclement weather, do occur but the port of Philadelphia has a supply of berths which generally exceeds demand and rescheduling of berthing is relatively simple. The influence of weather at sea on scheduling is moderated appreciably by the up-river transit time from the Delaware Bay so that any economic loss was considered to be marginal.

Delays that result from decisions by berthing labor, pilots, and tugboat operators do also occur due to fog, but these are less and less frequent because of the successful use of radar in the navigation channels. There are occasions when tides are very high and strong, possibly for two days with N or NW winds, which can limit ship movement and causes flooding at piers. This is very infrequent. Ice has not occurred in the river since the early 1930s.

Penalties levied by the port because of cargo infractions resulting from weather were thought to be non-existent, although no statistical data is kept since the organizations involved are interested in collecting the money owed and not in knowing why the money is owed. Wharf demurrage and storage charges would only occur under very unusual weather since import cargo can remain on the wharf five days and export cargo seven days before charges begin. Ground transportation costs could conceivably be incurred if a ship was obliged to bypass the port of Philadelphia and go to Baltimore, for example, and ship the cargo by land from Baltimore to Philadelphia. Such action, because of weather, is very unlikely. It is more likely to occur as a deliberate tactic by the ship owner to save money because the cargo to be offloaded at Philadelphia is small in volume, and all port charges would be avoided.

Ship master or owner decisions concerning cargo transfer in inclement weather are assumed to be subsumed under the actions of safety by labor in inclement weather. That is, labor is generally fully aware of the existence of weather susceptible cargo and the general attitude of the ship owner when inclement weather conditions occur.

Thus, the source of economic loss in the Ports of Philadelphia to be studied more deeply will be that resulting from guarantees to the labor force involved in moving cargo.

4.3.3 Weather Related Economic Losses to Ship Owners

When a ship is berthed, its services are provided by the International Longshoremen's Association, ILA (AFL-CIO). The total service organization consists of longshoremen, car-loaders, carpenters, ship cleaners, mechanics, lockermen, gearmen, crane operators, truck drivers, clerks, checkers, timekeepers and coopers. These crafts and trades perform administrative functions, repair cargo damage, secure cargo stowage, clean various ship parts and move cargo between piers and trains or trucks, or move cargo between piers and the ship's holds or decks, rigging the vessels for cargo transfer as required. Crane operators, in addition, move container cargo between ship and pier.

During inclement weather, most crafts and trades can be assigned to productive work. The longshoremen, handling the cargo between ship and pier, may suspend their operations as a safety measure for both cargo and longshoremen. Crane operators, for example, responsible for precise movement and stowage of bulky and heavy containers, may, in high winds, decide that their operation is no longer safe and suspend operations as a consequence, although this particular condition occurs very, very infrequently in the ports of Philadelphia.

For the longshoremen, inclement weather is the occurrence of rain, snow, or sleet during a day working shift, one of two in a normal day, the first being from 8 a.m. to 12 noon, the other from 1 p.m to 5 p.m. Night shift work and weekend work is also undertaken with an identical weather definition. The amount of inclement weather precipitation that is required to cause a work stoppage is not defined but as a practical operating entity, its existence seems well-understood by labor, its management, and the ship owners. Working rules are established in a written agreement between labor and the Philadelphia Marine Trade Association, some pages of which are shown in Figures 4.3, 4.4, 4.5 and 4.6 taken from the agreement

1, 1970 unless the ILA District Council decides otherwise and advises PMTA.

	From 10-1-68 to 9-30-69	From 10-1-69 to 9-30-70	From 10-1-70 to 9-30-71
General Cargo			
STRAIGHT TIME	$4.00	$4.25	$4.60
OVERTIME RATE	6.00	6.375	6.90
Oil, Kerosene, Gasoline, Grease, Naphtha in Barrels, drums, cases or other container (in excess of 2 hours per day per gang)			
STRAIGHT TIME	4.15	4.40	4.75
OVERTIME RATE	6.225	6.60	7.125
Tallow, Vegetable Oil, Asphalt, and Pitch in barrels and drums (in excess of 2 hours per day per gang)			
STRAIGHT TIME	4.15	4.40	4.75
OVERTIME RATE	6.225	6.60	7.125
Hides, Wet			
STRAIGHT TIME	4.15	4.40	4.75
OVERTIME RATE	6.225	6.60	7.125
Grain — Trimming, Bagging and Stowing at Grain Elevator			
STRAIGHT TIME	4.20	4.45	4.80
OVERTIME RATE	6.30	6.675	7.20
Bog Ore, Sulphur and all other Bulk Cargoes			
STRAIGHT TIME	4.05	4.30	4.65
OVERTIME RATE	6.075	6.45	6.975
Naphthalene, in bags, inbound only			
STRAIGHT TIME	4.25	4.50	4.85
OVERTIME RATE	6.375	6.75	7.275
Cresylic Acid, in drums, inbound only			
STRAIGHT TIME	4.50	4.75	5.10
OVERTIME RATE	6.75	7.125	7.65
Refrigerator Space Cargo—When carrying temperature of the cargo is 32 degrees Fahrenheit or below			
STRAIGHT TIME	4.20	4.45	4.80
OVERTIME RATE	6.30	6.675	7.20

12

	From 10-1-68 to 9-30-69	From 10-1-69 to 9-30-70	From 10-1-70 to 9-30-71
Fish Meal			
STRAIGHT TIME	$4.15	$4.40	$4.75
OVERTIME RATE	6.225	6.60	7.125
Bone Meal			
STRAIGHT TIME	4.15	4.40	4.75
OVERTIME RATE	6.225	6.60	7.125
Licorice Root			
STRAIGHT TIME	4.20	4.45	4.80
OVERTIME RATE	6.30	6.675	7.20
Horn Meal			
STRAIGHT TIME	4.25	4.50	4.85
OVERTIME RATE	6.375	6.75	7.275
Tapioca Flour			
STRAIGHT TIME	4.25	4.50	4.85
OVERTIME RATE	6.375	6.75	7.275
Bags of Bones			
STRAIGHT TIME	4.25	4.50	4.85
OVERTIME RATE	6.375	6.75	7.275
Umber (earth) in bags			
STRAIGHT TIME	4.25	4.50	4.85
OVERTIME RATE	6.375	6.75	7.275

(b) When men are hired to handle any of the above commodities, and when waiting time is incurred, the men shall receive the rate applicable for the specific commodity, provided the men stand by as directed.

7. Distress:

(a) When men are called upon to handle cargo under circumstances unusually distressing or obnoxious to the men, they shall be paid in accordance with the schedule as follows:

	From 10-1-68 to 9-30-69	From 10-1-69 to 9-30-70	From 10-1-70 to 9-30-71
8 A.M. to 12 Noon, 1 to 5 P.M., Monday through Friday, per hour	$8.00	$8.50	$9.20
12 Noon to 1 P.M., Monday through Friday, men will be guaranteed two (2) hours pay at (per hour)	8.00	8.50	9.20

13

Figure 4.3 Longshoremen Wage Rates

	From 10-1-68 to 9-30-69	From 10-1-69 to 9-30-70	From 10-1-70 to 9-30-71
(If they work beyond 1 P.M. they will be compensated from 1 P.M. at time and a half time until relieved).			
All other meal hours, per hour	$16 00	$17.00	$18 40
Overtime—per hour	12 00	12.75	13 80

(b) Wage differentials are provided in Clause 6(a) above as compensation for unusual conditions common to certain commodities. These commodities are not to be construed as creating conditions distressing or obnoxious unless damaged by fire, water or fuel oil, when payment will be made in accordance with the following schedule:

	From 10-1-68 to 9-30-69	From 10-1-69 to 9-30-70	From 10-1-70 to 9-30-71
8 A.M. to 12 Noon, 1 to 5 P.M., Monday through Friday, per hour	$8.00	$8.50	$9.20
12 Noon to 1 P.M., Monday through Friday, men will be guaranteed two (2) hours pay at (per hr.)	8.00	8 50	9 20
(If they work beyond 1 P.M. they will be compensated from 1 P.M. at time and a half time until relieved)			
All other meal hours per hour	16 00	17 00	18 40
Overtime—per hour	12.00	12 75	13 80

(c) A dispute as to whether, in any particular case, the cargo causes distress conditions shall be dealt with in accordance with Clause 30

(d) These rates are to apply only in the compartment where the conditions exist.

8. Explosives:

(a) Men handling explosives shall be paid as follows:

	From 10-1-68 to 9-30-69	From 10-1-69 to 9-30-70	From 10-1-70 to 9-30-71
8 A.M. to 12 Noon, 1 to 5 P.M., Monday through Friday, per hour	$8 00	$8 50	$9.20
12 Noon to 1 P.M., Monday through Friday, men will be guaranteed two (2) hours pay at (per hr.)	8 00	8 50	9 20
(If they work beyond 1 P.M. they will be compensated from 1 P.M. at time and half time until relieved.)			
All other meal hours, per hour	16 00	17.00	18.40
Overtime—per hour	12 00	12.75	13 80

(b) Men hired to handle explosives at Artificial Island or any other anchorage shall be paid travel time (68-69—$4 00, 69-70—$4.25, 70-71—$4.60 per hour) until they arrive at the launch pier in the vicinity of the anchorage. Explosive rates, as per the foregoing schedule, will become effective and remain in effect until the men are returned to shore. Travel time at (68-69—$4.00, 69-70—$4 25, 70-71—$4 60) per hour will then be paid until the men arrive back at the hiring point.

(c) Stand by time before boarding the launch shall be at explosive rates, and shall continue at those rates if men are transported to the ship. If work is cancelled prior to boarding the launch, men shall be returned to the hiring point and general cargo rates shall be paid for the remainder of the guarantee period.

(d) Men traveling beyond the guaranteed period will be paid the travel time rate of (68-69—$4.00, 69-70—$4 25, 70-71—$4 60) per hour back to the hiring point.

9. (a) Hiring System:

(1) For Tuesday through Saturday, day work, for either 8 A.M. or 1 P.M. start, orders must be placed by 4 P.M. the day before.

Figure 4.4 Longshoremen Wage Rates

(2) Men hired for a 1 P.M. start shall receive a 4 hour guarantee.

(3) For Sunday and Monday, day work, orders must be placed by Saturday at 9 A.M.

(4) From Monday through Friday, night work (5, 6 and 7 P.M.) orders must be placed by 1 P.M. the same day. Guarantee shall apply until 11 P.M.

(5) For Sunday, night work, orders must be placed by 9 A.M. Saturday. Guarantee shall apply until 11 P.M.

(6) Men working on Saturdays prior to 5 P.M. may continue to work overtime at their discretion. There will be no hire for work on Saturday nights beginning 5, 6, or 7 P.M.

(7) For work commencing at 8 A.M. on Monday or at 8 A.M. on the day following a holiday. Employers to have the right because of non-arrival of a vessel in port to cancel the gangs by 7:30 A.M. Gangs which have been cancelled on a Monday or a day following a holiday (from Monday to Friday, inclusive) shall be made available for re-assignment.

(8) Any new overtime hire for Saturdays, Sundays and Holidays, automatically entails four hours guarantee regardless of any conditions.

(9) Any new hire for a day following a holiday will be made by 4 P.M. the day before the holiday and will include the same cancellation rights provided for Monday.

(10) Any men short at the time work is scheduled to commence will be secured by replacements from the dispatching office.

(11) Ship side orders. The Employer must notify the gangs and the dispatching office not later than 3 P.M. of the day they are working whether or not they are required back that night or the following day for the same vessel

9. (b) Guarantees:

(1) Men employed from Monday to Sunday,

LONGSHOREMEN'S AGREEMENT

inclusive, shall be guaranteed four (4) hours' pay for the period between 8:00 A.M. and 12:00 Noon.

(2) Men re-employed at 1:00 P.M. from Monday to Sunday, inclusive, shall be guaranteed four (4) hours, with the exception of the finish of the hatch, or of a ship, for which they shall receive a minimum of two (2) hours.

(3) Men re-employed at 7:00 P.M. from Monday to Sunday, inclusive, who have worked during the day, may receive a minimum of two (2) hours due to weather conditions, or the finish of a ship or of a hatch (or upon the shifting of a ship to drydock or to another terminal in the port), otherwise a guarantee of four (4) hours.

(4) Men who have been ordered to report for work from Monday to Sunday, inclusive, at 5:00, 6:00 or 7:00 P.M., and have not worked during the day shall be paid until 11:00 P.M.

(5) Men re-employed at 1:00 A.M. from Monday to Sunday, inclusive, shall receive a guarantee of four (4) hours with the exception of weather conditions or the finish of the hatch or of a ship when they shall receive a two (2) hour minimum.

(6) If a ship is knocked off on account of inclement weather by the Ship's Master or his authorized representative the men will be paid the applicable guarantee, but in the event the men knock off themselves, they will be paid only for the time worked, regardless of guarantee provided for in this Agreement

(7) Men employed between 8.00 A.M. and 12.00 Noon who continue working through the meal hour and are relieved at 1:00 P.M., shall be notified prior to 1.00 P.M., that they are finished for the day, or if ordered back at 2.00 P.M. shall receive three (3) hours' pay at the straight time rate, except when the ship or the hatch in which the men are employed completes discharging or loading in less time, they shall receive a minimum of two (2) hours' pay.

Figure 4.5 Longshoremen Hiring and Guarantees

(8) Gangs shall be knocked off at a reasonable time, not less than ten (10) minutes before quitting time, to replace hatch covers. The full gang shall be used to remove or replace hatch covers.

10. Refusal to Work Overtime:

In the event that a gang or gangs have sufficient work on a ship to be expected to work a second day, and other gang or gangs have an amount of work which could be expected to complete in one day, by working not in excess of two (2) hours' overtime, and the Employer by 3 00 P.M. requests the gang or gangs with the shorter number of hours to work overtime to a finish, even though the other gang or gangs are ordered back for the next day, and the gang or gangs requested to work overtime refuse to work overtime to finish their hatches, they waive their right to the hatches and the work in those hatches can be completed by the remaining gang or gangs

In those cases where a gang or gangs are asked to work overtime and they agree, and at 5 00 P M. the ship or the stevedore changes the orders and sends the men home at 5 00 P M. (for any reason other than weather conditions), the gang or gangs sent home at 5 00 P M. shall be guaranteed two hours at the straight time rate

11. Flexibility:

(a) Having completed a work period on one vessel gangs may, at the beginning of the succeeding work period, with the prior approval of the Joint Dispatching Committee, be transferred to another job to supplement the gang or gangs previously hired in accordance with the provisions of Section 9 hereof, with the understanding that the work remaining in the hatches on the original vessel will be completed by the gangs remaining thereon, subject, however, to the condition that the opportunities on other ships shall be as great or greater than those on the original ship.

LONGSHOREMEN'S AGREEMENT

(b) The Employer will have first call on gangs registered with his company through the joint dispatching office. Where these gangs work for another Employer on a day on which their regular Employer has no work, it is understood that these gangs may be recalled on a subsequent day to their regular Employer. The work on the first vessel will, in this case, be completed by such gangs as may be available and secured through the joint dispatching office.

(c) After a vessel has worked through one or more guaranteed periods and there remains work on the vessel, certain gangs may be released at the discretion of the operator with the approval of the Joint Dispatching Committee, and re-registered at the joint dispatching office to be available to accept new work assignments with as great or greater work opportunity on the same or next day. The vessel shall be completed with the remaining gangs and the gangs which have been replaced will have no claim to work on the vessel provided that the gang received a job assignment for another hire through the joint dispatching office.

(d) The Union will designate a man to be on duty as a Union member of the Joint Dispatching Committee at all times and they will advise the Executive Secretary of PMTA a week in advance who has that duty for the following week. Employers will make the proper clearance as required in (b) and (d) above through that man. In his absence, the Employer will transfer or release gangs as set forth in (b) or (d) above and notify the Employer-member of the Joint Dispatching Committee, who will notify the designated Union member when he is available.

12. Holidays:

Legal holidays are New Year's Day, Lincoln's Birthday, Washington's Birthday, Good Friday, Decoration Day, Flag Day, Fourth of July, Labor Day, Columbus Day, November Election Day, Armistice Day, Thanksgiving Day, Christmas Day,

Figure 4.6 Longshoremen Hiring and Guarantees valid from October 1, 1968 to September 30, 1971. Paragraph 9 (a) establishes the hiring system or procedure by which longshoremen gangs are called or hired ahead of the arrival of the ship. Paragraph 9 (b) guarantees, establishes the wages that will be guaranteed to those gangs that are called under any conditions of operations.

Ship owners must, therefore, contract ahead of time for the service labor required and they have agreed to pay that labor for some hours of work whether that work is done or not done because of inclement weather.

These wage guarantees are the source of the economic loss sustained by the ship owners because of lack of precision in the prediction of inclement weather.

Wage rates, as shown in Figures 4.3 and 4.4, are dependent on the cargo handled. The most recent wage rates are shown in Figure 4.7 as an agreement with the Council of North Atlantic Shipping Associations (CONASA).

4.3.4 Derivation of the Maximum Labor Related Economic Loss

ILA labor is primarily concerned with the transfer of breakbulk cargo. This is general or non-homogeneous cargo. Cargo in the ports of Philadelphia is of many types as shown in Figure 4.8 breakbulk, container, dry bulk, tanker and passenger. Container, bulk and passenger vessels require little labor to unload, the first two because of the mechanization of cargo handling or of cargo unloading, the last one

MEMORANDUM OF AGREEMENT

COUNCIL OF NORTH ATLANTIC SHIPPING ASSOCIATIONS (CONASA) AND INTERNATIONAL LONGSHOREMEN'S ASSOCIATION AFL-CIO, AND THE ATLANTIC COAST DISTRICT, ILA, AFL-CIO (ILA)

The following is agreed to by CONASA and ILA in final and complete settlement of the seven (7) Master Contract issues:

1. WAGES
   1st Year — An increase of 70¢ per hour making a total straight-time wage rate of $6.80 per hour.
   2nd Year — An increase of 60¢ per hour making a total straight-time wage rate of $7.40 per hour.
   3rd Year — An increase of 60¢ per hour making a total straight-time wage rate of $8.00 per hour.

2. CONTRIBUTIONS TO THE WELFARE PLANS
   1st Year — An increase of 10¢ per hour making a total contribution of 90¢ per hour.
   2nd Year — An increase of 11¢ per hour making a total contribution of $1.01 per hour.
   3rd Year — An increase of 12¢ per hour making a total contribution of $1.13 per hour.

3. CONTRIBUTIONS TO THE PENSION PLANS
   1st Year — An increase of 15¢ per hour making a total contribution of $1.37 per hour.
   2nd Year — An increase of 16¢ per hour making a total contribution of $1.53 per hour.
   3rd Year — An increase of 18¢ per hour making a total contribution of $1.71 per hour.

4. HOURS
   To remain as in present CONASA-ILA agreements.

5. TERM OF AGREEMENT
   Three (3) Year contract.
   1st Year — Commence on October 1, 1974 to September 30, 1975.
   2nd Year — Commence on October 1, 1975 to September 30, 1976.
   3rd Year — Commence on October 1, 1976 to September 30, 1977.

6. CONTAINERIZATION — As set forth in appended Rules on Containers.

7. LASH — As set forth in appended Lash-Seabee Agreement.

Dated: June 21, 1974

COUNCIL OF NORTH ATLANTIC SHIPPING ASSOCIATIONS

by [signature]
President

[signature]
Secretary

INTERNATIONAL LONGSHOREMEN'S ASSOCIATION, AFL-CIO

by [signature]
President

ATLANTIC COAST DISTRICTS ILA, AFL-CIO

by [signature]
President

[signature]
Secretary

Figure 4.7

	TOTAL NET TONNAGE	BREAKBULK	CONTAINER	BULK	TANKER	PASSENGER
JAN	4,389,623 (462)	752,748 (159)	185,622 (28)	658,388 (88)	2,792,865 (187)	-
FEB	3,774,522 (394)	723,375 (135)	54,475 (21)	603,897 (76)	2,392,775 (162)	-
MAR	4,625,293 (448)	741,355 (147)	130,907 (17)	846,209 (102)	2,906,822 (182)	-
APR	4,358,409 (414)	573,774 (127)	203,269 (30)	732,463 (79)	2,848,903 (178)	-
MAY	4,405,248 (439)	624,963 (136)	156,149 (22)	943,104 (106)	2,681,032 (175)	-
JUN	4,117,823 (403)	619,854 (138)	193,288 (22)	737,768 (82)	2,556,847 (160)	10,066 (1)
JUL	4,614,008 (439)	744,080 (142)	170,797 (20)	926,773 (98)	2,742,160 (176)	30,198 (3)
AUG	4,518,721 (437)	659,363 (141)	218,218 (26)	839,061 (93)	2,793,689 (176)	8,390 (1)
SEP	4,137,154 (404)	538,367 (117)	243,127 (27)	857,971 (99)	2,464,129 (157)	33,560 (4)
OCT	4,408,677 (414)	547,993 (124)	193,275 (21)	883,333 (88)	2,756,674 (178)	27,402 (3)
NOV	4,460,079 (436)	601,575 (123)	293,934 (26)	867,361 (105)	2,678,941 (180)	18,268 (2)
DEC	4,732,592 (437)	534,528 (113)	167,382 (18)	926,877 (102)	3,103,805 (204)	- (0)
TOTAL	52,542,149 (5127)	7,661,975 (1602)	2,210,443 (278)	9,823,205 (1118)	32,718,642 (2115)	127,884 (14)

REMARKS: Numbers of vessels arriving are in parentheses.

Source: The Philadelphia Maritime Exchange, 620 Lafayette Building, Philadelphia, Pennsylvania 19106.

Figure 4.8 Net Registered Tonnage Statistics - 1973 because of the lack of cargo. Breakbulk cargo is primarily handled at the ports of Wilmington, Delaware and Philadelphia, Pennsylvania.

The derivation of the maximum loss will be performed for the ports of Philadelphia as a whole. The process will be to establish the weather conditions in the ports of Philadelphia and Wilmington during the year 1974 and then to determine the number of longshoremen gangs operating in these ports on precipitation days. The cost to ship owners of these gangs will be determined and based on certain assumptions about work cancellations; the aggregate cost to the ship owners will be derived for non-productive labor.

The ports of Philadelphia, on paper, have about 69 ILA longshoremen gangs with somewhere between 55 and 65 gangs operative. An average breakbulk gang consists of 19 men and one foreman, although the structure of gangs is very variable and related to cargo. A ship, on the average, may require three to four gangs for unloading with a large ship requiring six gangs. Gangs are supported by a variety of trades and crafts and administrative personnel, the support constituting an overhead cost on the basic labor changes.

Figure 4.8 identifies the breakbulk net registered tonnage as approximately 7.7 million tons. This is an indicator of the maximum tonnage moveable by the vessels entering the port. The PMTA estimates that about six million tons of cargo were moved in the port, with about five million man hours applied to the task. About 60 percent of these man hours were longshoremen man hours or man hours on board the vessel. There is thus a consistency between the statistics of the PMTA and the PME.

Weather data for the ports of Philadelphia is collected by the PME on a daily basis being reported in a format shown in Figure 4.9. The PME annual data for 1974 was compiled into precipitation days at Philadelphia and Marcus Hook (representative of Wilmington). This was assumed to indicate the identity of the local weather at Wilmington and Philadelphia where breakbulk cargos are unloaded. The results of this compilation are shown in Figure 4.10.

From the precipitation compilation of Figure 4.10 and the interpretation of the labor force guarantee rules, the following loss rule was selected:

1. If rain at 8 a.m and noon, then 4 hours lost.
2. If rain at 8 a.m. only, no decision (not known when it cleared).
3. If rain at noon and 4 p.m., no decision (gang termination time not known).

Applying the loss rule to Figure 4.10 produces the loss description shown in Figure 4.11 which incorporates the gangs actually called in Philadelphia and Wilmington as recorded by the PMTA for the days in question.

The rates for a gang are made up of basic wage, insurance, and taxes as a percentage of the basic wage and a

DATE Monday-30 1974

STATIONS	8 A.M.	NOON	4 P.M.
Philadelphia	Southwest Cloudy	West . Cloudy	Northwest Clear
Marcus Hook	Southwest Cloudy	West Partly Cloudy	Northwest Clear
Breakwater	Southwest/10 Cloudy	Northwest/10 Cloudy	Northwest/15 Cloudy

Source: The Philadelphia Maritime Exchange
Daily Station Weather Report.

Figure 4.9 Typical Weather Station Reporting

DAY	DATE	TIME OF DAY 8 A.M.	NOON	4 P.M.	LOCATION
	3 Jan 1974	R	R R	R R	Philadelphia and Marcus Hook
	9	R R			
	10	SL SL	R R		
	11	R RF	R RF	RF	
	21	R R	R RF		
	2 Feb 1974			R R	
	3			R R	
	8		SN SN	SN SN	
	19		R R	R R	
	22		R R		
	25	SN SN	SN SN	SN SN	
	2 Mar 1974		R R		
Sat	9	R R	R R		
	16		R R	R R	
	21	R R	R R		

Figure 4.10 Precipitation Days Compilation for the Port of Philadelphia 1974 at Philadelphia and Marcus Hook

		TIME OF DAY			
DAY	DATE	8 A.M.	NOON	4 P.M.	LOCATION
	24	R RF			Philadelphia and Marcus Hook
Sat	30	R R	R R		
Sun	31	R R	R R		
	1 April 1974			R R	
	2		R R		
	5			R R	
	6			R R	
	8			R R	
	9	R R			
Sat	13 Apr 1974	R R	R R		
	19			R R	
	23	R R			
	3 May 1974	R R			
	9			R R	
	10	R			

Figure 4.10 Precipitation Days Compilation for the Port of Philadelphia 1974 at Philadelphia and Marcus Hook (cont'd)

DAY	DATE	TIME OF DAY 8 A.M.	NOON	4 P.M.	LOCATION
	12			R R	
	18	R			Philadelphia and Marcus Hook
	23		R R		
	29		R R		
	2 June 1974		R R	R R	
	12	R R			
Sun	16	R R	R R	R R	
	23		R R		
	25		R R	R R	
	28		R R	R R	
	24 July 1974	R R	R R		
	2 August 1974			R	
	7	R R			
	22	R			
	6 Sept 1974		R		
	7	R R			

Figure 4.10 Precipitation Days Compilation for the Port of Philadelphia 1974 at Philadelphia and Marcus Hook (cont'd)

DAY	DATE	TIME OF DAY 8 A.M.	NOON	4 P.M.	LOCATION
	14	R R			
	28	R R		R R	
	29			R R	
	16 Oct 1974	R R	R R		Philadelphia and Marcus Hook
	5 Nov 1974		R R		
	12		R R		
	1 Dec 1974		R R		
Sun	8	R R	R R		
	16	R R	R R	R R	
	25		R R		

Legend:

R	Rain
SL	Sleet
SN	Snow
F	Fog

Figure 4.10 Precipitation Days Compilation for the Port of Philadelphia 1974 at Philadelphia and Marcus Hook (cont'd)

DAY	DATE	NUMBER OF GANGS PHILA WILMINGTON		TOTAL
	3 Jan 1974	PHILA WILMINGTON	40 0	40
	10		46 0	46
	11		42 3	45
	21		30 9	39
	25 Feb 1974		52 13	65
Sat	9 Mar 1974		0 17	17
	21		37 3	40
Sat	30		28 0	28
Sun	31		36 0	36
Sat	13 Apr 1974		5 3	8
Sun	16 Jun 1974		25 3	28
	24 July 1974		38 9	47
	16 Oct 1974		12 3	15
Sun	8 Dec 1974		17 0	17
	16		37 0	37

Figure 4.11 Precipitation Loss Days in the Ports of Philadelphia 1974

benefit which is a fixed hourly sum, plus overhead charges which depend on the composition of the skills and crafts needed to support the longshoremen. On some ships, there is one cooper for every two gangs. Some operations require a head foreman and an assistant. The actual charge to the shippers during 1974 increased in magnitude due to contractual agreement by about 2 percent.

The basic standard cost (which was supplied in confidence) was rounded off to $400/hour/gang.

Saturday and Sunday work are performed at time and one half. Because the benefit does not enter into this rate, the Saturday and Sunday rate was estimated to be from $525-550/ hour/gang.

These rates will be applied to the tabulation of Figure 4.11 to derive a maximum benefit, due to guaranteed payment losses. A loss requires the payment of 4 hours of work as a guarantee.

Hence, the loss payment is $1600/gang on weekdays and $2100 to $2200/gang on Saturday and Sunday.

The labor loss computation is shown in Figure 4.12 and produces a maximum loss for the Ports of Philadelphia, in 1974, lying between $879,800 and $893,200. This estimate is held to be conservative since some of the no-decision events of Figure 4.10 could have produced losses that were excluded from the calculations. Losses, in addition to those related to labor, will also occur. These will be discussed later when loss equations are developed.

DAY	DATE	NUMBER OF GANGS	LOSS PER GANG ($)	LOSS ($)
	3 Jan 1974	40	1600	64000
	10	46	1600	73600
	11	45	1600	72000
	21	39	1600	62400
	25 Feb 1974	65	1600	104000
	Sat 9 Mar 1974	17	2100 - 2200	35700 - 37400
	21	40	1600	64000
Sat	30	28	2100 - 2200	58800 - 61600
Sun	31	36	2100 - 2200	75600 - 79200
Sat	13 Apr 1974	8	2100 - 2200	16800 - 1 600
Sun	16 Jun 1974	28	2100 - 2200	58800 - 61600
	24 July 1974	47	1600	75200
	16 Oct 1974	15	1600	24000
Sun	8 Dec 1974	17	2100 - 2200	35700 - 37400
	16	37	1600	59200
		TOTAL ANNUAL LOSS (1974)........		$879,800 - $893,200
Annual Loss Round-Off $900,000 (1974)				

Figure 4.12 Nonproductive Labor Related Costs or Losses to Breakbulk Shipowners Using the Ports of Philadelphia in 1974

4.3.5 The Variability in Labor Related Annual Losses

4.3.5.1 Precipitation Variation

The calculated actual total annual loss for 1974 will be assumed to be about $900,000.

This loss is evidently dependent on the total annual precipitation and snowfall though not in any obvious manner because of the particularized time constraints associated with the loss calculation.

However, assuming a uniform relationship between total annual precipitation and snowfall, and its appropriate constrained measure, climatological data can be used to indicate the possible spread. NOAA climatological data is provided in Figure 4.13 tabulated as total precipitation and total snow, up to 1973. The meteorological station at Philadelphia airport provided the following figures for 1974:

Total precipitation	37.78 inches		
Total snowfall	17.00 inches	Dec	0.8
		Nov	T
		Mar	T
		Feb	12.1
		Jan	4.1

Since the actual calculation produced a loss due to snow about 10 percent of the time, the variability in precipitation only will be used to illustrate the possible variability in loss. The recorded precipitation in Figure 4.13 ranges from a minimum of 29.34 inches to a maximum of 49.63 inches with a mean of 41.09 inches.

A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

LOCAL CLIMATOLOGICAL DATA

ANNUAL SUMMARY WITH COMPARATIVE DATA

PHILADELPHIA, PENNSYLVANIA

1973

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION ENVIRONMENTAL DATA SERVICE

NARRATIVE CLIMATOLOGICAL SUMMARY

The proximity of Delaware Bay probably has some effects on temperature conditions locally. Periods of extended cold weather are relatively rare, with below zero readings reported only 24 times since official records began. Sustained periods of very high or low temperatures seldom last more than 3 or 4 days as conditions change fairly rapidly.

Due to the prevalence of maritime air during the summer months, the humidity adds to the discomfort of the high temperatures. On the other hand, heavy fog seldom occurs over a large section of the City except during the autumn and winter months and then on an average of only 10 times per year. At International Airport, however, due to the proximity of the river and the low terrain, heavy fog is observed about 30 times per year.

Precipitation is fairly evenly distributed throughout the year with maximum amounts during the late summer months. Much of the summer rainfall is in connection with local thunderstorms and is variable in amount in different parts of the City, due in part to the higher elevations in the western and northern sections. Snowfall amounts often are considerably larger in the northern suburbs than in the central and southern parts of the City. In many cases, the precipitation will change from snow to rain within the City. Single storms of 10 inches or more occur about every five years. The maximum amount of 21.0 inches fell on December 25-26, 1909.

The prevailing wind direction for the summer months is from the southwest, while northwesterly winds prevail during the winter. The annual prevailing direction is from the west-southwest. Destructive velocities are comparatively rare and occur mostly in gustiness during summer thunderstorms. High winds occurring in the winter months, as a rule, come with the advance of cold air after the passage of a deep low pressure area. Only rarely have hurricanes in the vicinity caused widespread damage, then primarily through flooding.

Flood stages in the Schuylkill River normally occur about twice a year. Flood stages seldom last over 12 hours and usually occur after excessive falls of precipitation during summer thunderstorms. Flood stages in the Delaware River are caused by abnormally high tides that occur due to the water "backing up" under the influence of strong south or southeast winds.

Figure 4.13 Local Climatological Data, Annual Summary with Comparative Data

METEOROLOGICAL DATA FOR THE CURRENT YEAR

Station: PHILADELPHIA, PENNSYLVANIA INTERNATIONAL AIRPORT Standard time used: EASTERN Latitude 39° 53' N Longitude 75° 15' W Elevation (ground): 5 feet Year: 1973

Month	Temp. Averages: Daily maximum	Daily minimum	Monthly	Extremes: Highest	Date	Lowest	Date	Degree days (Base 65°): Heating	Cooling	Precipitation: Total	Greatest in 24 hrs	Date	Snow, Ice pellets: Total	Greatest in 24 hrs	Date	Relative humidity pct.: Hour 01	Hour 07	Hour 13	Hour 19	Wind: Resultant Direction	Resultant Speed	Average speed	Fastest mile: Speed	Direction	Date	Percent of possible sunshine	Average sky cover sunrise to sunset	Number of days: Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures Maximum 90° and above	Maximum 32° and below	Minimum 32° and below	Minimum 0° and below	Average daily solar radiation - Langleys
JAN	42.6	26.2	34.4	62	19+	13	9	940	0	3.93	1.49	28-29	T	T	29+	69	[illegible]	55	59	29	3.6	10.7	37	S	22	38	6.7	6	8	17	8	0	1	1	0	6	23	0	
FEB	[illegible]	25.3	33.4	65	2	8	17	876	0	2.96	1.49	1-2	T	T	21-22+	59	52	48	54	34	4.8	11.8	28	NW	17+	34	6.5	7	6	15	9	0	0	1	0	5	20	0	
MAR	55.5	39.9	47.7	70	17	27	1	547	0	3.52	1.57	25-26	T	T	21+	70	13	63	67	03	2.6	11.4	47	SW	17	40	5.3	3	4	24	14	0	1	5	0	0	5	0	
APR	62.4	44.3	53.4	85	22	29	13	359	16	6.60	1.99	25-26	T	T	11	82	12	54	65	27	3.0	12.0	32	NW	11	49	6.4	8	9	13	12	0	4	0	0	0	1	0	
MAY	[illegible]	[illegible]	63.3	[illegible]	30	40	16	176	35	6.14	1.09	27-28	0.0	0.0		87	13	67	72	24	2.2	10.5	34	SW	11	43	7.0	6	9	16	14	0	3	0	0	0	0	0	
JUN	82.0	66.4	74.5	93	11	57	1	1	294	7.68	4.52	29	0.0	0.0		91	14	66	71	23	1.7	8.8	28	SW	8	56	6.2	8	11	11	12	0	8	1	5	0	0	0	
JUL	86.9	69.9	77.9	[illegible]	9+	56	12	0	404	2.39	0.97	13	0.0	0.0		82	53	55	53	23	4.3	8.8	33	NW	11	64	5.4	10	12	9	8	0	3	1	4	0	0	0	
AUG	87.4	70.1	78.8	95	26	57	23	0	435	2.03	0.59	14-15	0.0	0.0		86	55	57	67	23	1.8	8.4	29	NW	31	57	5.3	13	7	11	8	0	4	0	12	0	0	0	
SEP	81.5	60.8	70.7	[illegible]	3	51	22+	19	193	3.39	2.53	14-15	0.0	0.0		84	54	54	67	24	1.7	8.7	26	NE	14	61	5.4	11	9	10	8	0	2	1	5	0	0	0	
OCT	67.5	48.3	59.2	[illegible]	5	37	19	196	23	2.16	1.49	28-27	0.0	0.0		87	12	55	70	26	1.9	9.0	30	W	14	67	4.4	13	13	5	9	0	0	2	0	0	0	0	
NOV	57.0	34.9	44.3	75	15	22	11	307	0	0.64	0.24	27-28	T	T	9	75	18	52	67	27	0.3	10.6	35	W	1	53	5.7	6	11	11	10	0	0	1	0	0	8	0	
DEC	46.3	30.9	38.5	64	5	17	17	810	0	6.34	1.32	20-21	4.4	3.8	16-17	74	53	60	68	31	1.2	11.0	32	NW	28	36	6.0	6	8	17	14	1	1	1	0	3	19	0	
YEAR	[illegible]	47.0	56.4	97	AUG. 26	6	FEB. 17	4424	1400	46.06	4.62	JUN. 29	4.4	3.8	DEC. 16-17	80	51	58	66	27	2.5	10.1	47	SW	MAR. 17	53	6.2	103	103	159	122	1	25	14	28	14	76	0	

NORMALS, MEANS, AND EXTREMES

Month	Temperature Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal heating degree days (Base 65°)	Precipitation: Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs	Year	Snow, Ice pellets: Mean total	Maximum monthly	Year	Maximum in 24 hrs	Year	Relative humidity pct.: Hour 01	Hour 07	Hour 13	Hour 19	Wind: Mean speed	Prevailing direction	Fastest mile: Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days: Sunrise to sunset Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures Max 90° and above	Max 32° and below	Min 32° and below	Min 0° and below	Average daily solar radiation - Langleys
(a)	(b)	(b)	(b)	14		14		(b)	(b)	31		31		27		31	31		31		14	14	14	14	33	23	33	33		31	33	33	33	33	33	33	33	33	14	14	14	14	
J	40.1	24.4	32.3	59	1957	-5	1963	1014	2.81	6.06	1949	0.45	1955	2.27	1960	5.4	19.7	1961	13.2	1961	71	73	59	65	10.3	WNW	61	NE	1958	51	6.6	7	8	16	11	2	*	3	0	9	26	*	
F	[illegible]	25.3	33.8	69	1972	-4	1961	871	2.62	5.43	1971	1.37	1954	1.95	1956	6.0	18.4	1967	13.0	1958	68	71	57	61	11.2	NW	59	NW	1956	53	6.4	7	7	14	9	2	*	3	0	5	23	*	
M	51.2	32.5	41.9	83	1953	9	1960	716	3.69	6.27	1953	0.68	1966	2.39	1958	3.9	13.4	1958	10.0	1958	69	72	54	59	11.5	N	56	NW	1955	56	6.4	8	8	15	11	1	1	2	0	1	16	0	
A	[illegible]	42.1	52.9	92	1963	24	1969	367	3.29	6.64	1973	1.13	1963	3.36	1970	0.3	4.3	1971	4.3	1971	69	70	50	55	11.0	SW	59	SW	1954	56	6.5	7	9	14	11	*	2	2	*	0	2	0	
M	[illegible]	52.3	63.2	98	1962	28	1955	122	3.35	7.41	1948	0.47	1964	2.09	1956	T	T	1963	T	1963	76	76	53	59	9.7	WSW	55	SW	1957	57	6.5	6	11	14	11	0	4	2	1	0	*	0	
J	83.0	61.6	72.3	103	1964	44	1972+	0	3.70	7.88	1973	0.11	1949	4.62	1973	0.0	0.0		0.0		81	78	55	62	8.8	WSW	73	NW	1958	63	6.2	6	12	12	10	0	3	3	4	0	0	0	
J	86.8	66.7	76.8	104	1966	51	1956	0	4.07	8.13	1959	0.56	1957	4.26	1969	0.0	0.0		0.0		82	80	53	63	8.1	WSW	47	W	1959+	62	6.2	7	12	12	9	0	5	1	7	0	0	0	
A	84.8	64.7	74.8	97	1955	45	1965	0	4.11	9.70	1955	0.49	1964	5.68	1971	0.0	0.0		0.0		82	81	54	65	7.9	SW	57	E	1955	62	5.9	8	11	12	9	0	5	1	5	0	0	0	
S	78.4	57.8	[illegible]	97	1973	35	1963	38	3.03	8.78	1960	0.44	1969	5.45	1960	0.0	0.0		0.0		82	83	56	70	8.3	SW	49	NE	1950	60	5.6	10	9	11	8	0	2	2	2	0	0	0	
O	67.9	45.9	57.4	88	[illegible]	25	1969+	249	2.55	5.21	1943	0.09	1963	3.78	1966	T	T	1972+	T	1972+	80	87	53	69	8.9	WSW	66	SW	1954	60	5.5	11	8	12	7	*	1	4	0	0	2	0	
N	55.3	35.9	45.2	83	[illegible]	17	[illegible]	564	3.39	9.06	1972	0.64	1973	3.46	1953	0.7	4.5	1953	8.7	1953	73	77	56	67	9.7	WSW	60	SW	1950	52	6.3	7	10	13	9	*	*	2	0	0	10	0	
D	43.2	27.2	35.2	72	1966	3	1962	924	3.32	7.23	1969	0.25	1955	1.77	1951	4.4	18.8	1966	14.6	1960	73	74	61	68	10.3	WNW	47	NW	1950	49	6.6	8	8	15	10	1	*	3	0	5	22	0	
YR	64.2	44.9	54.6	104	JUL. 1966	-5	JAN. 1963	4865	39.93	9.70	AUG. 1955	0.09	OCT. 1963	5.68	AUG. 1971	20.7	19.7	JAN. 1961	14.6	DEC. 1960	76	76	55	63	9.6	WSW	73	NW	JUN. 1958	57	6.2	92	113	160	114	6	26	24	18	20	102	*	

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: [illegible] temperature 106 in August 1918; lowest temperature -11 in February 1934; maximum monthly precipitation 12.10 in August 1911; maximum precipitation in 24 hours [illegible] in August 1898; maximum monthly snowfall 31.5 in February 1899; maximum snowfall in 24 hours 21.0 in December 1909; fastest mile of wind 88 from South in July 1931.

(a) [illegible]
(b) [illegible]

[illegible]

‡ To 8 compass points only.

Figure 4.13 Local Climatological Data, Annual Summary with Comparative Data (cont'd)

AVERAGE TEMPERATURE

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

HEATING DEGREE DAYS

PHILADELPHIA, PENNSYLVANIA

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TOTAL PRECIPITATION

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Record Mean	[illegible]	[illegible]	3.49	3.30	3.32	3.61	4.10	4.31	3.36	2.79	3.12	3.23	41.09

TOTAL SNOWFALL

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Record mean values above (not adjusted for instrument location changes listed in the Station Location table) are means for the period beginning in 1874 for temperature and 1872 for precipitation.

† Indicates a break in the data sequence during the year, or season, due to a station move or relocation of instruments. See Station Location table.

Temperature, Degree Days, and Precipitation: Data are from City Office locations through December 1940 (except through June 1940 for Degree Days), from Southwest Airport (later named International Airport) through June 1945, from 2nd and Chestnut Streets (Bourse Building for Precipitation) through November 1945 and from International Airport locations thereafter.
Precipitation totals for 1941 and 1942 are based on an observational day ending at 1:30 a.m.
Snowfall: Data are from City Office locations through 1942 and from International Airport locations thereafter except that data for November 1945 are from 2nd and Chestnut Streets.

Figure 4.13 Local Climatological Data, Annual Summary with Comparative Data (cont'd)

STATION LOCATION

PHILADELPHIA, PENNSYLVANIA

Location	Occupied from	Occupied to	Airline distance and direction from previous location	Latitude North	Longitude West	Elevation above Sea level: Ground at temperature site	Elevation above Ground: Wind instruments	Extreme thermometers	Psychrometer	Telepsychrometer	Tipping bucket rain gage	Weighing rain gage	8" rain gage	Hygrothermometer	Sea level: Pyranometer	Remarks
CITY																
Phila. Board of Trade 595 Chestnut Street	12/23/70	9/21/71		39° 57'	75° 09'											No record of elevations.
Chamber of Commerce Building, 133 S 2nd St.	9/21/71	2/01/82	0.3 mi. E	39° 57'	75° 09'	23	a122		b98				c91			a - about 129 feet to 8/4/75. b - 102 feet to 8/4/75. c - Elev. prior to 8/4/75 unknown.
Mutual Life Ins. Bldg. 10th & Chestnut Sts.	2/01/82	4/01/84	0.7 mi. W	39° 57'	75° 09'	40	107		54				ϕ106			ϕ - Approximate.
Post Office Building 9th & Chestnut Sts.	4/01/84	12/17/34	0.1 mi. E	39° 57'	75° 09'	39	175 d184 e190 f182 g341 h367	169 d117 e124	168 d116 e123		%114		167 d114			% - Added 1/27/14. d - Effective 2/1/04. e - Effective 1/27/14. f - Effective 7/23/24. g - Moved 1000 feet South to Edison Building, 2/2/28. h - Effective 10/27/28.
New Customhouse 2nd & Chestnut Sts.	12/17/34	12/31/54	0.6 mi. E	39° 57'	75° 09'	26	i367 k m148	175	174		166 k m132	j166	166			i - Remained on Edison Building. j - Added 1/1/43. k - Moved to SW Airport 1/1/43. m - Added 0.2 mi. West on Bourse Building 7/1/45.
New Customhouse 2nd & Chestnut Sts.	1/01/55	5/15/59				26		175			n160	n160	166			Cooperative Station. n - Added 5/1/55.
Bourse Building 4th Street Below Market	3/01/55	5/01/55	0.2 mi. W	39° 57'	75° 09'							133				
Phila Electric Building 10th & Chestnut Sts.	5/15/59	Present	0.7 mi. W	39° 57'	75° 10'	35		155								
AIRPORT																
Administration Building Southwest Airport #	6/20/40	6/22/45		39° 53'	75° 14'	13	a58	6	5			b3	3			a - 57 feet through 1942. b - Installed 1/1/43. # - Name changed to International Airport 4/1/48.
Administration Building N. Philadelphia Airport	6/23/45	11/30/45	18 mi. NE	40° 05'	75° 01'	100	51	6	5				4			
Administration Building International Airport	12/01/45	12/22/54	18 mi. SW	39° 53'	75° 14'	13	58	6 *22	5 *22			3	3			* - Changed to roof exposure 10/4/54. WB design wind equipment installed 5/17/49.
New Terminal Building International Airport	12/23/54	5/09/55	7/8 mi. SW	39° 53'	75° 15'	13	120	67	66			64	64			
New Terminal Building International Airport	5/09/55	12/31/59	0.2 mi. N	39° 53'	75° 15'	13	120	7	66	7	3	4	3			
New Terminal Building International Airport	1/01/60	Present		39° 53'	75° 15'	5	20	d4	d55		e64	e64		c4		c - Commissioned 3000 feet South of telepsychrometer site. d - Removed prior to December 1968. e - 4 feet to 7/13/70.

Requests for additional climatic information should be addressed to: Director, National Climatic Center, Federal Building, Asheville, N. C. 28801

Sale Price: 15 cents per copy. Checks and money orders should be made payable to Department of Commerce, NOAA. Remittances and correspondence regarding this publication should be sent to: National Climatic Center, Federal Building, Asheville, N. C. 28801. Attn: Publications.

USCOMM-NOAA-ASHEVILLE - 1500

U.S. DEPARTMENT OF COMMERCE
NATIONAL CLIMATIC CENTER
FEDERAL BUILDING
ASHEVILLE, N.C. 28801

AN EQUAL OPPORTUNITY EMPLOYER

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
210

FIRST CLASS

Figure 4.13 Local Climatological Data, Annual Summary with Comparative Data (cont'd)

Thus, tentatively based on precipitation records at Philadelphia, a representative annual maximum loss variation would lie between $702,000 and $1,179,000, i.e., $900,000 $^{+31\%}_{-22\%}$.

4.3.5.2 Other Applicable Cargo Types

The calculated annual loss relates to breakbulk cargo. Longshoremen are employed to transfer both container and bulk cargoes, but there are differences in expected nonproductive costs.

Container cargo transfer in the ports of Philadelphia employs gangs of the same size as for breakbulk cargo transfer, but the transfer productivity is greater by a factor of from 3 to 4, say 3.5.

Bulk cargoes require different size gangs according to the bulk cargo being transferred. If the cargo is ore, then only two men are required; if the cargo is sugar, then 45 men are required; if the cargo is grain, then six men and one foreman are required per ship hatch. Grain ships usually have two hatches. In the ports of Philadelphia, grain is only loaded onto ships. If coal is being handled, then the only requirement for longshoremen is to open and close hatches where six men are required per hatch. Some hatches close automatically. Assuming that the various bulk cargoes are uniformly distributed in the ports of Philadelphia over each day, the mean bulk operation will be assumed to require (2+45+14)/3 men or approximately one gang (19 men). Estimates can then be made of the nonproductive cost losses to container and bulk cargo handling as ratios of the breakbulk nonproductive costs of $900,000.

Estimate for Container Cargo

From Figure 4.8 the ratio of container to breakbulk registered net tonnage is (2210443)/7661975 or 0.288. Since the cargo transfer productivity for containers is 3.5 times that for breakbulk cargoes, the multiplicative factor for container cargo is (0.288)/3.5 or 0.082. From this, the container annual nonproductive cost estimate is $900,000 x 0.082 or $73,800 ($1974).

Estimate for Bulk Cargo

From Figure 4.8 the ratio of bulk to breakbulk registered net tonnage is (9823205)/7661975 or 1.282. From Figure 4.11, when losses occur, the mean number of gangs operating is 33.9. For bulk cargo, the number of gangs required is one.

A multiplicative factor for bulk cargo is then given by (1.282)/33.9 or 0.038.

The annual nonproductive cost estimate for bulk cargo transfer is then $900,000 x 0.038 or $34,200 ($1974).

Together, these add 12 percent to the $900,000 loss estimate or an additional $108,000 nonproductive costs in the ports of Philadelphia. Thus, from all sources in the ports of Philadelphia during 1974, economic losses related to labor are estimated to be as follows:

From breakbulk shipping	$ 900,000
From container shipping	73,800
From dry bulk shipping	34,200
Total	$1,008,000 (1974)

Annual climatological variation in precipitation will modify this estimate to be \$1,008,000 $^{+31\%}_{-22\%}$, so that the range of annual labor related loss will be from \$786,240 to \$1,320,480, in the ports of Philadelphia.

4.3.5.3 Weather Forecasting Requirements to Reduce These Losses

The calculated loss to ship owners using the ports of Philadelphia during 1974, of about \$1,008,000, is a loss assumed to be based on the current capability of weather prediction in the ports of Philadelphia, since the gangs involved were actually called.

The hiring rules for labor, see Figure 4.4, Paragraph 9 (a), establish the forecasting requirements and the procedure for calculating the maximum losses establishes the prediction quality required.

The hiring rules can be summarized as shown in Table 4.1.

Table 4.1 ILA Labor Hiring Rules

Work Day	Daytime		Nighttime	
	Order	Start	Order	Start
Su	9 A.M. S	8 A.M.; 1 P.M.	9 A.M. S	5,6,7 P.M.
M	9 A.M. S	8 A.M.; 1 P.M.	1 P.M. M	5,6,7 P.M.
Tu	4 P.M. M	8 A.M.; 1 P.M.	1 P.M. Tu	5,6,7 P.M.
W	4 P.M. Tu	8 A.M.; 1 P.M.	1 P.M. W	5,6,7 P.M.
T	4 P.M. W	8 A.M.; 1 P.M.	1 P.M. T	5,6,7 P.M.
F	4 P.M. T	8 A.M.; 1 P.M.	1 P.M. F	5,6,7 P.M.
S	4 P.M. F	8 A.M.; 1 P.M.	1 P.M. S	5,6,7 P.M.

A rehire of labor must be ordered at 3 p.m. for a start the next day.

The following prediction intervals for inclement weather can then be deduced from Table 4.1 as shown in Table 4.2.

Table 4.2 Prediction Intervals for Hiring ILA Labor

Forecasting Interval (hours)	Type of Work for Labor
32-34	night work - weekend
23	day work - weekend
17	rehire - same job
16	day work - week
4	night work - week

The maximum derived benefit assumes that precipitation at 8 a.m. was never correctly predicted.

Additionally, there is an implication that the 4-hour duration of precipitation was not predicted either, although this is not strictly true, since a ship owner can choose, when there is precipitation at the beginning of a shift, to either retain the gangs at the pier or to let them go. If the gangs are retained and the weather inclemency no longer exists, then the gangs can be recalled to work.

Any captured benefit depends on the relative accuracy of predicting the onset of precipitation locally for the ports of Philadelphia, and of predicting the duration of the precipitation.

Presuming that today the ship owners take advantage of all and any weather services, the maximum loss reflects today's prediction capabilities of predicting precipitation at or before 8 a.m. which will continue until noon, at least, with a prediction interval of 16 or 23 hours for the ports of Philadelphia.

A quantitative estimate of this weather forecasting capability will be developed subsequently.

4.3.6 The Growth in the Economic Loss

The labor related economic loss derived for the ports of Philadelphia will increase with growth in traffic into the port. This growth is briefly discussed below.

Activity in the ports of Philadelphia between 1974 and 1985, the time when SEASAT will become operational, will change appreciably.

Breakbulk cargo tonnage into the ports will grow, but it is expected that the number of ships carrying the tonnage will decline.

While today there are about 65 gangs of longshoremen in the ports, the expectation, according to PMTA, is a consolidation into 42-45 gangs since the current labor force was established on the past peak demand.

It is to be expected that labor wages, welfare costs and pension plan costs will continue to rise, guided by the trends illustrated in Figure 4.7.

Bulk cargo tonnage is also expected to grow and the port is planning a substantial growth in container cargo as, indeed, are all U.S. ports because of the worldwide growth of container usage.

Estimates shown in Figure 4.14 of breakbulk cargo tonnage growth made by the World Trade Division of the Delaware River Port Authority (DRPA) indicate a cargo handling growth of about 45 percent from 1973 to 1985. Using the PMTA figure of six million tons for 1974, the projected increase would be only about 30 percent from 1974 to 1985.

If the breakbulk cargo growth approximated the DRPA estimated, it seems unlikely that the labor force will decline because labor productivity per man hour would have to increase by about 175 percent, a condition that seems unlikely for breakbulk cargo handling.

By 1985, assuming weather forecasting quality remains constant and labor productivity is unchanged, then the number of applicable man hours must increase by 30 percent to 45 percent. If these are distributed throughout a year, then the previous typical nonproductive costs might be assumed to increase by an average of say 38 percent to range from $1,085,011 to $1,822,262 ($1974). It is assumed implicitly that labor's wages will keep pace with inflation.

This maximum loss estimated range should be modified by any expected improvement in local weather forecasting between 1974 and 1985, which is independent of any SEASAT data, although it might be argued that if forecasting improves significantly, labor may seek wage increases to maintain real take-home pay constant.

AMERIPORT
International Commerce
Exports & Imports - In Short Tons
Actual Tonnage through 1973 - Projected to 1985

Year	Total	Bulk	General Cargo	
			Break-Bulk	Container
1958	45,572,217	42,385,708	3,186,509	-
1959	46,392,332	42,965,679	3,426,653	-
1960	46,476,802	42,459,553	4,017,249	-
1961	43,881,659	40,122,590	3,759,069	-
1962	50,319,614	46,626,023	3,693,591	-
1963	50,385,455	46,211,789	4,173,666	-
1964	53,011,383	48,438,646	4,572,737	-
1965	54,073,297	49,652,387	4,420,910	
1966	55,763,624	51,022,001	4,741,623	-
1967	49,175,803	44,496,702	4,679,101	-
1968	53,799,031	48,456,899	5,342,132	-
1969	57,536,894	52,528,396	4,978,498	30,000
1970	54,057,635	48,661,376	5,286,259	110,000
1971	54,680,537	49,071,717	5,345,820	263,000
1972	63,970,228	57,874,384	5,549,084	546,760
1973	79,346,905	72,910,464	5,386,441	1,050,000
(Est.) 1974	83,200,000			

Figure 4.14 Ameriport Tonnage Projections

AMERIPORT
Projections of International Tonnage
In Short Tons

1975	87,100,000	79,539,000	5,990,000	1,571,000
1976				
1977	91,600,000	82,967,000	6,410,000	2,223,000
1978				
1979				
1980	97,500,000	87,272,000	6,990,000	3,238,000
....	....			
1985	116,700,000	103,867,000	7,800,000	5,033,000

Source: World Trade Division
Delaware River Port Authority

Figure 4.14 Ameriport Tonnage Projections (cont'd)

4.3.7 The Expected Economic Losses to a Ship Owner

When a ship is in port, a ship owner can expect economic losses to result as a consequence of the actual weather forecasting in the port during the ship's stay.

Some of these losses are unavoidable, because they occur when the weather occurs.

Other losses are avoidable to the extent that weather conditions in the port can be correctly predicted. The dependence of avoidable losses on weather prediction capability will be developed in this discussion.

4.3.7.1 Other Charges to a Ship Owner While in Port

Two basic charges are levied by the port against the ship owner. These are called wharfage and dockage, tariffs for which are established in the port and paid to the terminals of the port.

Wharfage is a charge levied against the ship's cargo, paid by the ship owners but passed on to the consignor or consignee, in most cases. The tariff is diverse and complicated and examples are quoted below for information only, since this charge will be assumed not to reside with the ship owner.

The wharfage tariffs, in the ports of Philadelphia, is as follows:

- For cargo up to 80 cu.ft./2000 lbs., the charge is 90¢/net short ton
- For cargo greater than 80 cu.ft./2000 lbs., the charge is 60¢/measurement ton of 40 cu.ft. of cargo

There are exceptions to this basic tariff for some cargoes, such as passenger automobiles where the charge is $4.00/automobile for up to 100 automobiles. Another example is the charge for cocoa beans in bags where sorting is required. The tariff is then $1.80/short ton.

Dockage is a charge levied against the ship for port services and it is paid by the ship owner. For a ship in working status, the charge is 12¢/net registered ton/calendar day, or part thereof, with a minimum charge of $300/calendar day. If the ship is in idle status, then the charge is 6-1/2¢/net registered ton/calendar day, or part thereof, with a minimum charge of $200/calendar day. A ship is in working status for each day when gangs are called to transfer cargo on the ship. This tariff changes with time. It became 9-1/2¢ on October 7, 1972; it became 10¢ on November 5, 1973; it became 12¢ on October 1, 1974.

Dockage estimates can be made using the data in Figure 4.15 to determine the average net registered tonnage of different cargo tariffs. The results are shown in Table 4.3.

Table 4.3 Dockage Charge Estimates

Vessel	Estimated Net Registered Tonnage (Average)	Vessel Status ($1974) per Calendar Day: Working	Idle
Breakbulk	4,783	574	311
Container	7,951	974	517
Bulk	8,786	1,054	571

	Total Net Tonnage	Breakbulk	Container	Bulk	Tanker	Passenger
Jan	4,389,623 (462)	752,748 (159)	185,622 (28)	658,388 (88)	2,792,865 (187)	-
Feb	3,774,522 (394)	723,375 (135)	54,475 (21)	603,897 (76)	2,392,775 (162)	-
Mar	4,625,293 (448)	741,355 (147)	130,907 (17)	846,209 (102)	2,906,822 (182)	-
Apr	4,358,409 (414)	573,774 (127)	203,269 (30)	732,463 (79)	2,848,903 (178)	-
May	4,405,248 (439)	624,963 (136)	156,149 (22)	943,104 (106)	2,681,032 (175)	-
Jun	4,117,823 (403)	619,854 (138)	193,288 (22)	737,768 (82)	2,556,847 (160)	10,066 (1)
Jul	4,614,008 (439)	744,080 (142)	170,797 (20)	926,773 (98)	2,742,160 (176)	30,198 (3)
Aug	4,518,721 (437)	659,363 (141)	218,218 (26)	839,061 (93)	2,793,689 (176)	8,390 (1)
Sep	4,137,154 (404)	538,367 (117)	243,127 (27)	857,971 (99)	2,464,129 (157)	33,560 (4)
Oct	4,408,677 (414)	547,993 (124)	193,275 (21)	883,333 (88)	2,756,674 (178)	27,402 (3)
Nov	4,460,079 (436)	601,575 (123)	293,934 (26)	867,361 (105)	2,678,941 (180)	18,268 (2)
Dec	4,732,592 (437) {(10,248)}	534,528 (113) {(4,783)}	167,382 (18) {(7,951)}	926,877 (102) {(8,786)}	3,103,805 (204) {(15,470)}	- (0) {(9,135)}
TOTAL	52,542,149 (5127)	7,661,975 (1602)	2,210,443 (278)	9,823,205 (1118)	32,718,642 (2115)	127,864 (14)

Remarks: Number of vessels arriving are in parentheses.
Average vessel net registered tonnage { }.

Source: The Philadelphia Maritime Exchange, 620 Lafayette Building, Philadelphia, Pennsylvania 19106.

Figure 4.15 Net Registered Tonnage Statistics - 1973 and Averages

While the ship is in port, the ship owner must pay for the ship operating costs. These vary from $1500/day for foreign registered vessels to $10,000/day for the newest U.S. registered vessels, based on estimates from the PMTA.

4.3.8 The Influence of Weather Forecasting Quality

The basic objective in the port is to successfully predict the occurrence of precipitation at 8 a.m. sufficiently ahead in time that labor gang calls will result always in productive labor costs. This, it can be anticipated, will not always be possible.

For prediction to be significant to ship owners, correct forecasting must produce profitable results when acted on by the ship owners.

When a ship is berthed, three basic costs are incurred by the ship owner--labor costs to transfer cargo, dockage or berthing costs and ship operating costs. Lack of predictive knowledge about precipitation results in labor being called, that does not work, but has to be paid. Nonproductive labor periods must in essence be replaced by equivalent productive labor periods, so that berthing and operating costs during the nonproductive labor periods are also essential losses to the ship owner.

If the prediction interval being considered is exclusively that between 8 a.m. and 12 noon, so that outside of this interval knowledge is assumed to be perfect, then Table 4.4 illustrates the consequences of prediction quality

Table 4.4 Costs and Prediction Quality

Precipitation		Nonproductive Costs		
Prediction	Observation	Labor	Dockage	Operating
NP	NP	O	O	O
P	NP	O	C_{DW}	C_O
P	P	O	C_{DW}	C_O
NP	P	C_L	C_{DW}	C_O

NP = no precipitation; P = precipitation.

in terms of nonproductive costs. A correct forecast, either (NP;NP) or (P;P), produces in effect no avoidable losses. There are nonproductive costs associated with (P;P) but they cannot be avoided.

An incorrect forecast, (P;NP), produces an avoidable loss (C_{DW}+C_O); an incorrect forecast, (NP;P), produces an avoidable loss C_L since, when P is observed, (C_{DW}+C_O) cannot be avoided.

C_{DW} is the docking cost for a working ship. Under the conditions (P;NP) or (P;P), this could be C_{DI}, the docking costs for an idle ship, but this would depend on whether or not labor was called for the afternoon shift. Currently, the tariffs are such that C_{DI}=0.542 C_{DW} in the ports of Philadelphia.

Evidently, improvement in correct forecasting is sought, since no avoidable costs are associated with such a forecast; ultimately then, in a port, ship owners will have to contend with the non-avoidable costs of precipitation. In this discussion, these are docking costs C_{DW} and operating costs C_O for four hours for the days when precipitation is observed in the port from 8 a.m. to 12 noon.

If the probability of correct forecasting in the port is p, i.e., this is the composite probability for the conditions (NP;NP) and (P;P), then the probability of error is (1-p). Suppose that a fraction α of error forecasts are of the type (P;NP) so that $(1-\alpha)$ are of the type (NP;P). Then the expected loss, associated with forecasting error which is avoidable, E_u, is

$$E_u = \alpha(1-p)(C_{DW}+C_O) + (1-\alpha)(1-p)C_L$$

$$= (1-p)[C_L + \alpha(C_{DW}+C_O-C_L)].$$

Evidently E_u is independent of α if $C_{DW}+C_O-C_L=0$, a condition that is unlikely. For the ports of Philadelphia in 1974, from data in Figure 4.11, which represents errors of the type (NP;P) if α_T and p_T represent today's experience then

$$(1-\alpha_T)(1-p_T) = {}^{15}/365 = {}^{3}/73.$$

If it is assumed that the fraction α remains constant with p then

$$(1-\alpha)(1-p_T) = {}^3/73$$

$$\text{or} \qquad \alpha = 1-{}^3/73\ (1-p_T)^{-1}$$

If it is assumed that p_t is small compared to unity then

$$\alpha = 1-{}^3/73 - {}^3/73\ p_T = {}^{70}/73 - {}^3/73\ p_T.$$

It is then reasonable to assume that $\alpha = {}^{70}/73$ and

$$E_u = (1-p)[C_L + {}^{70}/73\ (C_{DW}+C_O-C_L)]$$

$$= (1-p)[{}^{70}/73\ (C_{DW} + C_O) + {}^3/73\ C_L].$$

The assumption about α implies that the technique of prediction will not change to produce improvements in p. This assumption also seems reasonable and the equation developed for E_u will be employed to determine losses and benefits. This equation strictly describes the expected avoidable cost to a ship owner in 1974 per ship berthed between 8 a.m. and 12 noon in the ports of Philadelphia as a function of ship type and of the capability, p, to correctly predict the conditions (NP;NP) and (P;P) in the port. Implicitly, this prediction has an associated time interval of 23 hours. For each ship, labor has been called for the afternoon, i.e., the ship is a working ship.

The equation can be calculated for different vessel types and for different values of the parameters of the equation.

4.3.8.1 Data and Coefficients for the Expected Loss Equation

Data

1. 1974 Philadelphia ports shipping traffic

Breakbulk	1,346
Container	260
Bulk	1,178
Tanker	2,015
Passenger	15
Total	4,814

2. Collected data

Vessel Type	Number of Vessels in 1974	Dockage Costs ($) Per Calendar Day		Daily Operating Cost Range ($)	Annual Labor Losses ($) 1974
		Working	Idle		
Breakbulk	1,346	574	311	1500-10000	900,000
Container	260	954	517	1500-10000	73,800
Dry Bulk	1,178	1,054	571	1500-10000	34,200

3. Number of precipitation loss days in 1974 at the ports of Philadelphia

Number of days 15

4.3.8.2 Loss Equation Coefficients

C_{DW} = nonproductive dockage cost per working ship

= 1/2 calendar day dockage per working vessel

C_{DI} = nonproductive dockage cost per idle ship

= 1/2 calendar day dockage per idle vessel

Dockage is assumed to be a cost applicable to the time that a ship could be worked, i.e., eight hours.

C_O = nonproductive operating costs per ship

= 1/6 daily operating costs per vessel

Operating costs are assumed to be applicable over a period of 24 hours.

C_L = nonproductive labor costs per ship

$$= \frac{\text{(Annual labor loss per vessel type)}}{\text{(Annual Number of vessels of that type) X 15/365}}$$

Coefficient	Ship Operating Cost/day ($)	SHIP TYPE Breakbulk	Container	Bulk
C_L		16,269	6,906	706
$(3C_L)/73$		669	284	29
$C_{DW}+C_O$	10,000	1,954	2,144	2,194
$70(C_{DW}+C_O)/73$		1,873	2,056	2,104
$C_{DW}+C_O$	1,500	537	727	777
$70(C_{DW}+C_O)/73$		515	697	745
$C_{DI}+C_O$	10,000	1,823	1,926	1,953
$70(C_{DI}+C_O)/73$		1,748	1,847	1,875
$C_{DI}+C_O$	1,500	406	509	536
$70(C_{DI}+C_O)/73$		389	488	514

These values of coefficients for the expected loss per ship can be substituted into the loss equation to give the set of equations shown in Table 4.5. In Table 4.5, the parameter p is that of the probability of correctly forecasting throughout a four hour time interval from 8 a.m. to 12 noon in the ports of Philadelphia.

These loss equations will subsequently be employed to derive the benefits attributable to weather forecasting and to the incremental forecasting contributions from SEASAT-collected data.

4.3.8.3 Quantitative Estimates of Forecasting Probability

The parameter p is a measure of the probability of correctly forecasting the events (NP;NP) and (P;P) throughout the whole of a four hour interval from 8 a.m. to 12 noon in the ports of Philadelphia, with a prediction or forecasting interval of 16 hours or 23 hours. This defines p in terms of the conditions on which the economic losses have been calculated. To extend this to the full requirement the forecasting interval should be a maximum of 32-34 hours as demonstrated in Table 4.2.

Strictly from the point of view of ship owner decision, forecasting does not have to be continuous in nature

Table 4.5 Equations of Expected Loss Per Ship Type

Daily Operating Costs ($)	Ship Berthing Status	Equation of Expected Loss Per Ship		
		Breakbulk	Container	Dry Bulk
10000	working	$E_u=2542(1-p)$	$E_u=2340(1-p)$	$E_u=2133(1-p)$
10000	idle	$E_u=2417(1-p)$	$E_u=2131(1-p)$	$E_u=1902(1-p)$
1500	working	$E_u=1184(1-p)$	$E_u=981(1-p)$	$E_u=774(1-p)$
1500	idle	$E_u=1058(1-p)$	$E_u=772(1-p)$	$E_u=543(1-p)$

throughout the interval. Subjectively, that is, the forecasting may have the appearance of being continuous throughout the interval with respect to working a ship. Transitions in the weather occur throughout intervals of time too small to effect a transition in the working status of gangs. A transition from NP to P may however result in a prompt transition from working to nonworking for gangs while a transition from P to NP may have to last 15 minutes or 30 minutes for a transition in working status to occur.

Previous discussion has indicated an assumption that ship owners currently make use of any and all forecasting in making their decisions. It has not been possible to determine by inquiry that any forecasting is used in a systematic manner. The forecasting event of interest in this problem is then that of determining the composite probability that either it will be fine at 8 a.m. and will remain fine until 12 noon or there will be precipitation at 8 a.m. which will continue until 12 noon.

Knowledge of p, even subjective estimates, are sought to describe current 1974 capability of event forecasting and the expected improvement that can result in 1985 and to the year 2000; together with an estimate of the incremental forecasting improvement that is strictly contributed by SEASAT's data collection and assumed integration with all other sources of weather and sea condition data.

The U.S. Weather Service does not develop predictions today that could be of direct service to ship owner decisions. Evidently though all weather maps can be obtained by specialized meteorologists who could provide a prediction service to ship owners for a fee. In general such private services do not seem to have been very successful.

The USWS makes predictions of the occurrence of precipitation at 0500, for the time intervals of twelve hours, the next twelve hours and the next twelve hours, measured from 0700. They are only predicting the occurrence or otherwise of precipitation sometime during these intervals. In validating the prediction quality, precipitation occurs if more than 0.01 inches of rain is measured during the interval. This is called measurable precipitation. Local offices of the USWS generate local precipitation forecasts using large scale data supplied to them by the weather service data dissemination system. The general form of generation of this local forecast appears to require the introduction of local meteorological judgment into the large scale data before subsequent processing by computer. Forecasting for the first 12-hour period appears to be more accurate when generated by the human but subsequent prediction accuracy is best when generated by computer. There is a current controversy in the weather service over the usage of the man-machine combination for forecasting, specifically concerned with accuracy and reliability.

Quality of local forecasting is dependent on both the interval of concern and the season of the year (winter/summer). In Philadelphia the mean success probability for the first 12-hour interval is 0.83-0.85 and this degrades by the third 12-hour interval to about 0.80. The first interval winter time probability is 0.90-0.91 and the summer time probability is about 0.75. The degradation of the probability with time is attributed to the data nonuniformity within the measuring regional size needed for longer term prediction. The seasonal variation is concerned with the seasonal data scales of significance, these being smaller in the summer than the winter. If, in addition, the probability of successful prediction during a 12-hour interval is 0.82, the probability during a 6-hour interval is estimated to be 0.78 and during a four hour interval it is estimated to be 0.76.

During the last 20 years or so precipitation prediction accuracy has improved by about 5 percent, largely as a consequence of superior physical modelling and improved data quality. By 1985 it is estimated that a 5-10 percent improvement from 1974 quality will result partly as a consequence of satellite data supply such as will be available from the Synchronous Meteorological Satellites (or their operational equivalents) (1 and 2) which can provide national weather pictures updated every 30 minutes, if required, and the global ESRO, Japanese and Russian meteorological satellite programs. Subsequent to this it is expected that there will be a slowdown in accuracy improvement, a suggested 2 percent improvement being thought reasonable, between 1985 and 2000.

These improvements in operational forecasting will result from the current research programs which concentrate on expansion of computer models to use more data. Such techniques will increase the vertical layering from six-to-eight-to-ten layers and employ sophisticated but well-known statistical processing techniques to better control the input data and the output numerical values (temperature, relative humidity, pressure, winds, moisture condensed and fallen out) which are developed centrally for the United States and provided to local forecasting offices. Data is developed on a scale of 1000 km and is then analyzed and related statistically to a grid of smaller scale say 200-300 km and this process must be repeated down to the level of local weather forecasting. Errors easily occur and they are not easily recognized. The modelling of physical processes, while recognized as being not fully adequate is in second place in the research programs. Improvement is sought to diminish ignorance, but the concentration is on the computer power and data processing. The thrust seems to be to fully exploit with current physical modelling all the power of data processing and statistical techniques of controlling the data, and its numerical derivations. It is considered that fifth generation computers are adequate to current physical modelling.

It is conjectured that the principal contribution of an operational SEASAT to local weather forecasting will be in improved determination of surface wind data. Currently wind data improvement is being sought through data processing and statistical procedures and it is thought that the input from SEASAT will only be a second order effect. SEASAT appears to offer a second order improvement to the expected 2 percent forecasting improvement from 1985 to 2000.

The weather service does not attempt to predict the time of occurrence of precipitation nor its duration once onset has occurred. It does not do so because the problem is a very difficult one in terms of data, computer power and modelling and the result currently obtainable would be no better than a guess.

Quality prediction with prediction intervals of less than twelve hours places great demands on computer capability to complete the task in sufficient time for the resulting information to be appropriately disseminated. Currently an 18-layer atmospheric model is in existence but it requires about 23 hours of computer time to produce a result, required only twelve hours ahead.

Studies have been made by the Weather Service to use data and computer processing to generate 6-hour interval forecasts. The data for this is available but the descriptive equations must be modified to produce a result in a useful length of time considering the evanescent nature of the output.

It is therefore very difficult to know, with confidence, that the cost losses calculated are dependent on some current form of weather prediction knowledge. They are most likely based on the current state-of-the-art in prediction of the weather phenomena of interest but it appears to be no more useful than a guess. However, if most ship owners do have some source of weather prediction input to their decisions, the quality of this should be determined since future prediction can only be incremental to what already exists and hence the benefits must also be incremental. At this time the evidence indicates that no weather prediction estimates are used by the ship owners so that currently the loss equations should be written with p=0.

The dependence of loss production on prediction capability, cannot be resolved by current forecasting knowledge, or by future trends in forecasting improvements according to a number of experts intimately involved with the forecasting process, its difficulties and its expectation. The general contention is, if we could do it, it would already be offered as a service. The question of how well it could be done if an attempt was made is therefore one of conjectural judgment.

An attempt will be made to develop some reasonable quantitative estimates of the prediction capability of continuous forecasting during a 4-hour interval. The quantitive estimate will be related to Philadelphia.

To give perspective to the prediction problem being addressed, the observed data of Figure 4.11 indicates that, in Philadelphia, there were 15 days during 1974 when precipitation resulting in work loss occurred. The probability of occurrence during 1974 was therefore 0.041.

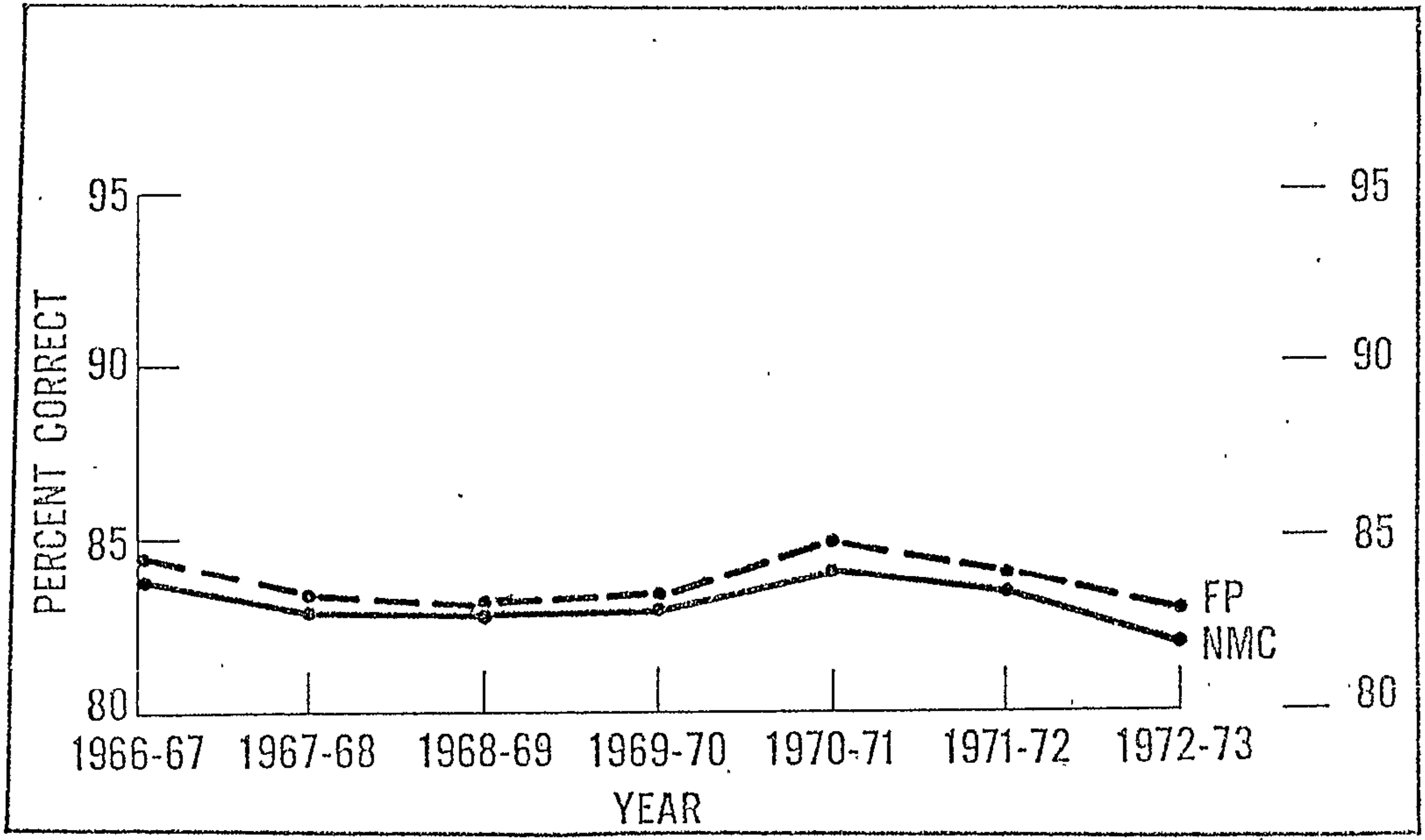
Precipitation days are recorded in Philadelphia. These are the days when more than 0.01 inches of precipitation was measured. The data for 1974 from the Philadelphia International Airport recording was:

Month	J	F	M	A	M	J	J	A	S	O	N	D
No. of Days	13	10	11	10	13	13	8	9	11	2	8	8

The total observed number of days is 116 giving a probability of occurrence of measurable precipitation per day of 0.32. Loss precipitation is therefore much less likely to occur than precipitation days, about which most prediction quality information is available. The weather service discusses its prediction quality score (the total of precipitation and nonprecipitation) in terms of first, second and third intervals, which are for the first, second and third twelve hours following the forecast.

The interest in this problem is most closely represented by the third interval. Today correct prediction quality drops from about 0.84 (as shown in Figure 4.16 published by the National Weather Service) in the first interval to 0.80 in the third interval. Further, if prediction quality in the third interval is 0.80 for a 12-hour interval then for a 4-hour interval the prediction quality is estimated to be $0.80 \times \frac{0.76}{0.82}$ or 0.74. This then is an estimated prediction during a 4-hour interval from 24 to 36 hours ahead. What is required is an estimate of the prediction quality of continuous forecasting during the 4-hour interval.

It has been suggested by the weather service personnel that this type of precipitation is most likely to require that during the four hours preceeding and following the interval some measurable precipitation should also occur. It is thus suggested that the estimation procedure requires some knowledge of conditional probabilities. These are those that are associated with the dependence of precipitation in one interval on



Source: NOAA Technical Memo. NEW FCST-21, June 1974.

Figure 4.16 Comparison of NMC and WSFOs (193 stations) total precipitation and no precipitation forecasts correct nationally 1966-1973. Morning (0600 GMT) and afternoon (1800 GMT) forecasts for all three periods were averaged over the conterminous United States.

the knowledge of the existence of precipitation in contiguous intervals.

Some data relating to this problem, of a research nature, exists in ESSA Technical Memorandum WBTM TDL 31 which was provided by telephone by Lawrence Hughes, Kansas Central Region HQ WWS (186 374 5672). It concerns conditional probabilities for 6-hour intervals, not 4-hour intervals. The data, tabulated below, is understood to have been derived from the basic 12-hour data of the NWS, pertaining to Philadelphia, and is based on 15 years of accumulated data.

Quarter of the Year	Observed Conditional Frequency
Dec., Jan., Feb.	0.60
Mar., Apr., May	0.54
June, July, Aug.	0.48
Sep., Oct., Nov.	0.50

There are evident seasonal variations, but these will be ignored and an arithmetic average of 0.53 will be assumed for the probability of occurrence of measurable precipitation in a 6-hour interval if measurable precipitation occurred in the previous 6-hour interval.

The estimated score for correct prediction during a four hour interval is 0.76. This is the combined score for predicting the conditions (NP;NP) and (P;P). The score for each event is not, however, equal using today's prediction information. The score for the event (P;P) is, in general, about three times that for the event (NP;NP) as shown in Figure 4.17. That is, approximately, the score for the event

OCT 1972 - MAR 1973 2ND PERIOD PRECIPITATION FORECASTING PERFORMANCE WITHIN ECHELONS

		F	P	PC	MP	MN	PF	B	BC	S	BS	SS
EASTERN												
067	NMC	5980	1597	82.1	58.1	19.0	.2671	.1242	.1957	36.6	.1839	32.5
	FP	5980	1597	82.6	57.9	17.4	.2671	.1207	.1957	38.3	.1839	34.4
187	NMC	6071	1611	80.4	57.6	19.9	.2654	.1304	.1955	33.3	.1855	29.7
	FP	6071	1611	81.5	53.8	17.4	.2654	.1260	.1955	35.6	.1855	32.1
SOUTHERN												
067	NMC	7575	1515	83.6	42.6	14.1	.2000	.1153	.1602	28.0	.1504	23.3
	FP	7575	1515	84.3	43.7	11.7	.2000	.1131	.1602	29.4	.1504	24.8
187	NMC	7683	1453	83.2	39.2	14.6	.1891	.1164	.1544	24.6	.1441	19.3
	FP	7683	1453	84.3	42.9	12.2	.1891	.1118	.1544	27.6	.1441	22.4
CENTRAL												
067	NMC	6245	1330	84.2	47.6	15.0	.2130	.1123	.1661	32.4	.1563	28.2
	FP	6245	1330	84.5	46.7	14.1	.2130	.1118	.1661	32.7	.1563	28.5
187	NMC	6325	1268	85.2	47.7	16.0	.2005	.1076	.1572	31.6	.1480	27.3
	FP	6325	1268	84.6	47.5	15.4	.2005	.1075	.1572	31.6	.1480	27.4
WESTERN												
067	NMC	4394	975	80.3	48.0	19.1	.2224	.1345	.1672	19.5	.1506	10.7
	FP	4394	975	81.6	47.3	15.6	.2224	.1251	.1672	25.2	.1506	16.9
187	NMC	4446	979	78.4	51.0	21.1	.2202	.1442	.1654	12.8	.1493	3.4
	FP	4446	979	80.7	49.1	17.4	.2202	.1308	.1654	20.9	.1493	12.4
ALASKAN												
067	NMC	1015	308	72.9	43.9	24.6	.3034	.1785	.2036	12.3	.1828	2.3
	FP	1015	308	75.9	47.6	21.2	.3034	.1669	.2036	18.0	.1828	8.7
187	NMC	1076	348	72.3	46.9	23.9	.3234	.1887	.2065	8.6	.1879	-.4
	FP	1076	348	75.3	48.2	21.3	.3234	.1668	.2065	19.2	.1879	11.2
NATIONAL												
067	NMC	25199	5725	82.4	49.3	16.7	.2272	.1225	.1730	29.2	.1611	24.0
	FP	25199	5725	83.1	49.2	14.6	.2272	.1189	.1730	31.3	.1611	26.2
187	NMC	25601	5659	81.7	49.8	17.6	.2210	.1254	.1689	25.8	.1576	20.5
	FP	25601	5659	82.7	48.4	15.4	.2210	.1197	.1689	29.1	.1576	24.1

F = NUMBER OF FORECASTS
P = NUMBER OF PRECIPITATION CASES
PC = TOTAL PERCENT CORRECT
MP = MEAN PROBABILITY FORECAST, PRECIPITATION
MN = MEAN PROBABILITY FORECAST, NO PRECIPITATION
PF = RELATIVE PRECIPITATION FREQUENCY
B = BRIER SCORE
BC = CLIMATOLOGICAL BRIER SCORE
S = PERCENT IMPROVEMENT OF B OVER BC
BS = SAMPLE BRIER SCORE
SS = PERCENT IMPROVEMENT OF B OVER BS

Source: NOAA NWS PCB7-21

Figure 4.17 Forecasting Quality Precipitation and No Precipitation

(P;P) is 0.56 and that for the event (NP;NP) is 0.19 on the average.

Tentatively, the forecasting score of the event of interest will be estimated to be Q, where

$$Q = [0.56 \times (0.53)^2] + 0.19$$
$$= 0.16 + 0.19$$
$$= 0.35 .$$

This is an estimate of the degree of success that would be possible if current methods and data, etc., were employed to predict the event of interest. It uses the unproven, but reasonable assumption, that measurable precipitation on either side of the time interval of interest is a necessary condition to work stopping precipitation during the whole of the interval. Practically, work stopping precipitation implies that rain may cease for intervals of time of 15-30 minute duration, not sufficiently long to allow work to resume.

The forecasting score estimate of the event of interest will be larger than can be obtained in practice because the observable conditional probabilities would be determined with some error.

By 1985, forecasting quality in the third interval is expected to increase from 0.80 to 0.84 or 0.88 for reasons previously discussed. It is conjectured that, by 1985, the decline in quality as a result of shifting from 12-hour to 4-hour intervals will remain the same as today because this form of forecasting will not be of general concern. Thus, the forecasting quality of interest will improve from 0.74 to 0.78 or 0.82. The previously employed conditional probability is expected to remain the same and the score relationship to the events (P;P) and (NP;NP) are also expected to remain as they are today.

Thus, by 1985, the score for the event of interest Q_{85} will have an expected range as shown below.

$$[0.58 \text{ X } (0.53)^2] + 0.20 < [0.61 \text{ X } (0.53)^2] + 0.21$$

$$0.36 < Q_{85} < 0.38$$

By 2000, an incremental score improvement of 2 percent is expected from that of 1985, i.e., a fundamental scoring improvement to 0.86 or 0.90. Based on current knowledge, all the other modifiers of these scores to the scores of interest are expected to remain constant. Hence, the score in 2000, Q_{00}, is expected to range as shown below.

$$[0.60 \text{ X } (0.53)^2] + 0.20 < Q_{00} < [0.62 \text{ X } (0.53)^2] + 0.21$$

$$0.37 < Q_{00} < 0.38$$

This analysis indicates that, between 1974 and 2000, the forecasting quality of the event of interest will improve as a consequence of significant improvements in scoring of the events of major forecasting interest. That is, the analysis assumes that there will be no concerted effort directed to prediction in 4-hour intervals of the event of interest to this study. The analysis further indicates a current (1975) capacity to predict the event of interest with a probability of 0.35, although it is fully recognized that there may not be a mechanism for producing this forecast.

The significant question, at this juncture, is to estimate what incremental forecasting quality of the event of interest can be associated exclusively with the data supplied by an operational SEASAT. Evidently, such an estimate is extremely difficult to develop because the development of the operational system has not yet begun and because, if surface wind measurement is a prime measurement, the sensitivity of forecasting quality to improvement in knowledge of this parameter is unknown. The judgmental qualitative opinion is that SEASAT's influence will be second order.

If general forecasting in the third 12-hour interval was perfect, the probability of correct forecasting of the event of interest would be 0.46. This, then, would be the best possible indirect forecast without an attempt to deal specifically with 4-hour interval continuous forecasts.

The incremental improvement in forecasting the event of interest by 1985 lies between 0.01 and 0.03 and, by 2000, it lies between 0.02 and 0.03. From 1974 to 1985, the average increment in forecasting quality is 0.02; from 1985 to 2000, the average increment is 0.005.

Accepting that SEASAT will be a second order influence only, it is difficult to visualize an incremental forecasting probability in excess of 0.001 due to SEASAT alone.

This figure, 0.001, will be employed as the operational SEASAT's contribution to forecasting quality in determining SEASAT benefits from the expected loss equations for the ports of Philadelphia.

To add perspective to the estimation of predictability discussed here the following statement is presented.

4.3.9 Estimation of Benefits

Today (1974), it seems reasonable to assume that the probability of predicting the occurrence of events useful to the reduction of nonproductive costs to ship owners in ports and harbors because of precipitation duration is very close to zero.

This, it is argued, arises from the difficulty of useful prediction and a resulting lack of interest in 4-hour interval prediction. It is thought, on the basis of limited knowledge and data, that occurrence of the event of interest could be predicted with a probability of about 0.35. This derivation of forecasting inherent capability does not, in any way, consider if the forecasting system is structured to produce and disseminate such a forecast.

By 1985, under the impetus of forecasting improvements directed to the more general aspects of forecasting, it is

POLICY STATEMENT OF THE AMERICAN METEOROLOGICAL SOCIETY ON WEATHER FORECASTING

(As adopted by the Council on October 20, 1972)

One of the most important activities in the field of meteorology is the preparation of weather forecasts as a vital service to public and private interests. Weather forecasts are used by individuals to guide their daily living and by industry, agriculture, forestry, commerce, transportation, and government to guide their operations. The widespread need for accurate advice on expected future weather conditions and the critical dependence of public safety and welfare upon the quality of such information make it desirable to describe the present weather forecasting capability of the meteorological profession.

With the introduction of high-speed computers into numerical weather prediction in recent years, along with improved numerical descriptions of the real atmosphere, and the development of modern observational techniques, such as radar and weather satellites, forecast accuracy has shown a significant improvement. Although the national economy directly benefits from increased forecast accuracy, the value of a weather forecast depends not only on its accuracy but also on the manner in which it is utilized and the method by and speed with which it is communicated to users.

Forecast accuracy attained by procedures such as predicting that the weather will remain unchanged (persistence), or by predicting average weather occurrences based upon past weather records (climatology), or simple variations on these procedures, serve as objective bases for measuring forecasting skill. Unless forecast accuracy exceeds levels achieved by basic methods such as these, skill cannot be said to exist. Moreover, skill in weather forecasting varies with the meteorological situation, geographical area, and season.

Weather forecasts prepared by professionally trained personnel presently achieve the following levels of skill, on the average:

> *For periods up to 48 hours*, weather forecasts of considerable skill and utility are attained. Detailed forecasts of weather and its changes can be made for the first 36 hours. Probability estimates markedly increase the information content of such forecasts, especially with regard to precipitation occurrence. In this period skill is a maximum in predicting the motion and general effects of weather systems having dimensions of five hundred miles or more. However, small-scale features imbedded in these systems cause hour-to-hour variations in weather which are difficult to predict, especially for local areas with irregular topography. Also, the exact location of certain highly significant weather phenomena, such as severe thunderstorms and tornadoes, cannot be forecast accurately with any degree of skill beyond a few hours, although the general area of severe storm activity may be predicted up to 24 hours in advance. Accurate forecasts for infrequent events such as heavy snow, sleet and damaging winds are usually limited to periods not exceeding 24 hours.
>
> *For periods up to 5 days*, daily temperature forecasts of moderate skill and usefulness are possible for periods extending to about 5 days. Precipitation forecasts to 3 days, at an equivalent level of skill, can be made, but the skill drops to marginal levels on the fourth and fifth days.
>
> *For periods of more than 5 days*, average temperature conditions for periods from a week up to a month or season can be predicted with some slight skill. Day-to-day or week-to-week forecasts within this time range have not demonstrated skill. There is some skill in prediction of total precipitation amounts for periods of 5 to 7 days in advance; skill for longer periods is marginal.

Recent theoretical work on atmospheric predictability indicates that the intrinsic properties of the atmosphere, together with the impossibility of observing every detail of atmospheric behavior, impose an upper limit for the prediction of day-to-day weather changes. This period is believed to be about one to two weeks, depending on the criteria used to define a useful forecast. Present day forecasting accuracy, as cited above, falls short of the theoretical limit. There are also limits to the extent of time for which average quantities such as weekly or monthly mean temperatures can be forecast, but theoretical estimates of these limits are not available as yet.

Source: Bulletin American Meteorological Society, Vol. 54, No. 1, January 1973.

estimated that the prediction probability in the event of interest to this study will have increased to 0.370. Further, by 2000, this probability may have improved to 0.375.

The estimates for the future are carried to three decimal places to indicate that changes will occur and that these changes will be very small and not to indicate precision in the estimates. These estimates also assume that general forecasting will not seek to include forecasting of the event of interest to this problem. This assumption seems both reasonable and valid because of the concentration on improving the general forecasting quality with its particular difficulties.

The operational SEASAT in 1985 will, it is conjectured, contribute to prediction of the event of interest by the provision of more accurate and more widely collected surface wind data, which will enter into the general forecasting process. Since there are already computational and statistical schemes in process to improve surface wind data estimates, the contribution of SEASAT alone to the predictability of the event of interest is considered to be second order. It is expected, as an estimate, that SEASAT will produce an increase of predictability in 1985 from 0.370 to 0.371 and in 2000 from 0.375 to 0.376.

Therefore, considering all sources of data, the predictability and its expected improvements for the special event of interest to this problem are not expected to be large. The major increment appears to be one that could currently be made if the actual form of prediction was attempted, by the National Weather Service, and if provision was made for appropriate dissemination of the forecast.

The incremental forecasting probability allocated to SEASAT alone is about 20 percent of the increment expected between 1985 and 2000 in forecasting the event of interest. It is also about 1 percent of the maximum attainable increment in forecasting the event of interest, assuming only general forecasting is pursued. The maximum probability increment from 1985 onward is (0.460-0.370)=0.090.

Benefits are generated from estimates of the expected savings in avoidable losses that result from forecasting probability improvements for each pertinent type of shipping in the ports of Philadelphia, i.e., breakbulk, bulk (dry) and container. Tanker type shipping or bulk wet is not included because its operation does not require longshore labor.

Tables 4.6, 4.7 and 4.8 identify the per-ship costs and savings in 1974 dollars for breakbulk, dry bulk, and container shipping derived by insertion of the noted probabilities p in the loss equations. The losses and savings depend on the ship daily operating costs and on the ship berthing status which determines the ship dockage costs.

Tables 4.9, 4.10 and 4.11 translate the data of Tables 4.6, 4.7 and 4.8 into maximum and realizable annual benefits, based on the number of ships in each category per

Table 4.6 Avoidable Nonproductive Losses and Savings Per Ship as a Consequence of Correct Weather Forecasting Probability. Ports of Philadelphia - Breakbulk Shipping

Ship Operating Costs $/day	Ship Berthing Status	1974 (P=0) Expected Avoidable Loss ($)	1977 (P=0.35) Expected Avoidable Loss Savings ($)	1985 (P=0.37) Expected Avoidable Loss Savings ($)	2000 (P=0.375) Expected Avoidable Loss Savings ($)	1985-2000 SEASAT Expected Avoidable Loss Savings ($) Δp=0.001
10000	working	2542	889.70	940.54	953.25	2.54
10000	idle	2417	854.95	894.29	906.38	2.42
1500	working	1184	414.40	438.08	444.00	1.18
1500	idle	1058	370.30	391.46	396.75	1.05

All costs are $1974.

Table 4.7 Avoidable Nonproductive Costs and Savings Per Ship as a Consequence of Correct Weather Forecasting Probability. Ports of Philadelphia - Dry Bulk Shipping

Ship Operating Costs $/day	Ship Berthing Status	1974 (P=0) Expected Avoidable Loss ($)	1977 (P=0.35) Expected Avoidable Loss Savings ($)	1985 (P=0.37) Expected Avoidable Loss Savings ($)	2000 (P=0.375) Expected Avoidable Loss Savings ($)	1985-2000 SEASAT Expected Avoidable Loss Savings ($) Δp=0.001
10000	working	2133	746.55	789.21	799.88	2.13
10000	idle	1902	665.70	703.74	713.25	1.90
1500	working	774	270.90	286.38	290.25	0.77
1500	idle	543	190.05	200.91	203.63	0.54

All costs are $1974.

Table 4.8 Avoidable Nonproductive Costs and Savings Per Ship as a Consequence of Correct Weather Forecasting Probability. Ports of Philadelphia - Container Shipping

Ship Operating Costs $/day	Ship Berthing Status	1974 (P=0) Expected Avoidable Loss ($)	1977 (P=0.35) Expected Avoidable Loss Savings ($)	1985 (P=0.37) Expected Avoidable Loss Savings ($)	2000 (P=0.375) Expected Avoidable Loss Savings ($)	1985-2000 SEASAT Expected Avoidable Loss Savings ($) Δp=0.001
10000	working	2340	819.00	865.80	877.50	2.34
10000	idle	2131	745.85	788.47	799.13	2.13
1500	working	981	343.35	362.97	368.88	0.98
1500	idle	772	270.20	285.64	289.50	0.77

All costs are $1974.

Table 4.9 Annual Benefits, Ports of Philadelphia - Breakbulk Shipping

Ship Operating Costs	Ship Berthing	1974 Maximum Benefit	Estimated Realizable Annual Benefit from Appropriate Weather Forecasting		Estimated Range of Realizable Annual Incremental Benefit from SEASAT		
$/day	Status	$	1985($)	2000($)	1985-2000 ($)		
10000	working	3,421,532	1,746,583	1,770,185	3,679	4,717	6,174
10000	idle	3,253,282	1,660,697	1,683,148	3,505	4,494	5,887
1500	working	1,593,664	813,515	824,508	1,709	2,191	2,870
1500	idle	1,424,068	726,941	736,765	1,521	1,950	2,555

Number of breakbulk Ships per annum	1974	Growth factor	1985-2000(estimate)
	1346	1.38	1857

All benefits have a range +31%, - 22% about quoted value based on port climatology.

All costs are $1974.

Table 4.10 Annual Benefits, Ports of Philadelphia - Dry Bulk Shipping

Ship Operating Costs $/day	Ship Berthing Status	1974 Maximum Benefit $	Estimated Realizable Annual Benefit from Appropriate Weather Forecasting 1985 ($)	Estimated Realizable Annual Benefit from Appropriate Weather Forecasting 2000 ($)	Estimated Range of Realizable Annual Incremental Benefit from SEASAT 1985-2000 ($)		
10000	working	2,512,674	1,320,348	1,338,199	2,779	3,563	4,668
10000	idle	2,240,556	1,177,357	1,193,267	2,480	3,179	4,164
1500	working	911,772	479,114	485,588	1,005	1,288	1,687
1500	idle	639,654	336,122	340,673	704	903	1,183

Number of dry bulk Ships per annum	1974	Growth factor	1985-2000
	1178	1.42	1673

All benefits have a range +31%, - 22% about quoted value based on port climatology.

All costs are $1974.

Table 4.11 Annual Benefits, Ports of Philadelphia - Container Shipping

Ship Operating Costs $/day	Ship Berthing Status	1974 Maximum Benefit $	Estimated Realizable Annual Benefit from Appropriate Weather Forecasting 1985($)	2000 ($)	Estimated Range of Realizable Annual Incremental Benefit from SEASAT 1985-2000 ($)		
10000	working	608,400	513,419	520,358	1,083	1,388	1,818
10000	idle	554,060	467,563	473,991	985	1,263	1,655
1500	working	255,060	215,241	218,746	453	581	761
1500	idle	200,720	169,385	171,674	184	457	599

Number of container ships per annum	1974	Growth factor	1985-2000
	260	2.28	593

All benefits have a range +31%, - 22% about quoted value based on port climatology.

All costs are $1974.

annum in the port and of the growth predicted for each ship category by 1985-2000. Benefits all have associated with them a range based on port climatology with respect to annual precipitation. The range for the incremental realizable benefit exclusively allocated to SEASAT is specified.

Table 4.12 sums the realizable incremental annual benefits exclusive to SEASAT for all the shipping categories in the port.

Table 4.13 sums the realizable annual benefits from appropriately applied weather forecasting for all the shipping categories in the port.

It is important to stress that realizable benefits, including those exclusive to SEASAT, are dependent on the application of available weather forecasting information to the specialized forecasting requirements of this problem. Currently, this form of forecasting is not available. It would, therefore, require a specific implementation and dissemination.

Table 4.12 Realizable Incremental Annual Benefit Exclusive to SEASAT 1985-2000 Ports of Philadelphia - Combining Breakbulk, Bulk and Container Shipping

Ship Operating Costs $/day	Ship Berthing Status	Realizable Incremental Benefit Range Exclusive to SEASAT ($)		
10000	working	7,541	9,668	12,665
10000	idle	6,970	8,936	11,706
1500	working	2,169	4,060	5,319
1500	idle	2,582	3,310	4,336

The range quoted for benefits is a result of port climatology.

All benefits are in $1974.

Table 4.13 Annual Benefits from Appropriately Applied Weather Forecasting. Ports of Philadelphia - Breakbulk, Bulk, Container Shipping Combined

1985 Maximum Benefit	Annual Realizable Benefits ($) 1985	2000	Ship Operating Costs $/day	Ship Berthing Status
9,305,666	3,580,350	3,628,742	10000	working
8,934,376	3,305,617	3,350,406	10000	idle
4,075,509	1,507,870	1,528,842	1500	working
3,331,165	1,232,448	1,249,112	1500	idle

All benefits have a range +31% - 22% about quoted value based on port climatology.

All benefits are in $1974.

5. ESTIMATION OF NATIONAL BENEFITS

5.1 Introduction

The data and its analysis for the ports of Philadelphia will be used as a model basis for estimating the national benefits to ports and harbors from SEASAT's data integration.

To generate a national benefit, each of the remaining 116 ports and harbors in the United States must be composed into an equivalent to ports of Philadelphia in terms that are appropriate to the process of benefit development.

Equivalence requires that the following parameters be transformed by a ratio procedure:

1. precipitation loss days
2. the breakdown of shipping arrival traffic
3. the wage, benefit and overhead cost of long-shore labor.

Precipitation loss days will be transformed through port precipitation climatology, in particular through the annual mean precipitation relative to Philadelphia. The range of national cost losses in ports and harbors will be defined in terms of an average precipitation climatological variation for all the ports of the United States.

The breakdown of shipping arrival traffic in other ports will be collected from each port. In general, the data obtained will be very diverse and quite different from that in

Philadelphia. Each Port Authority or Marine Exchange or Pilot's Association collects shipping data according to its own needs or according to requirements of the U.S. Department of Commerce or the U.S. Corps of Engineers. These requirements are not those of this problem that is concerned with the utilization of labor in loading and unloading shipping. Interpretation of the data available is, therefore, required in many cases and these interpretations will be documented in Appendix A.

The costs to ship owners for longshoremen labor are not generally easy to obtain since each port has very many stevedoring companies or their equivalents that operate terminals and costs are a factor in competition among these stevedoring companies. It would be a monumental task to solicit the nation's stevedoring companies with, in general, little expectation of success. Regional labor cost factors could be applied to the Philadelphia costs, but, in this study, they have not been used and the Philadelphia costs have been held constant throughout.

Many random effects are evident in determining non-productive costs to ship owners in ports as a result of precipitation loss. These are concerned with the number of ships and the number of gangs called to service them on a precipitation day; whether a precipitation day occurs at the weekend and, thus, is chargeable at time and one half, etc.

Random effects of this type require either very fine accounting of detail in each port or can be subsumed into averages. In this study, averages have generally been employed.

There are, in the United States, 11 major ports which handle over 90 percent of the shipping traffic in the United States. The remaining 106 minor ports have been subsumed into a multiplication factor of the results for the eleven major ports.

Development of benefits from ports and harbors requires the projection of shipping growth into each port between 1985 and 2000 in the categories of shipping that are significant to this problem. Some general trends are apparent. Shipped tonnages tend to grow at about 2 percent per year but the economics of vessel employment tend to reduce the number of ships required by making them larger. Economics again, then, requires that vessel turnaround be reduced to a minimum, thus demanding expeditious loading and unloading and collection of cargoes. Most ports thus seek to indicate a growth in container, but Lash and Seabee concepts compete with palletized and unitized cargo concepts for general breakbulk cargoes. It does not seem possible to containerize all breakbulk cargoes and it seems likely that only a few ports will actually enjoy a large growth in container shipping. Bulk cargoes, wet and dry, are projected for the import-export trade to double in tonnage in the next ten years and to double again by 1995 dominated by VLCC tankers and OBO deep draft vessels. However, practically, no U.S. port can berth the large vessels proposed and offshore unloading is not always seen as being economically advantageous to the regions served by a port. In addition, there is the mini-bridge concept which transfers hemispheric traffic between the east and west of the United States by rail transportation, thus reducing the need for shipping and causing pressures for regulation.

These brief notes are introduced here only to indicate that the rules for projection of the change in number of ship arrivals in U.S. ports to 2000 are complex.

5.2 Development of the National Benefit

5.2.1 Vessel Arrivals at Major U.S. Ports

The totals of vessel arrivals of the eleven major U.S. ports are given in Table 5.1 from 1962 to the present.

In general, the actual numbers are never quite firm because what constitutes a ship is not unified in concept for each port.

The general trend of decline in the total number of ship arrivals is clearly indicated by the cited table.

Figure 5.1 indicates, in Table No. 992, the total number of vessels that arrived annually or averaged per annum. Comparison of the data in Figure 5.1 and in Table 5.1 indicates that, on the average, about 90.6 percent of all vessel arrivals are handled by the 11 major ports.

Table 5.1 Vessel Arrivals of Major U.S. Ports

PORT	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
New York	12,838	12,448	12,289	11,564	12,115	11,462	10,395	10,110	10,338	9,066
Philadelphia	6,697	6,548	6,901	6,425	5,572	6,396	5,694	5,406	5,817	5,064
Baltimore	5,284	5,329	5,367	4,997	5,104	4,683	4,348	4,031	4,661	3,988
Hampton Roads	5,424	5,339	5,683	5,240	5,248	5,104	4,557	4,424	4,882	4,075
Boston	2,275	2,189	2,109	2,039	1,975	1,896	1,705	1,574	1,736	1,525
San Francisco	4,777	4,253	4,566	4,710	5,088	5,186	5,213	5,136	4,642	4,099
Los Angeles	5,056	4,754	4,743	4,732	5,090	5,250	5,520	5,019	5,022	4,000
New Orleans	4,821	4,755	5,276	4,496	4,810	4,570	4,633	4,143	4,630	4,231
Houston	4,204	3,919	4,194	3,805	4,316	4,229	4,255	3,504	4,009	4,035
Seattle	2,156	2,146	2,090	2,213	2,353	2,491	2,453	2,456	2,481	1,810
Portland, Ore.	1,986	2,102	1,977	2,031	2,155	2,122	2,088	2,076	2,019	1,637
Total	55,518	53,782	55,195	52,252	54,826	53,386	50,861	47,879	50,237	43,530

Sources: The Maritime Association of the Port of New York.
The Philadelphia Maritime Exchange.

Table 5.1 Vessel Arrivals of Major U.S. Ports (Cont'd)

PORT	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
New York	9,347	9,093	8,375								
Philadelphia	5,147	5,127	4,814								
Baltimore	4,392	4,334	4,193								
Hampton Roads	4,389	4,312	3,934								
Boston	1,549	1,629	1,280								
San Francisco	4,330	4,243	3,855								
Los Angeles - Long Branch	4,718	5,019	5,702								
New Orleans	4,635	4,924	4,865								
Houston	4,171	4,805	4,413								
Seattle	2,249	2,331									
Portland, Ore.	1,930	2,133	1,966								
Total	46,859	47,950									

Sources: The Maritime Association of the Port of New York.
The Philadelphia Maritime Exchange.

1974 and Corrections - Collected.

No. 991. Federal Expenditures for Civil Functions of the Corps of Engineers, United States Army: 1940 to 1973

[In millions of dollars. For years ending June 30 Includes Puerto Rico and outlying areas Represents funds actually expended under the direction of the Chief of Engineers for maintenance and improvement of rivers and harbors, flood control, and other miscellaneous works]

YEAR	Amount	YEAR	Amount	YEAR	Amount	YEAR	Amount
1940	214	1961	938	1965	1,211	1970	1,186
1945	134	1962	965	1966	1,291	1971	1,474
1950	635			1967	1,266		
1955	512	1963	1,093	1968	1,275	1972	1,535
1960	869	1964	1,097	1969	1,191	1973	1,737

Source: U.S. Corps of Engineers, *Statement of Costs*, annual.

No. 992. Vessels Entered and Cleared in Foreign Trade—Net Registered Tonnage, by Flag of Carrier Vessel: 1951 to 1972

[In millions of net tons, except as indicated. Includes Puerto Rico and Virgin Islands. Excludes domestic trade. See also *Historical Statistics, Colonial Times to 1957*, series Q 192-203]

YEARLY AVERAGE OR YEAR	ALL PORTS					SEAPORTS[1]					
	Number of vessels	All vessels				All vessels			With cargo		
		Total tonnage	U.S	Percent U.S	Foreign	Total tonnage	U.S.	Foreign	Total tonnage	U.S.	Foreign
ENTERED											
1951–1955	48,082	115	39	34.3	76	101	35	65	78	27	52
1956–1960	51,874	155	31	20.0	121	139	27	112	110	22	88
1961–1965	49,670	188	33	17.9	155	166	30	136	128	19	109
1966–1970	53,159	232	29	12.5	203	206	27	180	157	18	139
1955	48,415	128	34	26.7	94	114	30	83	90	25	64
1960	51,375	163	30	18.5	133	146	27	119	119	20	99
1965	51,357	209	34	16.3	175	184	31	153	139	18	121
1970	53,293	254	26	10.3	228	227	24	202	171	19	152
1971	51,443	256	24	9.2	232	229	22	207	176	18	159
1972	51,147	295	25	8.4	271	267	23	244	203	19	184
CLEARED											
1951–1955	45,324	115	40	31.2	76	101	36	66	68	25	43
1956–1960	49,079	156	31	19.9	125	110	27	113	85	20	65
1961–1965	48,078	189	34	17.9	155	168	30	137	96	20	76
1966–1970	52,115	232	30	12.8	202	206	27	179	122	23	99
1955	46,642	129	34	26.6	95	115	31	84	74	21	53
1960	49,809	167	31	18.8	135	150	28	122	84	19	66
1965	49,779	209	34	16.3	175	184	31	152	103	21	82
1970	52,195	253	27	10.6	226	226	25	201	132	20	112
1971	50,400	258	24	9.1	231	231	23	208	118	18	100
1972	53,615	300	27	9.0	273	271	25	246	112	20	122

[1] Comprises all ports except Great Lakes ports

Source: U S Bureau of the Census, *Foreign Commerce and Navigation of the United States*, and *Vessel Entrances and Clearances*, FT 975, annual.

No. 993. Vessels Entered and Cleared in Foreign Trade—Net Registered Tonnage, by Customs Districts. 1960 to 1972

[In millions of net tons. Excludes domestic trade Beginning 1970, Puerto Rico included in South Atlantic Coast, Hawaii in South Pacific Coast, and Alaska in North Pacific Coast]

CUSTOMS DISTRICT	VESSELS ENTERED					VESSELS CLEARED				
	1960	1965	1970	1971	1972	1960	1965	1970	1971	1972
North Atlantic Coast	75.8	88.6	102.1	97.1	110.6	80.8	59.7	99.9	97.6	110.3
With cargo	66.6	76.5	85.1	83.3	94.9	35.5	37.8	43.7	35.5	12.7
South Atlantic Coast	8.8	10.9	27.3	29.9	37.1	8.6	11.2	25.5	28.2	36.1
With cargo	7.8	8.7	21.2	22.5	28.1	5.1	5.3	11.4	11.0	14.1
Gulf Coast	27.0	37.6	36.1	39.5	45.3	25.2	36.3	42.8	46.2	53.9
With cargo	15.6	18.5	23.0	26.1	27.9	18.8	29.0	36.8	37.1	43.5
South Pacific Coast	17.1	21.5	27.5	28.7	33.2	18.0	21.8	27.7	27.6	32.7
With cargo	15.0	17.7	21.8	21.0	28.5	11.6	16.1	20.9	17.2	19.5
North Pacific Coast	10.1	13.0	24.9	22.6	27.9	9.1	12.8	21.3	23.4	28.2
With cargo	7.6	7.9	13.6	12.6	11.9	6.9	9.8	19.0	16.1	21.4
Great Lakes	16.9	25.3	27.5	26.8	28.2	16.9	25.2	27.2	26.9	28.6
With cargo	7.8	14.5	15.2	15.3	15.7	13.1	18.6	20.2	19.0	20.5
Alaska, Hawaii, P.R. and V.I.	6.9	12.2	8.8	11.2	13.1	7.7	11.7	5.8	8.2	10.0
With cargo	6.0	9.7	5.9	7.9	8.7	3.5	5.6	.5	9	1.3

Source. U.S Bureau of the Census, *Foreign Commerce and Navigation of the United States*, and *Vessel Entrances and Clearances*, FT 975, annual

Source: Statistical Abstract of the United States 1974

Figure 5.1 Vessels Entered and Cleared in Foreign Trade

5.2.2 Port Climatological Precipitation

Local climatological data for points close to the 11 major ports are available as publications from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration Environmental Data Service. The current available issue extends to 1973.

Total precipitation and total snowfall is tabulated for each month of the year and summed for each year and then averaged over the years for each month for the year.

This data has been abstracted and tabulated in Table 5.2 from which mean values for each port relative to Philadelphia have been determined and a national range has been computed in terms of actual recorded annual precipitation in 1974 in Philadelphia.

Thus, the row (mean)/(mean Philadelphia) represents the major port precipitation multiplier and the national mean range for modifying benefits because of precipitation is calculated to be -37.5 percent; +42.4 percent.

5.2.3 Port Shipping Breakdown for 1974

Shipping breakdown data was collected from various sources for each of the major ports and is shown in Table 5.3.

Data was not always in an appropriate form and, in these cases, the shipping breakdown was deduced. The process of deduction is presented in Appendix A. In Table 5.3, the received data is indicated where underlined.

Table 5.2 Major U.S. Port Climatological Precipitation

Port	Philadelphia	Boston	NY NJ	Baltimore	Hampton Roads	New Orleans	Houston	Los Angeles	Long Beach	San Francisco	Portland	Seattle	Σ	Mean
Precipitation (Inches) Annual Minimum	29.34	23.71	22.17	27.89	26.67	40.17	28.32	3.12	2.58	9.20	25.70	23.78		
Annual Maximum	49.63	62.37	51.35	53.33	57.78	83.54	72.86	23.91	20.02	32.91	51.09	55.14		
Annual Mean	41.09	41.52	42.38	41.33	45.15	58.13	46.90	12.04	9.56	19.01	37.86	40.25		
Ratio Mean to Phila.	1	1.010	1.031	1.006	1.099	1.415	1.142	0.263 average		0.463	0.922	0.980		
1971 Actual Precip.	37.78													
[illegible] Phila. 1971													Σ	Mean
Min	0.777	0.628	0.587	0.738	0.706	1.063	0.750	0.075		0.244	0.680	0.629	6.877	0.625
Max	[illegible]	1.650	1.359	1.412	1.529	2.211	1.929	0.582		0.871	1.350	1.460	15.667	1.424

Table 5.3 Major U.S. Port 1974 Breakdown

Port	Breakbulk	Container	Dry Bulk	Tanker	Passenger	Other
Philadelphia (4,814)	1,346	260	1,178	2,015	15	---
Boston (1,280)	196	276	132	633	24	19
NY/NJ (8,375)	1,249	1,364	2,708	2,732	319	---
Baltimore (4,193)	1,162	770	1,764	497	---	---
Hampton Roads (3,934)	1,320	662	464*	428	28	218
New Orleans (4,779)	3,452	143	830		---	354
Houston (4,413)	1,428	156	1,219	1,610	---	---
Los Angeles Long Beach (5,702)	2,432	508	470	1,742	193	357
San Francisco (3,855)	1,655	120	762	1,147	105	66
Portland (1,966)	634	191	851	262	---	28
Seattle (2,334)	1,014	528	304	292	184	112

_____ indicates data provided, remainder were deduced.

* excludes 814 coal ships handled by railroad labor.

Numbers under ports in parentheses are shipping arrival totals
Seattle based on 1973 data.

The dry bulk traffic at the port of Hampton Roads was reduced by 814 coal ships which are loaded and unloaded by railroad personnel and not ILA labor.

5.2.4 Climatology and Shipping Breakdown Equivalences

In the ports of Philadelphia, the number of precipitation days per annum and the number of ships berthed on any day combine to generate, by multiplication, the total number of ships per annum that can incur nonproductive costs from called labor.

For any other port, these two factors will play the same role and the multiplicative factor relative to Philadelphia will define the loss for each particular port. This implies that loss precipitation days are linearly related to mean annual precipitation and that the number of ships that can be berthed in any day at a port is not restricted by the number of ships arriving at the port. The former implication is conjectural, the latter implication seems reasonable for most ports.

It is not at all clear that the frequency with which there is precipitation in a port at 8 a.m. which will continue until noon is linearly related to the average annual precipitation in that port. It seems reasonable to assume that the two factors are related, but it is not clear that the functional relationship is linear. But then, no functional relationship has been found and the linear one is accepted in order to determine an answer.

The combination influences are given in Tables 5.4, 5.5 and 5.6 for equivalences for East Coast, Gulf Coast and West Coast major U.S. ports and the equivalences when summed provide benefit multipliers for the different categories of ships being considered.

It is observed that, for the East Coast, container traffic is very significant; for the Gulf Coast, breakbulk traffic predominates; while on the West Coast there is a strong climatological influence.

Table 5.4 East Coast Ports Equivalences
(5 Ports)

Port	Climatology Factor	BREAKBULK		CONTAINER		DRY BULK	
		Without Climatology	With Climatology	Without Climatology	With Climatology	Without Climatology	With Climatology
Philadelphia	1.	1.	1.	1.	1.	1.	1.
Boston	1.010	0.147	0.148	1.061	1.072	0.112	0.113
NY/NJ	1.031	0.935	0.964	5.246	5.409	2.299	2.370
Baltimore	1.006	0.870	0.875	2.961	2.979	1.498	1.507
Hampton Roads	1.099	0.989	1.087	2.546	2.798	0.394	0.433
Σ		3.941	4.074	12.814	13.258	5.303	5.423

This benefit multipliers for the 5 major East Coast U.S. Ports for 1974 are:

For breakbulk ships 4.074
For container ships 13.258
For dry bulk ships 5.423.

Table 5.5 Gulf Coast Ports Equivalences (2 Ports)

Port	Climatology Factor	BREAKBULK Without Climatology	BREAKBULK With Climatology	CONTAINER Without Climatology	CONTAINER With Climatology	DRY BULK Without Climatology	DRY BULK With Climatology
Philadelphia	1.	1.	1.	1.	1.	1.	1.
Houston	1.142	1.061	1.212	0.601	0.686	1.035	1.182
New Orleans	1.415	2.565	3.629	0.550	0.778	0.705	0.998
Σ		3.626	4.841	1.151	1.464	1.740	2.180

This benefit multipliers for the 2 major Gulf Coast U.S. Ports for 1974 are:

For breakbulk ships 4.841
For container ships 1.464
For dry bulk ships 2.180.

Table 5.6 West Coast Ports Equivalences
(4 Ports)

Port	Climatology Factor	BREAKBULK Without Climatology	BREAKBULK With Climatology	CONTAINER Without Climatology	CONTAINER With Climatology	DRY BULK Without Climatology	DRY BULK With Climatology
Philadelphia	1.	1.	1.	1.	1.	1.	1.
San Francisco	0.463	1.230	0.569	0.462	0.214	0.646	0.299
Los Angeles Long Beach	0.263	1.807	0.475	1.954	0.514	0.399	0.105
Seattle	0.980	0.753	0.738	2.031	1.990	0.258	0.253
Portland	0.922	0.471	0.434	0.735	0.678	0.722	0.666
Σ		4.261	2.216	5.182	3.396	2.025	1.323

Note: Seattle based on 1973 data

The benefit multipliers for the 4 major West Coast U.S. Ports for 1974 are:

For breakbulk ships	2.216
For container ships	3.396
For dry bulk ships	1.323.

The benefit multipliers for each coast are summed in Table 5.7 to give an equivalence for the major ports which is then multiplied by 1.104 to give a national equivalence to account for the traffic in the minor ports. The minor port traffic is implicitly assumed to be structured like the average traffic in the major ports. This assumption is not proven, and seems unlikely to be true, since minor port handling of container traffic is expected to be negligible. Because the increment is 10 percent, it has been applied uniformly.

5.2.5 1974 Benefits Exclusive to SEASAT

Benefits exclusive to SEASAT, decribed as 1974 benefits, are developed nationally in Table 5.8. The benefits are described as 1974 benefits although 1974 shipping breakdowns are used in combination with an operational, 1985, SEASAT capability. By 1985, shipping breakdowns are expected to exhibit growth factors. These growth factors are not known at this time nationally, although estimates are available for the ports of Philadelphia.

It is to be recalled that the integration of SEASAT data is assumed to provide an increment equivalent to 20 percent of that expected to develop through general forecasting improvements up to 2000, as applied to the forecasting probability of the event of interest. Alternatively, the SEASAT data integration is 1/90 of the absolute maximum improvement in general forecasting quality, as applied to the forecasting probability of the event of interest to this

Table 5.7 1974 Benefit Multipliers

Ship Type	East Coast Equivalences (5 ports)	Gulf Coast Equivalences (2 ports)	West Coast Equivalences (4 ports)	Major Port Equivalences (11 ports)	National Equivalence 1.104 (11 ports)
Breakbulk	4.074	4.841	2.216	11.121	12.278
Container	13.258	1.464	3.396	18.118	20.002
Dry Bulk	5.423	2.180	1.323	8.926	9.854

Table 5.8 1974 Annual National Benefits to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration

Ship Operating Costs $/day	Ship Berthing Status	BREAKBULK		DRY BULK		CONTAINER		Range of 1974 National Benefit $		
		Phila $	National $	Phila $	National $	Phila $	National $			
10000	working	3,148	41,966	2,509	24,724	609	12,181	49,294	78,871	112,312
10000	idle	3,256	39,977	2,239	22,063	554	11,081	45,701	73,121	104,124
1500	working	1,588	19,497	907	8,938	255	5,101	20,960	33,536	47,755
1500	idle	1,413	17,349	636	6,267	200	4,000	17,260	27,616	39,325

The 1974 National Benefit has an associated range, based on climatological precipitation +42.4% / -37.5%.

problem. This absolute maximum assumes that general forecasting will achieve a forecasting probability of unity.

Philadelphia's 1974 benefits are derived from Tables 4.9, 4.10 and 4.11 by discounting the 1985-2000 benefits by the related shipping growth factors. The national benefits are determined by multiplying the Philadelphia 1974 benefits by the national benefit multipliers.

5.2.6 General National Annual Losses and Benefits

To put the SEASAT incremental benefits in perspective, the national annual maximum avoidable loss to ship owners from precipitation in ports and harbors has been calculated. This is a national annual loss for 1974, and is shown in Table 5.9. Maximum avoidable losses for other years require the prediction of shipping traffic variations as a function of time, data which is not currently collected. Of this maximum loss, a certain loss saving or assumed annual benefit to ship owners is realizable. This benefit is presented in Table 5.10. These benefits assume a 1974 national shipping distribution combined with a weather forecasting capability estimated to be possible in 1985-2000. This capability can only be realized if its implementation is specifically developed for this application.

The annual maximum benefits result from multiplying the 1974 maximum benefits of Tables 4.9, 4.10 and 4.11, by the national equivalences for 1974. For the annual realizable benefits, take the 1985 realizable benefits of Tables 4.9, 4.10 and 4.11 discounted by the tabulated growth factors and multiplied by the national equivalences for 1974.

Table 5.9 1974 National Annual Maximum Avoidable Losses to Ship Owners from Precipitation in Ports and Harbors

Ship Daily Operating Costs ($)	Ship Berthing Status	TYPE OF SHIPPING			National Total Annual $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	42,009,569	24,759,889	12,169,216	78,938,674
10000	idle	39,943,796	22,078,438	11,082,308	73,104,542
1500	working	19,567,006	8,984,601	5,101,710	33,653,317
1500	idle	17,484,706	6,303,151	4,014,801	27,802,658

- Losses have a range $^{+42.4\%}_{-37.5\%}$ due to climatology.

Table 5.10 1974 Estimated National Annual Benefit to Ship Owners from Appropriately Applied Weather Forecasting, from all Sources, to Ports and Harbors

Ship Daily Operating Costs ($)	Ship Berthing Status	TYPE OF SHIPPING			National Total Annual $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	15 539 348	9 161 895	4 504 225	29 206 468
10000	idle	14 775 221	8 169 680	4 101 430	27 046 831
1500	working	7 237 843	3 324 572	1 888 309	12 450 724
1500	idle	6 467 594	2 332 351	1 486 015	6 285 960

Assumptions

- National Shipping Arrival Distribution for 1974
- 1985-2000 Weather Forecasting Capability
- Implemented Weather Forecasting Quality for Use in Ports and Harbors

Benefits have a range $^{+42.4\%}_{-37.5\%}$ due to ports climatology.

5.3 Generalization of the Ports and Harbors Case Study

5.3.1 Introduction

The generalization that will be developed will be restricted to estimating the changes in shipping traffic arrivals in U.S. ports. The generalization will be directed to the time interval 1985-2000.

In the case study, shipping arrivals were categorized according to the laborer's handling the cargo as breakbulk, dry bulk and container shipping. The generalization requires, for each port, the development of the changes in these shipping arrivals with time. The influence of local climate on the results of the generalization requires that each port be treated individually. Such a treatment however adds greatly to the complexity of generalization.

The complexity arises not so much from estimating the trends in growth of world trade with the United States or from changes in the commodities transported but from the current and continuing substantial activity in evaluating economical modes of sea and inter-modal transportation, including offshore systems and their associated concepts for feeder transportation.

Shipping economies seem to clearly indicate the advantages of larger vessels. To support the income in ship productivity vast improvement in cargo storage and cargo handling are necessary for both import and export commodities, specifically in non-full tonnages. The cargoes of concern are not the day bulk commodities such as sugar, iron ore, wheat, etc., which are shipped as homogeneous cargoes in specialized vessels which today are loaded and unloaded with the maximum of automation and machine handling. It is the general cargo and its subdivision as breakbulk and containerized cargo that is undergoing transition.

This transition leads to competitive interaction among the major ports because a large number of inderdependencies result from attempts to create economical transportation.

For example, larger container ships with their consequent increase in draught imply the requirement for public financing approval to engineer a port to properly service the vessels. The railroads with containers and trailer-on-flatcar/container-on-flatcar (TOFC/COFC) cargoes have foreseen a means for short circuiting the Panama Canal giving rise to the mini-bridge transportation concept. The regulatory concepts, programs and implementations of the Interstate Commerce Commission and the Federal Maritime Commission on motor and rail tariffs will influence the development of the mini-bridge implementation. There are difficulties within the marine insurance underwriters in structuring liabilities for container and inter-modal traffic. The Jones Act by requiring inter-U.S.

port feeder traffic to be U.S. flag operated encourages foreign flag shipping to utilize Canadian ports and foreign feeder vessels. Intense developments in technology will allow commodities to be effectively containerized that today cannot be and also are likely to produce more efficient port handling equipment for cargo handling. All in all the trend is to shift port operations from being labor intensive to being capital intensive. It is however most difficult to estimate what the results of competition amongst each of the major ports will be as they initiate and undertake vigorous marketing programs to maximize their shares of containerizable cargo capture, import, export and domestic.

Some of the great variability in estimation of container shipping growth is illustrated by Figure 5.2 taken from a report by C.E. Maguire Inc., in a container facilities feasibility study for the Massachusetts Port Authority. It results in a 4:1 variation in facilities requirements. The report recommends that there should be added to the current facilities capacity of 140,000 20-foot equivalent containers (teu), two additional berths to give a total capacity of 240,000 (teu), to be available by 1978. This is a recommended growth factor of about 1.7, instead of a maximum of 2.8.

Ship size will influence the labor demand and the time to unload. Hence, the influence of weather even for equivalent magnitudes of cargo because of the reduction of

Maximum Growth Projection

If one were to assume that growth and conversion of both foreign and domestic traffic would be coupled with major recapture from the Prime Market Area plus the addition of even a small percentage of increased traffic from the Secondary Market Area, the facility requirement projection would rise to some 360,000 TEU's by 1990. While it is felt that this number is unrealistic and represents a level of optimism unjustified by the existing or future condition of the container industry in the North Atlantic, it is provided as a point of reference.

The various combinations of cargo sources upon which traffic can be forecast and the resulting facility requirements in TEU's can be summarised are as follows:

Source	Facility Requirements 1980	Facility Requirements 1990
Basic Foreign Trade Only	76,300	98,200
Basic Foreign Trade Plus Recapture of Prime Market	148,100	184,400
Growth and Conversion Domestic and Foreign	185,000	271,300
Domestic and Foreign Plus Major Recapture	266,900	360,000

Figure 5.2 Port of Boston

vessel preparation time. Current average container ship capacity is about 370 (teu); the modern Japanese vessel of today carries about 2000 (teu) and the super containership will carry 3000 (teu). How such a size of cargo will relate to the statistics of the case study is not known. General statements are made that ship productivity will improve by a factor 3 and dock labor and resources productivity by a factor 10.

The U.S. Maritime Administration (MARAD) projections for the import and export trade indicate that by 1990, 1787 million long tons of cargo will be involved or more than three times the volume of 1971. Alternatively they project that the tonnage in the next ten years will double and by 1995 it will double again. In these projections liquid and dry bulk are expected to predominate. MARAD also forecasts that by 1980 import and export containers across U.S. piers will have increased from 2.4 million (teu) in 1968 to 3 million (teu) in 1975 to 3.6 million (teu) in 1980, an increase of about 20 percent from today. Projections of this type are difficult to use rigorously without knowing the current capacity of all the major ports.

Capital expenditures in the ports for the years 1966-1972 and proposed capital expenditures for the years 1972-1977 have also been collected by MARAD and are shown in Figure 5.3. These expenditures, according to MARAD do not adequately represent private expenditures. The large expenditure on

NORTH AMERICAN PORT
CAPITAL EXPENDITURES, 1966-72
(in millions of $)

Region	General Cargo	Spec. Gen. Cargo	Bulk Liquid & Dry	Region Total	% Grand Total
North Atlantic	110.9	193.9	120.4	452 2	34%
South Atlantic	56.4	25.2	27.1	108.7	9%
Gulf Coast	55.4	19.0	107.3	181.8	14%
Pacific Coast	81 2	164.6	62.8	308.7	24%
Alaska, Hawaii, Puerto Rico	7.4	28.1	30.9	66.3	6%
U.S. Great Lakes	18.7	1.8	4.4	24.9	2%
U.S. Total	330.2	432.6	352.9	1115.6	89%
Canada	48.3	23 3	62.5	134.1	11%
Grand Total North America	378.5	455.9	415.4	1249.8	100%

WORLD PORTS: September 1974

PROPOSED NORTH AMERICAN PORT
CAPITAL EXPENDITURES, 1972-77
(in millions of $)

Region	General Cargo	Spec. Gen. Cargo	Bulk, Liquid & Dry	Region Grand Total	% Grand Total
North Atlantic	119.4	230.0	5 8	335.2	20%
South Atlantic	53.5	55.1	5.1	113.6	7%
Gulf Coast	52.2	45.8	496.6	594.6	34%
Pacific Coast	77.5	220.0	71.5	368.0	21%
Alaska, Hawaii, Puerto Rico	22.3	7.6	5.7	35.7	3%
U.S. Great Lakes	7.4	4.0	5.8	17 3	2%
U.S Total	332.3	561.7	590 5	1484 5	87%
Canada	36.0	113.5	51.1	220 5	13%
Grand Total North America	368.3	695.1	641.5	1705.0	100%

WORLD PORTS: September 1974

Figure 5.3 Port Capital Expenditure

the Gulf Coast for bulk liquid and dry is purported to be for the development of offshore ports in Louisiana and Texas; its increment being totally for this purpose. The expenditures indicated show a fairly constant value for general cargo, an increase for specialized general cargo or container type traffic and essentially a decline for bulk liquid and dry, if the offshore port development funds are subtracted.

A generalization procedure has been selected which seems appropriate both to the complexity of the problem and to the magnitude of the benefits in particular those exclusive to SEASAT.

Foreign ports have been excluded from this generalization previously because of the differences in port and labor contracts.

5.3.2 The Generalization Procedure

The benefits from ports and harbors do not seem to be sufficiently significant to warrant in-depth attempts at generalizing for individual ports or in attempting to estimate very specifically the characteristics of the shipping arrivals expected in these ports during 1985-2000.

It is proposed to generalize using the capital expenditures as a basis, with the implicit assumption that during the time period of interest the expenditures proposed up to 1977 will be operating at capacity. The projections of MARAD and the explicit projections for Philadelphia will be used as a controlling guide.

The quoted capital expenditures are grouped as shown in Table 5.11 to be relevant to the case study. It is proposed to try to relate the purchasing power of the 1972-1977 capital expenditures to those of 1966-1972 by discounting them due to inflation at about 4 percent per annum or for five years by 21.6 percent and to remove from the table the incremental expenditures in the Gulf for offshore port development. This process produces the results in Table 5.12.

The adjusted capital expenditures for 1966-1972 will be assumed to be representative of the regional ports 1974 capacity. The expenditures during 1972-1977 will be assumed to be representative of the 1985-2000 relative capacity. The adjusted capital expenditures can then be normalized as a relative port growth estimator as shown in Table 5.13. This gives rise to the following growth factors in shipping for the various port regions for the time period 1985-2000, as shown in Table 5.14.

The national average growth factor is the arithmetic mean of the regional growth factors and these are compared to those developed separately for the ports of Philadelphia by the Delaware River Port Authority. It is to be noted that the port capital expenditures are not only relative to the import-export trade but also to the domestic trade. Growth in domestic trades does not appear to be as well documented as expected growth in import-export trade. It is also noted that these capital

Table 5.11 Port Capital Expenditures ($ million)

Time Period	General Cargo		Specialized General Cargo		Bulk Liquid and Dry Cargo	
	1966-1972	1972-1977	1966-1972	1972-1977	1966-1972	1972-1977
Atlantic	167.3	172.9	219.1	285.1	147.5	10.9
Gulf	55.4	52.2	19.0	45.8	107.3	496.6
Pacific	81.2	77.5	164.6	220.0	62.8	71.5

Table 5.12 Adjusted Capital Expenditures ($ million)

Time Period	General Cargo		Specialized General Cargo		Bulk Liquid and Dry Cargo	
	1966-1972	1972-1977	1966-1972	1972-1977	1966-1972	1972-1977
Atlantic	167.3	135.6	219.1	223.5	147.5	8.54
Gulf	55.4	40.9	19.0	35.9	107.3	84.1
Pacific	81.2	60.8	164.6	172.5	62.8	56.1

Table 5.13 Normalized Port Growth Estimators

Time Period	General Cargo		Specialized General Cargo		Bulk Liquid and Dry Cargo	
	1974	1985-2000	1974	1985-2000	1974	1985-2000
Atlantic	1	0.81	1	1.02	1	0.06
Gulf	1	0.74	1	1.89	1	0.78
Pacific	1	0.75	1	1.05	1	0.89

Table 5.14 Estimated Growth Factors (1985-2000)

	General Cargo	Specialized General Cargo	Bulk Liquid and Dry Cargo	Shipping Arrival Growth
Atlantic	18.1	2.02	1.06	4.89
Gulf	1.74	2.89	1.78	6.41
Pacific	1.75	2.05	1.89	5.69
National Average	1.77	2.32	1.58	5.67
Philadelphia Ports	1.38	2.28	1.42	5.08

expenditures do not include a great deal of private capital. Since private wharfs, docks, etc., do not generally use ILA labor, this is appropriate to this particular study. Further, if these expenditures are almost all public, very little of the bulk growth is due to oil movement. This is also pertinent to this problem. The question of the time lag between capital expenditure expansion and the actual operational use of the provided expansion is difficult to estimate. One supporting estimate will be offered. In the port of Boston in 1972, 59,642 containers were handled but the theoretical port capacity at that time was estimated to be 140,000 containers. According to the projections made for the port of Boston this capacity would be actually utilized somewhere between 1980 and 1990 depending on the marketing success by the Massachusetts Port Authority.

Shipping arrival growth to correspond with the growth in transportation is shown in the right hand column of Table 5.14. The national average relative to today's ship arrivals shows a growth factor of 5.67. This factor is appropriate to the relativity needed in the generalization but in actuality the number of ship arrivals will be considerably less. This will result from the expected increase in the capacity of individual ships. For example, the capacity of a container ship may increase from 400 (teu) to 3000 (teu), a factor of 7.5 which for container shipping would reduce the number of container ship arrivals from a factor of 2.32 to a representative factor of 0.31.

The generalization of benefits will use the regional growth factors developed in Table 5.14.

5.3.2.1 The Ports and Harbors Generalization

The 1974 benefit multipliers previously developed in Table 5.7 are as follows:

Ship Type	East Coast Equivalences	Gulf Coast Equivalences	West Coast Equivalences	Major Port Equivalences	National Equivalences
Breakbulk	4.074	4.841	2.216	11.121	12.278
Container	13.258	1.464	3.396	18.118	20.002
Dry Bulk	5.423	2.180	1.323	8.926	9.854

The proposed growth factors from Table 5.14 for the time period 1985-2000 are as follows:

Ship Type	East Coast	Gulf Coast	West Coast
Breakbulk	1.81	1.74	1.75
Container	2.02	2.89	2.05
Dry Bulk	1.06	1.78	1.89

Assuming that growth is regionally uniform these two tabulations multiplied together at each array point will produce the benefit multipliers for 1985-2000 shown in Table 5.15.

Table 5.15 1985-2000 Benefit Multipliers

Ship Type	East Coast Equivalences	Gulf Coast Equivalences	West Coast Equivalences	Major Port Equivalences	National Equivalences
Breakbulk	7.374	8.423	3.878	19.675	21.721
Container	26.781	4.231	6.962	37.974	41.923
Dry Bulk	5.748	3.880	2.500	12.128	13.389

Annual Benefit for 1985-2000 exclusive to SEASAT's data integration can be derived as in the case study and are shown in Table 5.16 Both the maximum national avoidable losses and the national benefits to shipowners from precipitation in the nation's ports and harbors for 1985-2000 can be derived as in the case study. These are presented in Tables 5.17 and 5.18 using figures previously developed for the ports of Philadelphia and the estimated growth in shipping arrivals.

5.3.3 <u>The Benefits to Shipping in Ports and Harbors from SEASAT and Weather Forecasting</u>

The movement and distribution of cargo by shipping, to be as efficient as possible, requires the selection of the most advantageous route for the shipping and the most efficient employment of port and harbor facilities and services. The objective throughout is to minimize avoidable losses or enforced idle time of the shipping involved. Idle time, in a general sense, implies that the ship operation is not functioning at its optimum or minimum cost level, so that the

Table 5.16 1985-2000 Annual National Benefit to Ports and Harbors Exclusive and Incremental to SEASAT Data Integration

Ship Operating Costs $/day	Berthing Status	BREAKBULK		BREAKBULK		BREAKBULK		Range of 1974 National Benefit $		
		Phila $	National $	Phila $	National $	Phila $	National $			
10000	working	3,418	74,243	2,509	33,593	609	25,531	83,354	133,367	189,915
10000	idle	3,256	70,724	2,239	29,978	554	23,225	77,454	123,927	176,472
1500	working	1,588	34,493	907	12,144	255	10,690	35,829	57,327	81,634
1500	idle	1,413	30,692	636	8,515	200	8,385	29,745	47,592	67,771

National Benefit Range due to port climatology variation, +42.4% -37.5%

$ are $1974.

Table 5.17 1985-2000 National Annual Maximum Avoidable Losses to Ship Owners from Precipitation in Ports and Harbors

Ship Daily Operating Costs $	Ship Berthing Status	TYPE OF SHIPPING			National Total Annual Maximum $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	74,319,096	33,642,192	25,505,953	133,467,241
10000	idle	70,664,538	29,998,804	23,227,857	123,891,199
1500	working	34,615,975	12,207,715	10,692,880	57,516,570
1500	idle	30,932,181	8,564,327	8,414,785	47,911,293

Losses have a range +42.4% -37.5% due to climatology.

$ are $1974.

Table 5.18 1985-2000 Estimated National Annual Benefit to Ship Owners from Appropriately Applied Weather Forecasting from all Sources, to Ports and Harbors

Ship Daily Operating Costs ($)	Ship Berthing Status	TYPE OF SHIPPING			National Annual Benefit $
		Breakbulk $	Dry Bulk $	Container $	
10000	working	27,489,106	12,451,015	9,440,856	49,380,977
10000	idle	26,137,365	11,102,595	8,597,645	45,837,605
1500	working	12,803,744	4,518,093	3,958,990	21,280,827
1500	idle	11,441,173	3,169,665	3,114,687	17,725,525

Benefits have a range $^{+42.4\%}_{-37.5\%}$ due to ports climatology.

$ are $1974.

productivity of the capital and labor of the ship is not maximized.

The structure of port and harbor services is such that a ship owner can expect certain avoidable costs to arise, which are essentially levied against his ships. The avoidable costs, in this case study, which are the source of benefits, are those associated with the forecasting of the occurrence or nonoccurrence of precipitation in the port or harbor. More precisely they arise from forecasting errors, or from lack of useful knowledge about precipitation.

To discuss benefits it will be assumed that a forecasting system exists, that its findings are adequately disseminated to the ship owners who follow the forecast, that is, they make decisions consonant with the forecast.

When forecasting is correct, that is, the conditions forecasted are observed at the time forecasted, there are no avoidable costs; there may be unavoidable costs as a result of enforced idle time for the shipping. These unavoidable costs are a minimum constraint on the productivity of the capital and labor of the shipping. The avoidable costs increase the magnitude of this minimum constraint.

When no precipitation is forecasted and precipitation is observed, labor called to service the ship at berth must be paid under the guarantees of contractual agreement, even though the labor performs no productive output because of the precipitation.

When precipitation is forecasted and no precipitation is observed, the ship at berth remains idle because no labor has been called to service it. Thus the ship owner must pay nonproductive or avoidable operating and dockage costs. He may in addition have to pay premium rates for labor to turn his ship around in an allotted time.

Reduction of these forecasting errors results in a reduction of avoidable costs which constitute an apparent benefit to the ship owners as a result of forecasting improvements.

The consequent increment in productivity improvement could result in a reduction in the price of shipping services, uniformly for all shipping, so that society at large should be a direct beneficiary as a result of incremental price reductions in all goods that are shipped.

Alternatively it could be argued that shipping is a patterned activity and local weather forecasting is a regional patterned activity so that incremental differences in the price of goods with respect to regions would become less pronounced, again benefiting elements of society.

However, the gradual elimination of forecasting errors implies that port and harbor labor is more and more compensated precisely for productive work, a trend which ultimately results in a reduction in labor's paid work week.

It seems reasonable to assume that labor will seek, by contract, to obtain a fixed annual wage, possibly through rules of compensation or royalty payments as has happened when containerized cargo is handled.

In this manner longshore labor may become the beneficiary of some benefits, rather than the shipowners. Labor's precipitation days will, as it were, become for them paid holidays. Those benefits arising from nonproductive costs paid for ship operation and docking when precipitation is predicted and is not observed, will still remain potential social benefits.

If labor seeks, by contractual means, to eliminate the influence of any improvement in weather forecasting on their take home pay then labor-related <u>avoidable</u> losses will become labor-related <u>unavoidable</u> losses. This transfer will result from assumed incremental wages related to the degree of precipitation forecasting success which labor will demand.

The expected avoidable loss equation will then change from

$$E_u = (1-p)\ [{}^{70}/73\ (C_{DW} + C_o) + {}^{3}/73\ C_L]$$

to

$$E_{uL} = (1-p)\ [{}^{70}/73\ (C_{DW} + C_o)].$$

Hence $$\frac{E_{uL}}{E_u} = \frac{70(C_{DW} + C_o)}{70\ (C_{DW} + C_o) + 3C_L}.$$

The ratios E_{uL}/E_u are tabulated in Table 5.19.

Table 5.19 The Values of E_{uL}/E_u

Shipping Daily Operating Costs ($)	Shipping Berthing Status	SHIPPING TYPE		
		Breakbulk	Container	Dry Bulk
10000	working	0.7368	0.8786	0.9864
10000	idle	0.7232	0.8667	0.9848
1500	working	0.4350	0.7105	0.9625
1500	idle	0.3601	0.6321	0.9466

These ratios, operated on the SEASAT exclusive benefits, reduce them as shown in Table 5.20 and Table 5.21 for 1974 and 1985-2000. A column is added to indicate the percentage of benefits lost to labor loss exclusion. Similarily the 1985-2000 national annual benefit from appropriately applied weather forecasting is modified as shown in Table 5.22.

Table 5.20 SEASAT Exclusive National Benefits with Labor Losses Excluded

Ship Operating Costs $/day	Ship Berthing Status	SHIPPING TYPE			National Annual Benefit $	Benefit % Reduction
		Breakbulk $	Dry Bulk $	Container $		
10000	working	30,921	24,388	10,702	66,011	16.31
10000	idle	28,911	21,728	9,604	60,243	17.61
1500	working	8,481	8,603	4,910	21,994	34.42
1500	idle	6,247	5,932	3,979	16,158	41.49

Benefits have a range $^{+42.4\%}_{-37.5\%}$ based on ports climatology.

All benefits are in $1974.

Table 5.21 1985-2000 SEASAT Exclusive National Benefits with Labor Loss Excluded

Ship Operating Costs $/day	Ship Berthing Status	SHIPPING TYPE			National Annual Benefit $	Benefit % Reduction
		Breakbulk $	Dry Bulk $	Container $		
10000	working	54,702	33,136	22,432	110,270	17.32
10000	idle	51,148	29,522	20,129	100,799	18.67
1500	working	15,004	11,689	7,595	34,285	40.19
1500	idle	11,052	8,060	5,300	24,412	48.71

Benefits have a range $^{+42.4\%}_{-37.5\%}$ based on ports climatology.

All benefits are in $1974.

Table 5.22 1985-2000 Estimated National Annual Benefits to Ship Owners from Appropriately Applied Weather Forecasting, with Labor Losses Excluded

Ship Operating Costs $/day	Ship Berthing Status	SHIPPING TYPE Breakbulk $	SHIPPING TYPE Dry Bulk $	SHIPPING TYPE Container $	National Annual Benefit $
10000	working	20,253,973	12,281,681	82,947,36	40,830,390
10000	idle	18,902,542	10,933,835	74,515,79	37,287,956
1500	working	5,569,629	4,348,665	28,128.63	12,731,157
1500	idle	4,119,966	3,000,404	19,687,94	90,891,64

The annual national benefits to port and harbors during the time period 1985-2000 are distributed among the ports as percentages from different types of shipping and as accumulated totals as shown in Table 5.23.

Table 5.23 Benefit Distribution Amongst Ports

Port	SHIPPING TYPE BENEFIT Breakbulk %	SHIPPING TYPE BENEFIT Container %	SHIPPING TYPE BENEFIT Dry Bulk %	Total Benefit %
Philadelphia	4.64	0.92	2.00	7.56
Boston	0.68	0.99	0.23	1.90
NY/NJ	4.47	4.99	4.73	14.19
Baltimore	4.06	2.75	3.01	9.82
Hampton Roads	5.04	2.58	0.86	8.48
Houston	5.41	0.90	3.96	10.27
New Orleans	16.18	1.03	3.34	20.55
San Francisco	2.56	0.20	1.06	3.82
LA/LB	2.13	0.48	0.37	2.98
Seattle	3.31	1.86	0.90	6.07
Portland	1.95	0.64	2.37	4.96
Minor Ports	5.24	1.80	2.36	9.40
Total	55.67	19.14	25.19	100.00

Table 5.24, identifies the actual benefits to individual ports, both those exclusively from SEASAT data and those from all forecasting sources.

The total benefits employed in this distribution are taken from Tables 5.16 and 5.17.

These percentages are appropriate either for the benefits resulting exclusively from SEASAT or for those resulting from an appropriate application of weather forecasting to the meteorological phenomenon of significance to port and harbor avoidable costs. The percentages are representative of the benefit distribution for working ships with daily operating costs of $10,000 per day. Shipping with different costs or berthing status would have somewhat different allocations of benefits.

Table 5.24 1985-2000 Annual National Benefit Distribution to Ports and Harbors

Port	SEASAT Exclusive Annual Benefit $ (all shipping)	Annual Benefit From All Forecasting Sources $ (all shipping)
Philadelphia	10,083	10,090,123
Boston	2,534	2,535,878
New York/New Jersey	18,925	18,939,002
Baltimore	13,097	13,106,483
Hampton Roads	11,310	11,318,022
Houston	13,697	13,707,086
New Orleans	27,407	27,427,518
San Francisco	5,095	5,098,449
Los Angeles/Long Beach	3,974	3,977,324
Seattle	8,095	8,101,462
Portland	6,615	6,619,975
Minor Ports	12,535	12,545,919
TOTAL	133,367	133,467,241

APPENDIX A

A.1 Source Data

The following sources of data are collected here for their general pertinency to U.S. ports and harbors rather than for specific information that they contain.

Port of Los Angeles, 1974 Annual Report.

The American Association of Port Authorities Inc., 1974 Handbook.

The Philadelphia Maritime Exchange Inventory, 1974-1975.

Negotiated Agreements Between PMTA and ILA, 1968-1971.

Ameriports General Cargo Forecasts by Trade Route, 1975 and 1980.

Large Acreage Sites Available for Water-Related Industrial Development, WTD DRPA.

International Waterborne Commerce (Ameriport), 1971 and 1973.

Forecast of Container Tonnage Through Ameriport, WTD DRPA.

New Container Facilities for Ameriport, C.E. Maguire Inc.

World Ports, September, October and December, 1974.

Boston Marine Guide, October 4, 1974.

MassPort Annual Report, 1974.

What the Port of Boston Contains for You.

Waterborne Commerce, Boston, 1973.

Waterfront Commission of New York Harbor, Annual Report, 1973-1974.

Climatological Estimates of Clock Hour Rainfall Rates, Technical Report 702, QWS USAF.

NWS Public Forecast Verification Summary, NWS, FCST, 16, 17,19,21.

Long Term Verification Trends of Forecasts, NOAA TM NWS FCST-18.

Probability Verification Studies, Los Angeles, CRH,NWS, Kansas City, Missouri.

Operations of NWS, November 1974.

Summary of Draft Report of the Panel on Weather and Climate (NRC).

Baltimore Cargo Statistics and Projections.

Foreign Trade Annual Report Ports, 1974.

Hampton Roads Maritime Association, Maritime Bulletin, January 1975.

Foreign Trade During 1973 at the Ports of NY/NJ.

Selective Guide to Climatic Data Sources (Documentation), DOC 1969.

Environmental Guide for U.S. Gulf Coast NOAA, November 1972.

Environmental Guide for U.S. Ports Observation Approvals, NOAA, 1972.

A.2 Data and Information Sources and Data Derivations

This appendix documents the data and information acquired and the sources of the data and information. In addition, since the data acquired was not always in the form required for this application, the data was manipulated. The manipulations involved are also documented.

Each major port is treated separately.

Information and conjectures relating to weather forecasting quality in the future were collected from various members of the National Weather Service organization who, in general, preferred not to be identified with the conjectures made. A list of these individuals is provided.

Consultations on Weather Prediction, Trends, and Quality

Dr. William Klein	301 427-7745
Dr. John Brown	301 763-8005
Dr. Havermale	301 763-8056
Dr. Kikuro Miyakoda	609 452-6540
	452-6500
Dr. Duane Cooley	301 427-7713
Dr. Alika	301 427-7768
Dr. Bob Glahn	301 427-7768
Dr. Alexander Sadowski	301 427-7713
Dr. Carlos Dunne	212 995-8616
Dr. Wassal	215 627-5575
Dr. Max Kazak	215 448-1000

Ports of Philadelphia, Pennsylvania

The weather data for 1974 was compiled from the records of the Philadelphia Maritime Exchange (215 WA5-1522) which were made available by William Harrison. This organization also provided the breakdowns of shipping in the port and the statistics of the total number of ship arrivals in all major ports up to 1973.

The data which described the number of longshore gangs called in the ports on the days when precipitation loss occurred was supplied by James P. Traynor (215 922-7510) from the call records of the Philadelphia Marine Trade Association.

Data relating to the costs of longshore gangs was provided, in confidence, by a principal stevedoring company in the port of Philadelphia.

Projection data for traffic and tonnage in the ports was provided by Nelson Bean and William Bennington of the World Trade Division of the Delaware River Port Authority (215 WA5-8780).

1974 Weather Statistics were provided by the Philadelphia Airport Meteorological Station (215 365-0823) and discussions with the Weather Bureau Service in Philadelphia (215 MA7-5575).

Port of Boston, Massachusetts

The data for the Port of Boston was provided by Rino Moriconi, statistician of the Massachusetts Port Authority (617 482-2930) as follows:

1974 Shipping Arrivals

Bulk	132
Breakbulk	196
Container (full)	276
Tanker (oil)	633
Passenger	24
Others (repair, non-cargo discharge)	19
Total	1,280

Ports of New York and New Jersey

The following data was provided by Mr. Filosa of the New York Maritime Exchange (212 944-8360):

Bulk, Breakbulk, Container	5,321
Tanker	2,732
Passenger	319
Total	8,372

Since this data was not appropriate, it had to be manipulated which required additional data.

The 1972 tonnages for NY/NJ showed 75 percent was bulk cargo and 1973 tonnages showed 79 percent was bulk cargo. It was, therefore, assumed that an average bulk cargo tonnage was 77 percent of the total. (Data from Jerry Gilbert - Port Economist and Amis Ilan - Trade Research & Analysis Economist 212 466-8685.)

The 1973 monthly and total shipping data for the ports of Philadelphia provided the following breakdown of average net registered tonnages.

Overall average	10,248
Breakbulk	4,783
Container	7,951
Bulk	8,786
Tanker	15,470
Passenger	9,135

This breakdown data was used in combination with data concerning the number of vessels in NY/NJ to derive an appropriate breakdown since 1974 tonnages were not available.

Total tonnage equivalent 8372 x 10248	85,796,256
Bulk at 77% average	66,063,117
Tanker Bulk 15470 x 2732	42,264,040
Dry Bulk = Bulk-Tanker	23,799,077

Number of dry bulk Ships (23,799,077) = 2,708

Therefore, number of breakbulk and container ships is 5321-2708 = 2,613.

Non-bulk tonnage	19,733,139
Passenger tonnage	2,914,065
Container & Breakbulk tonnage	16,819,074

Suppose there are X container ships, then

$$7951\,x + (2613-X)\,4783 = 16{,}819{,}074$$

i.e., X = 1364 = No. of containers
1249 = No. of breakbulk

These results seemed reasonable giving a number of container ships of the order of twice those of Hampton Roads and Baltimore which are principal container ports in the United States.

[Additional information was obtained that the port of New York can handle 1200 containers in 24 hours. Breakbulk ships require four or five days to unload.]

Port of Baltimore, Maryland

The following data was supplied by Miriam Brannon, Port Statistician (301 383-6878) and by Mr. Shandrowski.

Tankers	497		
Dry cargo	3,696	containers	770
		remainder	2,926

This data could not be manipulated using the procedure applied to the data of the port of New York, in that it did not yield consistent answers.

Additional data was obtained from W. C. Boyer (301 383-5780), the latest breakdown of Waterborne Commerce for the port of Baltimore for the year 1971. From this data, using the totals of foreign and domestic tonnages, the following ratios were obtained:

Bulk	Tanker	General
58.4	28.9	12.7
4.60	2.28	1

It was then assumed that in 1974, based on tonnage, for Baltimore

$$\frac{\text{Bulk}}{\text{Tanker}} = \frac{4.60}{2.28} = 2.02$$

Using Philadelphia data relating to net registered tonnage of the vessels arriving there

$$\frac{\text{Tanker}}{\text{Dry Bulk}} = \frac{15470}{8786} = 1.76.$$

From this, it was inferred that the number of bulk ships required is given by

$$2.02 \times 1.76 \times 497 = \underline{1764}$$

where there are 497 tankers arriving in Baltimore in 1974.

The number of breakbulk ships required is then

$$2926 - 1764 = \underline{1162}.$$

Port of Hampton Roads, Virginia

The following data was provided by John Hunter, Jr., Director of Research for the Virginia Port Authority (804 622-1671). It is from a compilation by the Virginia Port Authority and the Virginia Pilot's Association.

Tankers	428
Colliers	814
Dry Bulk (other)	431
Breakbulk	1289
Passenger	28
Container	662
LASH	31
Combination Bulk & General	33
All other	218
TOTAL	3934

In the shipping breakdown, the colliers were excluded from the bulk shipping because they are owned by the railroads and use railroad labor in their operations. The LASH vessels were added to the breakbulk vessels because it was Mr. Hunter's opinion that most of their cargo was breakbulk. The combination bulk and general cargo vessels were added to the bulk vessels because, again, this was Mr. Hunter's opinion.

These adjustments gave the following breakdown of vessels:

Tankers	428
Dry Bulk	464
Breakbulk	1320
Container	662
Passenger	28
Other	218
TOTAL	3120

Port of Houston, Texas

Data was initially supplied by Mr. Waterland of the Port of Houston Authority (713 225-0671) as follows:

Number of ships	4413	
Total tonnage	83,897,448	short ton
General	7,899,853	
Bulk	75,997,595	
No. of containers	116,381	20' equivalents (TEU)

Waterborne Commerce - Port of Baltimore - 1971

	Total	Foreign		Domestic				
				Coastwise		Internal		Local
		Imports	Exports	Receipts	Shipments	Receipts	Shipments	
Total	44,002,785	18,281,691	6,474,738	5,487,590	1,511,948	5,034,834	2,078,051	5,133,933
General Cargo	5,578,042	2,207,754	1,684,401	541,525	1,144,362	-	-	-
Grain	707,229	6	612,120	-	63,696	30,405	1,002	-
Ore	9,520,012	9,519,872	140	-	-	-	-	-
Coal	9,425,620	-	3,435,042	-	9	3,024,086	-	2,966,493
Sugar	556,914	478,758	-	52,212	-	-	25,944	-
Oil Products	12,742,393	2,698,504	17,689	4,838,502	209,834	1,675,682	1,487,743	1,814,439
Miscellaneous	5,472,565	3,376,797	725,346	55,351	94,047	304,661	563,362	353,001

Source: Walter C. Boyer, Deputy Administrator
Maryland Department of Transportation

No breakdown of shipping could be found, although the following additional possible sources were contacted:

West Gulf Maritime Association. R. George Wiley (713 227-1429) who identified that there were 52 shipping companies, five flag ships, 600 foreign flag ships and 35 stevedoring agents.

Houston Pilot's Association. Capt. Lightsee (713 645-4174) who do not record vessel arrivals.

Marine Reporting Service. Karl Bond (713 222-0123) who do not keep accumulated records, only day-by-day records.

With this data, the only breakdown possible was into container and breakbulk traffic. A TEU was assumed equivalent to 8.4 tons of cargo. Hence, the container tonnage is

. 116 381 x 8.4 = 977,600 and the

Breakbulk tonnage = 6,871,201.

Recording these tonnages by the net registered tonnages for these ship categories in Philadelphia, i.e., 7951 and 4783, gave the following breakdown:

Breakbulk	1437
Containers	123
	1560

The number of tankers was then obtained from Mr. Moore, the port of Houston's representative in New York, as 1610.

Thus the estimated breakdown was

Breakbulk & Dry Bulk	2608
Container	143
Tankers	1610
LASH (Barges only)	26
LASH (Barges & Containers)	26
TOTAL	4413

From the initial computation, the additional 23 containers were subtracted from the breakbulk to give

Breakbulk	1417
Container	143
Tanker	1610
Dry Bulk	1243
TOTAL	4413

where the sum of breakbulk and dry bulk = 2660. The above breakdown for break and dry bulk was, therefore, adjusted by the ratio 2608/2660 = 0.9805 to give

Breakbulk	1389
Container	143
Tanker	1610
Dry Bulk	1219
	4361
LASH (B)	26
LASH (B&C)	26
TOTAL	4413

The LASH were then allocated 39 to breakbulk and 13 to container to give

PORT OF HOUSTON AUTHORITY

Executive Offices: 1519 Capitol Avenue • P. O. Box 2562 • Houston, Texas 77001
Telephone: (713) 672-8221

J. K. Henderson
Controller

February 20, 1975

Mr. K. Hicks
Econ Incorporated
419 N. Harrison St.
Princeton, N. J. 08540

Dear Mr. Hicks:

In response to our telecon yesterday, I submit the following tabulation of ship arrivals at the Port of Houston for the year 1974.

Break Bulk & Dry Bulk Ships	2,608
Container "	143
Lash (Barges Only) "	26
Lash (Barges & Containers)	26
Tankers	1,610
Total	4,413

I was not able to distinguish between Break Bulk and Dry Bulk Ships. This would have required verification against a statement of cargo for each vessel as many Dry Bulk Carriers transport Break Bulk cargo. The contour of the vessel is not always indicative of the cargo transported.

The distinction between Lash (Barges only) and Lash (Barges & Containers) was shown to permit your consideration. The Delta Line Lash ships also transport containers and handle the container to and from the ship with ship's gear.

Also, I submit for your consideration the following tabulation:

Lash Barges unloaded from or loaded to Mother Vessel at Barbours Terminal Facility of Port of Houston.

Import	751
Export	1,105
	1,856

Mr. K. Hicks
Econ Incorporated
February 20, 1975

Page Two

Lash & Seabee Barges stuffed and/or stripped at

General Cargo Docks	2,082
Elco Elevator	78
	2,160

Of these 2,160 barges, 967 barges were loaded or unloaded from the mother vessel at locations other than our Barbours Terminal facility.

I hope that I have not confused you with this additional data. If I can be of further assistance, please let me know. Also I repeat, please let us have a copy of the study when it is released.

Very truly yours,

J. K. Henderson
Controller

JKH/vv

Breakbulk	1428
Container	156
Tanker	1610
Dry Bulk	1219
TOTAL	4413

Port of New Orleans, Louisiana

Data for this port was provided by Mr. Kirby and Pierre Reesh (504 522-2551). The only 1974 data available was the total number of ships at 4865.

Data for 1973 was provided as follows:

Grain	567
Dry Bulk	443
Liquid Bulk	100
General	3814
TOTAL	4924

Total 1973 tonnage 136,000,000; general cargo tonnage 7,500,000. It was estimated that about 11 percent of this tonnage was container traffic, i.e., about 825,000 tons. Using Philadelphia ship sizes, this results in 104 container ships.

Thus, breakdowns for 1973 and 1974 are as follows:

	1973	1974
Dry Bulk	1010	998
Tankers	100	99
Container	104	103
Breakbulk	3710	3665
TOTAL	4924	4865

where for 1974 the breakdown is a ratio for 1973 based on the ratio of the number of ships.

1974 data was received from Mr. Kirby as follows (March 5, 1975):

General Cargo (breakbulk bananas)	3375	7,098,000
Container	143	844,000
LASH & CB (more general than bulk)	77	655,000 (1,125,000)
Grain	605	8,055,000
Bulk Terminal (dry)	225	1,613,000
Miscellaneous (including tankers)	354	no tonnage
TOTAL	4779	

to give

Breakbulk	3452
Container	143
Dry Bulk	830
Other	354
TOTAL	4779

Port of San Francisco, California

Turnie Grinstead (415 391-8000), Port Traffic Manager of the San Francisco Port Commission, was able to supply only 1973 data.

However, Bob Langer at the San Francisco Marine Exchange (415 982-7788), supplied the following data for Golden Gate traffic for 1974.

	American Flag	Foreign Flag	Total
Cargo	751	1666	2417
Passenger	54	51	105
Tanker	882	265	1147
Seagoing Barge	94	26	120
Military (MSC)	64		64
Tug		2	2
TOTAL			3855

Mr. Langer's quote was for 3870 ships and he had no explanation for the difference. Hence, 3855 was used. There was a similar discrepancy in the 1973 data ... 4465 ship arrivals quoted, but only 4243 identified in the breakdown.

A breakdown of the number of cargo ships is required, but no information was available either as ship percentages or tonnages.

The Department of Commerce, Waterborne Commerce for 1972, identified for the port of San Francisco the following breakdown by weight:

	Import	Export	Total
Dry Cargo	6056	9410	15466
Tanker	16939	1991	18930

Thus, the 1972 data gives the ratio of dry cargo to wet cargo as 45:55. This ratio was assumed to be carried through to 1974.

To generate a reasonable breakdown, the data from Philadelphia for net registered tonnage is again used, as ratios

X	Breakbulk	1
Y	Container	1.662
Z	Bulk (dry)	1.836
T	Tanker	3.233

If X, Y, Z, T are the numbers of different ship types, then for San Francisco

$$3.233\ T \equiv 3708.25$$

$$X + 1.662\ Y + 1.836\ A \equiv 3033.35$$

where $T = 1147$

and $X + Y + Z = 2417$

Thus, giving two basic equations

$$X + 1.662\ Y + 1.836\ A = 3033.35$$

$$X + Y + Z = 2417$$

It is seen that tanker bulk is 55 percent of the total tonnage. Dry bulk is added to tanker bulk to give the bulk tonnage at any port. In general, for the U.S. ports as an average, the total bulk is less than 90 percent, so that dry bulk can be varied to give different breakdowns for cargo ships, e.g., wet bulk cargo be 65 percent of the tonnage.

Dry bulk is then equivalent to 10% of the tonnage

$$1.836 \equiv 0.10 = 674.9$$

$$\text{i.e.,} \quad Z = \underline{368}.$$

Then, since

$$0.662\ Y + 0.836\ Z = 616.35$$

$$Y = \underline{466}$$

$$X = \underline{1583}.$$

By varying bulk cargo percentage, the following breakdowns can be generated:

Bulk cargo %	75	72.5	70	65	55
Breakbulk	1679	1655	1631	1583	1486
Container	3	120	235	466	931
Bulk (dry)	735	642	551	368	0
TOTAL	2417	2417	2417	2417	2417

The choice is quite arbitrary, since there is no additional data available. The choice was made based on the assumption that San Francisco port is a moderate container port and the following breakdown was selected:

Breakbulk	1655
Container	120
Bulk (dry)	642.

It was then decided to add the 120 seagoing barges to the bulk ships based on the opinion of Grinstead.

Thus, the selected breakdown was as follows:

Breakbulk	1655
Container	120
Dry Bulk	762
Tanker	1147
Passenger	105
Other	66.

Port of Portland, Oregon

Data was sought for the port of Portland, Portland Harbor, and for shipping entering the Columbia River, since this seems to be the reporting method that makes Portland into a major harbor.

From the port of Portland, comprehensive data was supplied by Myrla Turner and Elaine Lycan of the Research Department of the port of Portland (503 233-8331).

Received data		Allocation	Disposition	
Breakbulk	364		419	
			72	
Ocean vessels	55		6	502
			5	
Containers only	61		61	
Containers & bulk	10	+ 5	5	191
Containers & breakbulk (more containers)	197		125	
Tankers only	21			
Tanker & breakbulk	1	22		22
Bulk (1 cargo only)	188	188	188	
			6	
Bulk & breakbulk	12	6 +	5	205
			1	
Bulk (2 cargoes)	5	5	5	
Bulk (2 cargoes) & breakbulk	1	1		
Seagoing Barges	5			
Repairs	9	9		9
Stopped only	19	19		19
TOTAL	948			

The received data for the port of Portland was disposed as shown to give the following breakdown:

Breakbulk	502
Container	191
Bulk	205
Tanker	22
Other	28
TOTAL	948

Candler Smith of the Portland Merchants Exchange provided the following data about the total number of ships:

Entering Columbia River	1966
To Portland Harbor	1308

Of the 360 additional ships entering Portland Harbor, Mr. Smith estimated these all to be bulk carriers, 240 being tankers, 120 dry bulk.

Of the additional 658 ships entering the Columbia River, 80 percent were estimated to be bulk carriers (grain, wood, ships, logs and lumber), the remainder general cargo not containerized.

The breakdown used in this study is, therefore, as follows:

	Port of Portland	Portland Harbor	Columbia River	Total
Breakbulk	502		132	634
Bulk	205	120	526	851
Container	191			191
Tanker	22	240		262
Other	28			28
TOTAL	948	360	658	1966

Port of Seattle, Washington

Data was received from Seattle from two sources. Vac Breindl (206 587-4961), Assistant Director of Planning and Research for the port of Seattle, forwarded the schedule of sailings from Seattle as of February 1, 1975. To this he added that 52 banana ships, 75 grain ships and 24 cement gypsum ships sailed from Seattle but were not scheduled. Otherwise, the port of Seattle kept no other data.

The Seattle Marine Exchange (206 447-7262) sent the 1973 Annual Report of vessel movements on Puget Sound. The 1974 Annual Report is not yet ready. Both documents are attached.

The data used is basically that of 1973 which is broken down as follows:

Steam and Motor Commercial	2027
Tanker	292
Military (MSC)	12
TOTAL	2331

Using the 1975 schedule for container traffic and the telephone information that there should be more than 151 dry bulk ships, then by counting the monthly sailings on the 1975 schedule, the full container traffic/month was estimated as follows:

Latin America	none
ANZAC	2
Puerto Rico	none
Hawaii	4
Alaska	15
Trans Pacific	19
UK, etc.	4
TOTAL	44

To give an annual container traffic of 528.

The 1975 schedule also indicates a considerable amount of passenger service between Seattle and British Columbia.

The basic Philadelphia net registered tonnage data was used together with the quoted 1973 net registered tonnage for all vessels, except military vessels, of 17,915,920 tons.

Net Registered Tonnage	17,915,920	
Tankers 292 x 15479	4,517,240	13,398,680
Container 528 x 7951	4,198,128	9,200,552

Suppose there are X, Y, Z breakbulk, dry bulk and passenger ships, then,

PORT OF SEATTLE

FEBRUARY 1, 1975

The following schedule of sailings from Seattle to Ports of the World is prepared by the Trade Development Department of the Port of Seattle and is subject to change without notice. REQUESTS FOR SPACE SHOULD BE DIRECTED TO THE AGENT INDICATED.

Port of Seattle Trade Development offices, listed below, will gladly assist you in any way possible: SEATTLE, P.O. Box 1209, phone 587-4825 (Area Code 206); SPOKANE, Old National Bank Bldg, phone Riverside 7-4440 (Area Code 509); WASHINGTON, D.C., Suite 803, 1801 K St. N.W., phone 638-5600 (Area Code 202); NEW YORK CITY, Suite 3447, One World Trade Center, phone 432-9088 (Area Code 212); CHICAGO, 327 South La Salle St., phone 922-5871 (Area Code 312).

LATIN AMERICA

(Including Mexico, Central America, Cuba, Caribbean, Panama Canal, East & West Coasts of South America)

SAILS SEATTLE	VESSEL	LINE	AGENT	PORTS OF CALL
Feb 4	r-Manuel Mejia*	Grancolombiana Line	BG	San Jose de Guatemala, Acajutla, Corinto, Puntarenas, Buenaventura, Guayaquil, Manta
6	r-M S Phrontis	Barber Blue Sea	Overseas	Balboa/Panama City, LaGuaira, Puerto Cabello, Maracaibo
10	Inca Tupac Yupanqui	Compania Peruana de Vapores	Kerr	Peruvian ports
13	Stranger	Westfal-Larsen Line	GS	Panama, Barranquilla Puerto Cabello Rio de Janeiro Santos, River Plate
15	r-Santa Magdalena*	Prudential-Grace Lines	PGL	Manzanillo Balboa, Barranquilla/Cartagena, Curacao, LaGuaira, Rio de Janeiro, Santos, Buenos Aires, Valparaiso
23	r-Ciudad De Barranquilla	Grancolombiana Line	BG	San Jose de Guatemala, Acajutla, Corinto, Puntarenas Buenaventura, Guayaquil, Manta
23	Prudential Seajet*	Prudential-Grace Lines	PGL	Acajutla Corinto, Buenaventura, Guayaquil, Valparaiso, Antofagasta, Ilo, Callao
25	r-M S Phemius	Barber Blue Sea	Overseas	Balboa/Panama City, LaGuaira, Puerto Cabello, Maracaibo
Mar. 2	r-Ciudad De Tunja	Grancolombiana Line	BG	San Jose de Guatemala Acajutla, Corinto, Puntarenas, Buenaventura, Guayaquil, Manta
3	r-Rio Los Sauces	Argentine Lines	TT	Buenaventura Guayaquil, Callao, Buenos Aires
3	r-Santa Mercedes*	Prudential-Grace Lines	PGL	Manzanillo, Acajutla, Balboa, Barranquilla/Cartagena, Curacao, LaGuaira, Rio de Janeiro Santos Buenos Aires Valparaiso
6	Hosanger	Westfal-Larsen Line	GS	Panama, Barranquilla Puerto Cabello, Rio de Janeiro Santos River Plate
7	r-Rio Saldana*	Grancolombiana Line	BG	San Jose de Guatemala Acajutla, Corinto, Puntarenas, Buenaventura, Guayaquil, Manta
9	Lloyd Curaba	Lloyd Brasileiro	Kerr	Santos Rio de Janeiro
15	Prudential Oceanjet*	Prudential Grace Lines	PGL	Acajutla, Corinto, Buenaventura, Guayaquil Valparaiso, Antofagasta, Ilo, Matarani, Callao
16	Cabo De Santa Marta	Lloyd Brasileiro	Kerr	Santos, Rio de Janeiro
19	r-Santa Mariana*	Prudential Grace Lines	PGL	Manzanillo, Balboa Barranquilla/Cartagena, Curacao LaGuaira, Rio de Janeiro, Santos Buenos Aires Valparaiso
22	r-M S Priam	Barber Blue Sea	Overseas	Balboa/Panama City, LaGuaira, Puerto Cabello, Maracaibo
25	r-Manuel Mejia*	Grancolombiana Line	BG	San Jose de Guatemala Acajutla Corinto, Puntarenas, Buenaventura, Guayaquil, Manta
25	Fauskanger	Westfal-Larsen Line	GS	Panama, Barranquilla, Puerto Cabello, Rio de Janeiro, Santos, River Plate

AUSTRALIA, NEW ZEALAND & SOUTH SEAS

SAILS SEATTLE	VESSEL	LINE	AGENT	PORTS OF CALL
Feb 3	r-Columbus Canada* (C)	Columbus Line	Bakke	Auckland Wellington, Melbourne, Sydney, Brisbane, Tarawa
10	r-Ragna Bakke	Knutsen Line	Bakke	Fremantle
10	r-Laship Australia Bear*	Pacific Far East Line	IS	Pago Pago, Auckland Melbourne Tasmania, Sydney, Brisbane, Lae Rabaul, Anewa Bay
13	r-Oilkara*	Pacific Australia Direct Line	GS	Melbourne, Sydney, Brisbane
19	r-Columbus California* (C)	Columbus Line	Bakke	Auckland, Wellington, Melbourne Sydney, Brisbane, Tarawa
23	r-Ellen Bakke	Knutsen Line	Bakke	Fremantle
25	r-Lashіp Golden Bear*	Pacific Far East Line	IS	Pago Pago Auckland Melbourne, Tasmania Sydney, Brisbane, Lae, Rabaul, Anewa Bay
Mar 5	r-Martha Bakke	Knutsen Line	Bakke	Fremantle
9	r-Columbus Capricorn*	Columbus Line	Bakke	Auckland Wellington Melbourne, Sydney, Brisbane Tarawa
10	r-Thorsisle*	Pacific Islands Transport Line	GS	Papeete, Pago Pago, Apia
15	r-Allunga*	Pacific Australia Direct Line	GS	Melbourne, Adelaide Sydney, Brisbane
23	r-Lasnip China Bear*	Pacific Far East Line	IS	Pago Pago, Auckland, Melbourne, Tasmania, Sydney Brisbane Lae Rabaul, Anewa Bay
25	r-Lloyd Bakke	Knutsen Line	Bakke	Fremantle
26	r-Oilkara*	Pacific Australia Direct Line	GS	Melbourne Adelaide Sydney, Brisbane

r-refrigerated space *rr-fully refrigerated* **-on inducement*

INTERCOASTAL and PUERTO RICO — TRAILERSHIP SERVICE

SAILS SEATTLE	VESSEL	LINE	AGENT	PORTS OF CALL
Sea-Land Service Inc Agent: Sea-Land — SL Phone: 764-4600				
VERIFY SAILING DATES AND SERVICE WITH LOCAL SEA-LAND OFFICE		Sea-Land	SL	*Balboa Panama, San Juan, Kingston and Elizabeth, N J

—All vessels accept cargo to San Juan, Ponce, Mayaguez, Puerto Rico, St Thomas and St Croix, Virgin Islands

HAWAII

MATSON NAVIGATION COMPANY

Date	Vessel		Port	Date	Vessel		Port
Feb 1	r-Hawaiian	(C)	Honolulu#	Feb 13	r-California	(C)	Honolulu#
				23	r-Hawaiian	(C)	Honolulu#

*(C)—Container Vessel r—Refrigerated Space *—Non-Containerizerable Cargo Only #—Neighborhood Island Containers Connect with Princess at Honolulu*

NORTHLAND MARINE LINES

Date	Vessel		Port
Feb 8	Fontana	(C)	Honolulu

AFRICA

Date	Vessel	Line	Agent	Ports of Call
Feb. 5	Nedlloyd Kingston	Nedlloyd Lines	TT	Capetown, Port Elizabeth, Durban, Beira, Tanga, Mombasa
Mar. 12	Nedlloyd Kyoto	Nedlloyd Lines	TT	Capetown, Port Elizabeth, Durban, Beira, Tanga, Mombasa

ALASKA

ALASKA HYDROTRAIN

Date	Vessel	Port	Date	Vessel	Port	Date	Vessel	Port	Date	Vessel	Port
Feb 1	Hydrotrain	Anchorage*	Feb 15	Hydrotrain	Anchorage*	Mar. 1	Hydrotrain	Anchorage*	Mar. 15	Hydrotrain	Anchorage*
5	Hydrotrain	Anchorage*	19	Hydrotrain	Anchorage*	5	Hydrotrain	Anchorage*	19	Hydrotrain	Anchorage*
8	Hydrotrain	Anchorage*	22	Hydrotrain	Anchorage*	8	Hydrotrain	Anchorage*	22	Hydrotrain	Anchorage*
12	Hydrotrain	Anchorage*	26	Hydrotrain	Anchorage*	12	Hydrotrain	Anchorage*			
						29	Hydrotrain	Anchorage*			

**—Fairbanks, Cordova Valdez, and intermediate points freight forwarded to other interior points via motor freight or air. Sailings Wednesday and Saturday*

FOSS ALASKA LINES

Date	Vessel	Ports	Date	Vessel	Ports
Feb 6	Vanliner 507	Ketchikan*, Wrangell, Petersburg, Juneau, Haines**, Skagway Sitka***	Mar 6	Vanliner 511	Ketchikan*, Wrangell, Petersburg, Juneau Haines**, Skagway, Sitka***
13	Vanliner 508	Ketchikan*, Wrangell, Petersburg, Juneau Haines**, Skagway, Sitka***	13	Vanliner 512	Ketchikan* Wrangell, Petersburg, Juneau Haines**, Skagway, Sitka **
20	Vanliner 509	Ketchikan*, Wrangell Petersburg, Juneau, Haines**, Skagway, Sitka***	20	Vanliner 513	Ketchikan*, Wrangell, Petersburg, Juneau Haines**, Skagway, Sitka***
27	Vanliner 510	Ketchikan* Wrangell, Petersburg, Juneau Haines**, Skagway, Sitka***	27	Vanliner 514	Ketchikan* Wrangell, Petersburg, Juneau Haines**, Skagway, Sitka***

** — Metlakatla via Ketchikan*
*** — Skagway via Haines*
**** — Mt Edgecumbe via Sitka*

(Vessels sail every Thursday)

RECEIVE FREIGHT Terminal 115
5700 W. Marginal Way S W
Seattle, WA 98106

NORTHLAND MARINE LINES

Date	Vessel	Ports	Date	Vessel	Ports
Feb 6	Container Barge	Juneau	Mar 5	Container Barge	Juneau, Haines
13	Container Barge	Juneau, Haines	12	Container Barge	Juneau
14	Container Barge	Valdez, Seward Kodiak	19	Container Barge	Juneau, Haines
19	Container Barge	Juneau	20	Container Barge	Anchorage
25	Container Barge	Juneau	25	Container Barge	Juneau Haines
28	Container Barge	Seward, Valdez			

Sailings every Wednesday   Refrigeration to Juneau only   Container and Break Bulk

SEA-LAND SERVICE

Date	Vessel		Ports	Date	Vessel		Ports
Feb. 1	A Vessel 1,3	(C)	Anchorage*, Kodiak, Adak, Capt. Bay Dutch Harbor, Sand Point	Mar 1	A Vessel 1,3	(C)	Anchorage*, Kodiak, Adak Capt Bay, Sand Point
4	A Vessel	(C)	Anchorage*	4	A Vessel	(C)	Anchorage*
6	A Vessel	(C)	Anchorage*	6	A Vessel	(C)	Anchorage*
8	A Vessel	(C)	Anchorage*, Kodiak	8	A Vessel 1	(C)	Anchorage*, Kodiak
11	A Vessel	(C)	Anchorage*	11	A Vessel	(C)	Anchorage*
13	A Vessel	(C)	Anchorage*	13	A Vessel	(C)	Anchorage*
15	A Vessel 1,3	(C)	Kodiak, Adak Capt. Bay, Sand Point	15	A Vessel	(C)	Anchorage*, Kodiak
18	A Vessel	(C)	Anchorage*	18	A Vessel	(C)	Anchorage*
20	A Vessel	(C)	Anchorage*	20	A Vessel	(C)	Anchorage*
22	A Vessel 1,2	(C)	Anchorage*, Kodiak, Cordova	22	A Vessel	(C)	Anchorage*, Kodiak
25	A Vessel	(C)	Anchorage*	25	A Vessel	(C)	Anchorage*
27	A Vessel	(C)	Anchorage*	27	A Vessel	(C)	Anchorage*
				29	A Vessel 1,2,3	(C)	Anchorage*, Kodiak, Adak Cordova

ALL VESSELS HAVE REFRIGERATED SPACE
Cargo to Fairbanks Kenai & other South Central Rail Belt locations is forwarded by Sea Land truck after arrival in Anchorage
**Due to Vessel Dry Docking and Ice Banding the actual vessels cannot be supplied at this time*
"S S SUMMIT" is the regularly scheduled vessel connecting at Kodiak for Cordova Adak and points down the Aleutian chain
(C)—Container Vessels   *2 — Perishable cargo will be accepted for Cordova*
1 — Perishable cargo will be accepted for Kodiak   *3 — Perishable cargo will be accepted for Adak*
NOTE Perishable cargo will be accepted for Kodiak on other vessels — must check with Special Commodities Department to find out which vessel

ALASKA MARINE HIGHWAY SYSTEM—Pier 48 Seattle Wash 98104 623-1970—Regular service direct to Southeastern Alaska ports
WESTERN PIONEER LINES—Pier 90 Seattle Wash 98119 284-7533—Monthly sailings to Kodiak Island and Aleutian ports as inducements offer
FOSS LAUNCH & TUG CO —660 West Ewing Seattle Wash 98119 285-0150—Car-barge service every 10 days to Ward's Cove Alaska.
JAMES GRIFFITHS & SONS INC —Pier 43 Seattle Wash 98134 622 3340—Car barge service every 12 days to Sawmill Creek (Sitka)
LYNDEN TRANSPORT INC —3615 W Marginal Way S W Seattle Wash 98106 767-7100—Daily service to Fairbanks and Anchorage three times weekly to Southeastern Alaska
PACIFIC WESTERN LINES—600 S Garden St. Seattle Wash 98108—Direct scheduled barge service between Seattle and Anchorage
WEAVER BROS., INC —54 S Dawson St Seattle Wash 98134 532 8250—Daily service to all points in Alaska except southeast.

ALASKA AIRLINES — Sea-Tac International Airport Seattle Wash 98158 246-3000 — Daily flights to Fairbanks Anchorage and all S E Alaska cities
NORTHWEST ORIENT AIRLINES — Sea-Tac International Airport Seattle Wash 98158 243-6000 — Daily flights to Anchorage
PAN AMERICAN WORLD AIRWAYS — 1320 - 4th Ave Seattle Wash 98101 624 2121 — Daily flights to Fairbanks
WESTERN AIRLINES — Sea Tac International Airport Seattle Wash 98158, 246-7600 — Daily flights to Anchorage

TRANSPACIFIC

(Japan & Far East)

SAILS SEATTLE	VESSEL	LINE	AGENT	PORTS OF CALL
Feb				
2	r-Jalamohan	Scindia Steam	TNC	Hong Kong, Manila Singapore Madras Bombay
2	r-SL Finance	Sea-Land Service	SL	Yokohama/Tokyo Kobe/Osaka, Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Saigon Manila, Singapore
3	r-Hotaka Maru (C)	x1 See Below	x2 See Below	Kobe, Nagoya, Yokohama
5	r-Washington Mail (C)	American Mail Line	AML	Yokohama, Nagoya, Kobe Busan, Hong Kong, Kaohsiung, Keelung
5	Gamzat Tsadasa	Fesco Pacific Line	PIF	Tokyo
6	r-Lion's Gate Bridge (C)	x1 See Below	x2 See Below	Kobe, Nagoya Tokyo
8	Oriental Amiga (C)	Orient Overseas Line	Eckert	Yokohama, Hong Kong, Keelung, Kaohsiung
9	r-SL Commerce (C)	Sea-Land Service	SL	Yokohama/Tokyo, Kobe/Osaka, Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Singapore Saigon
9	r-Bay Bridge (C)	"K" Line/PACFE	Kerr	Busan Hong Kong
10	r-Ragna Bakke	Knutsen Line	Bakke	Hong Kong, Manila Singapore
12	r-Oregon Mail (C)	American Mail Line	AML	Yokohama, Nagoya, Kobe, Busan, Hong Kong, Kaohsiung, Keelung
12	Pskov (C)	Fesco Pacific Line	PIF	Tokyo Kobe, Hong Kong
12	Indian Mail	American Mail Line	AML	Busan, Incheon, Japan ports
13	r-Beishu Maru (C)	x1 See Below	x2 See Below	Kobe Nagoya, Yokohama
13	Makhtum Kuli	Fesco Pacific Line	PIF	Singapore, Bangkok, Port Kelang
16	r-SL Trade (C)	Sea-Land Service	SL	Yokohama/Tokyo, Kobe/Osaka Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Saigon, Manila, Singapore
17	r-Alaska Maru (C)	x1 See Below	x2 See Below	Kobe, Nagoya, Tokyo
17	r-Hoegh Orchid	Hoegh Line	TT	Singapore, Karachi, Dubai/Abu Dhabi, Bahrein/Damman, Kuwait/Khorramshahr
18	r-Hawaii	States Line	States	Hong Kong Manila, Saigon Bangkok
18	Alisher Navoi	Fesco Pacific Line	PIF	Tokyo Yokohama, Kobe
19	r-Philippine Mail (C)	American Mail Line	AML	Yokohama, Nagoya, Kobe, Busan Hong Kong, Kaohsiung, Keelung
20	r-Atlantic Phoenix (C)	Phoenix Container Line	Kerr	Osaka Shimizu, Tokyo, Busan Keelung, Hong Kong Singapore
21	r-Hong Kong Mail	American Mail Line	AML	Busan Incheon, Keelung, Penang, Port Kelang, Singapore Kaohsiung
22	r-Vishva Amitabh	SCI Line	NL	Madras, Cochin, Bombay
23	r-Golden Arrow (C)	x1 See Below	x2 See Below	Kobe Nagoya, Yokohama
23	r-SL Galloway (C)	Sea-Land Service	SL	Yokohama/Tokyo Kobe-Osaka, Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Manila, Saigon Singapore
23	r-Ellen Bakke	Knutsen Line	Bakke	Hong Kong Manila, Singapore
24	r-Harbour Bridge (C)	"K" Line/PACFE	Kerr	Busan, Hong Kong
25	r-M M Dant	States Line	States	Manila, Saigon Bangkok, Hong Kong
26	r-Japan Mail (C)	American Mail Line	AML	Yokohama Nagoya Kobe, Busan Hong Kong Kaohsiung, Keelung
27	Nikolay Karamzin*	Fesco Pacific Line	PIF	Bangkok, Port Kelang, Penang, Belawan, Singapore
27	r-Hikawa Maru (C)	x1 See Below	x2 See Below	Kobe Nagoya Tokyo
28	r-Pacific Phoenix (C)	Phoenix Container Line	Kerr	Osaka, Shimizu, Tokyo, Busan, Keelung, Hong Kong, Singapore
Mar				
2	r-SL Exchange (C)	Sea-Land Service	SL	Yokohama/Tokyo Kobe/Osaka, Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Saigon Manila Singapore
3	r-Hotaka Maru (C)	x1 See Below	x2 See Below	Kobe Nagoya Yokohama
3	Pervomaysk (C)	Fesco Pacific Line	PIF	Tokyo, Kobe Hong Kong
5	r-Washington Mail (C)	American Mail Line	AML	Yokohama, Nagoya Kobe, Busan, Hong Kong, Kaohsiung, Keelung
5	r-Lion s Gate Bridge (C)	x1 See Below	x2 See Below	Kobe Nagoya, Tokyo
7	r-Vishva Shobha	SCI Line	NL	Singapore Bombay, Cochin, Madras, Calcutta
8	r-Martha Bakke	Knutsen Line	Bakke	Hong Kong, Manila, Singapore
9	r-Tower Bridge (C)	'K' Line/PACFE	Kerr	Busan, Hong Kong
9	Hong Kong Success (C)	Orient Overseas Line	Eckert	Yokohama, Kobe, Hong Kong, Keelung
9	r-SL Finance (C)	Sea-Land Service	SL	Yokohama/Tokyo Kobe/Osaka, Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Manila Singapore Saigon
12	r-Oregon Mail (C)	American Mail Line	AML	Yokohama Nagoya Kobe Busan Hong Kong, Kaohsiung, Keelung
12	Pravdinsk (C)	Fesco Pacific Line	PIF	Tokyo Kobe Hong Kong
12	r-Hoegh Pride	Hoegh Line	TT	Jakarta Singapore, Dubai/Abu Dhabi Bahrein/Damman, Kuwait/Khorramshahr
13	r-Beishu Maru (C)	x1 See Below	x2 See Below	Kobe Nagoya Yokohama
14	Anton Chekov*	Fesco Pacific Line	PIF	Singapore Bangkok Port Kelang
14	r-Washington	States Line	States	Manila Saigon Bangkok Hong Kong
16	r-SL Commerce (C)	Sea-Land Service	SL	Yokohama/Tokyo Kobe/Osaka Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Saigon Manila, Singapore
17	r-Alaska Maru (C)	x1 See Below	x2 See Below	Kobe Nagoya Tokyo
19	r-Philippine Mail (C)	American Mail Line	AML	Yokohama, Nagoya Kobe, Busan, Hong Kong, Kaohsiung, Keelung
23	r-SL Trade (C)	Sea-Land Service	SL	Yokohama/Tokyo Kobe/Osaka Hong Kong, Busan, Incheon, Kaohsiung, Keelung, Manila Singapore Saigon

(continued)

* — On Inducement r — Refrigerated Space C — Full Container Service

x1 — Japan Line K' Line Yamashita-Shinnihon Line, Mitsui-O S K Line N Y K Line, Showa Line

x2 — Japan Line Japan (USA), Ltd; K" Line, Kerr Yamashita-Shinnihon Line I S, Mitsui-O S K Line, W D; N.Y.K. Line, Matson, Showa Line Olympic

21	r-Atlantic Phoenix (C)	Phoenix Container Line	Kerr	Osaka Shimizu, Tokyo Busan, Keelung, Hong Kong, Singapore
23	r-Golden Arrow (C)	x1 See Below	x2 See Below	Kobe Nagoya, Yokohama
24	r-American Mail	American Mail Line	AML	Busan, Incheon, Keelung, Saigon, Hong Kong, Kaohsiung
24	Jalamoti	Scindia Steam	TNC	Hong Kong, Manila Singapore Madras Calcutta
24	r-Bay Bridge (C)	K" Line/PACFE	Kerr	Busan, Hong Kong
25	r-Lloyd Bakke	Knutsen Line	Bakke	Hong Kong, Manila Singapore
26	r-Korean Mail	American Mail Line	AML	Busan, Incheon Keelung, Penang, Port Kelang, Singapore, Kaohsiung
26	r-Japan Mail (C)	American Mail Line	AML	Yokohama, Nagoya, Kobe, Busan, Hong Kong, Kaohsiung, Keelung
27	r-Hikawa Maru (C)	x1 See Below	x2 See Below	Kobe, Nagoya, Tokyo
28	r-Pacific Phoenix (C)	Phoenix Container Line	Kerr	Osaka, Shimizu, Tokyo, Busan, Keelung, Hong Kong, Singapore
30	Putivl (C)	Fesco Pacific Line	PIF	Tokyo, Kobe Hong Kong
30	r-SL Galloway (C)	Sea-Land Service	SL	Yokohama/Tokyo, Kobe/Osaka, Hong Kong, Busan, Incheon Kaohsiung, Keelung, Saigon, Manila Singapore

UNITED KINGDOM & CONTINENT

(Includes Mediterranean)

SAILS SEATTLE	VESSEL	LINE	AGENT	PORTS OF CALL
Feb 5	r-Suffren	Euro-Pacific Line	BG	LeHavre, Rotterdam, Antwerp, Hull, Hamburg/Bremen
7	r-Margaret Johnson (C)	Johnson Scan/Star	GS	Liverpool, LeHavre Antwerp, Rotterdam, London Gothenburg, Copenhagen, Glasgow, Hamburg/Bremen
12	r-Axel Johnson (C)	Johnson Scan/Star	GS	LeHavre, Antwerp, Rotterdam, London, Gothenburg, Copenhagen, Glasgow Hamburg/Bremen
20	r-Westfalia	Euro-Pacific Line	BG	LeHavre, Rotterdam, Antwerp Hull Hamburg/Bremen
21	r-Falstria (C)	Johnson Scan/Star	GS	Liverpool, LeHavre, Antwerp Rotterdam London, Gothenburg, Copenhagen, Glasgow, Hamburg/Bremen
25	r-Antonia Johnson (C)	Johnson Scan/Star	GS	LeHavre, Antwerp, Rotterdam, London, Gothenburg, Copenhagen, Glasgow, Hamburg/Bremen
Mar. 3	Ikaros*	Hanseatic-Vaasa Line	WD	LeHavre, Antwerp, Rotterdam, Bremen, Hamburg, Helsinki
7	r-California Star (C)	Johnson Scan/Star	GS	Liverpool, LeHavre Antwerp, Rotterdam, London Gothenburg, Copenhagen Glasgow Hamburg/Bremen
11	r-Da Recco	Italian Line	OS	Naples, Leghorn, Genoa, Marseille, Valencia, Cadiz, Barcelona
12	r-San Francisco (C)	Johnson Scan/Star	GS	LeHavre, Antwerp, Rotterdam London, Gothenburg, Copenhagen Glasgow, Hamburg/Bremen
12	r-Falcon	Euro-Pacific Line	BG	LeHavre, Rotterdam Antwerp, Hamburg/Bremen
21	r-Meonia (C)	Johnson Scan/Star	GS	Liverpool, LeHavre Antwerp, Rotterdam, London Gothenburg, Copenhagen Glasgow, Hamburg/Bremen
24	Goranka	United Yugoslav Line	Kerr	Trieste, Rijeka, Piraeus, Beirut
25	r-Aubrac	Euro-Pacific	BG	LeHavre Rotterdam, Antwerp Hamburg/Bremen
25	r-Annie Johnson (C)	Johnson Scan/Star	GS	LeHavre, Antwerp, Rotterdam, London, Gothenburg, Copenhagen, Glasgow, Hamburg/Bremen

BRITISH COLUMBIA

Service to and from British Columbia Ports

BLACK BALL TRANSPORT, INC — Pier 30, Seattle, Wash 98134 622-2222 — M V "Coho" — Daily service to Victoria B C

CANADIAN PACIFIC RAILWAY B C coastal service — Pier 64 Seattle, Wash 98121 682-5222 — Daily passenger and auto service to Victoria, B C. will be resumed May 1 and continue through October 31, 1974

FOSS LAUNCH & TUG CO — 660 West Ewing Street, Seattle, Wash 98119 282-1210 — Twice weekly car-barge service to North Vancouver, B C

PUGET SOUND FREIGHT LINES — 3720 Airport Way S Seattle, Wash 98134, 623-1600 — Sailings Fridays to Powell River and Vancouver Sailings Mondays to Vancouver Island points

SEASPAN INTERNATIONAL, LTD — 1102 S.W. Massachusetts St Seattle Wash 98134, 682-0660 — Rail car-barge service to Victoria and North Vancouver, B C

AIR CARGO CARRIERS

AIR CANADA AIRLINES — 1307 - 4th Seattle, Wash 98101 — 624-2491
ALASKA AIRLINES — Sea-Tac Int'l Airport Seattle Wash 98158 — 433 3266
BRANIFF INT'L AIRWAYS — Sea-Tac Int'l Airport, Seattle Wash 98158 — 433-5095
CONTINENTAL AIR LINES — Sea-Tac Int'l Airport Seattle Wash 98158 — 433-5556
EASTERN AIR LINES — Sea-Tac Int'l Airport Seattle Wash 98158 — 433 5003
FLYING TIGER LINE — Sea-Tac Int'l Airport Seattle Wash 98158 — 433 5511
HUGHES AIR WEST — Sea-Tac Int'l Airport Seattle Wash 98158 — 433-3033
NORTHWEST ORIENT AIRLINES — Sea-Tac Int'l Airport, Seattle Wash 98158 — 433-3747
PACIFIC WESTERN AIRLINES — Sea-Tac Int'l Airport Seattle Wash 98158 — 433-5090
PAN AMERICAN WORLD AIRWAYS — 1300 - 4th Ave Seattle Wash 98101 — 432 4575
SCANDINAVIAN AIRLINES SYSTEM — Sea Tac Int'l Airport Seattle Wash 98158 — 433 5151
UNITED AIRLINES — Sea-Tac Int'l Airport Seattle Wash 98158 — 433 4000
WESTERN AIRLINES — Sea-Tac Int'l Airport Seattle Wash 98158 — 433-4900

KEY TO SEATTLE STEAMSHIP AGENTS

A H T. — Alaska Hydro-Trains, Inc., P O Box 3783 Seattle 98124 ... 682-0660
A M H — Alaska Marine Highway System Pier 48 Seattle 98104 ... 623-1970
A.M.L. — American Mail Line Ltd 1010 Washington Bldg Seattle 98101 ... 292 4646
A S — Alaska Steamship Co Pier 42 Seattle 98134 ... 622 4530
Bakke — Bakke Steamship Corp 1411 Fourth Ave Seattle 98101 ... 682 4060
B G — Balfour, Guthrie & Co Ltd 301 Norton Bldg Seattle 98104 ... 623-1454
B R A. — B R Anderson & Co, 100 - 2nd Ave Seattle 98104 ... 623-1249
C S — Cascade Shipping Co Norton Bldg Seattle 98104 ... 622-2203
Eckert — Eckert Overseas Agency Inc 1512 Seattle Tower Seattle 98101 ... 624 89-
F.A.L. — Foss Alaska Line P O Box 80537 Seattle 98108 ... 762 6000
F L & T — Foss Launch & Tug Co 660 West Ewing St Seattle 98119 ... 285 0150
F C. — Freighters Co Dexter Horton Bldg., Seattle 98104 ... 447-2580
F W — Furness Withy Agencies (USA) 508 Central Bldg Seattle 98104 ... 624-3224
G S — General Steamship Corp 1001 Fourth Ave Seattle 98154 ... 622 4701
I S — International Shipping Co., Inc. 916 Norton Bldg., Seattle 98104 ... 623-5511
Japan Line (U S.A) Ltd 2220 Pacific Bldg Seattle 98104 ... 682 2671
Kerr — Kerr Steamship Co Inc 1001 - 4th Ave Seattle 98154 ... 682 9012
M N — Matson Navigation Company 720 Third Ave Seattle 98104 ... 682-5870
N L — Norton Lilly & Co., 213 Norton Bldg Seattle 98104 ... 623 0930
N M L — Northland Marine Lines 653 N W 41st St Seattle 98107 ... 784-3403
O S — Olympic Steamship Co Inc 1000 Second Ave Seattle 98104 ... 622 -520
Overseas — Overseas Shipping Co Seattle Tower Seattle 98101 ... 682-8330
P I F — Pacific International Freightliners 411 Norton Bldg Seattle 98104 ... 623-5394
P G L — Prudential-Grace Line 720 - 3rd Ave Seattle 98104 ... 682 0090
S L — Sea Land Service Inc., 2505 25th Ave S W., Seattle 98106 ... 764 4600
States — States Steamship Company 618 Second Ave Seattle 98104 ... 622 7501
TNC — Transmarine Navigation Corp 608 Central Bldg Seattle 98104 ... 623 4704
T. T — Transpacific Transportation Co., 915 Norton Bldg Seattle 98104 ... 624-7393
W D — Williams Dimond & Co 1515 Pacific Bldg Seattle 98104 ... 622-5568
W S S.A. — Western Steamship Agency Inc Exchange Bldg Seattle 98104 ... 623 7719

Seattle Chamber of Commerce
215 Columbia St., Seattle, WA 98104

1973 ANNUAL REPORT OF
VESSEL MOVEMENTS ON PUGET SOUND

ARRIVALS

	COMMERCIAL			M.S.C.		
YEAR	NUMBER	% CHANGE	NET REGISTERED TONS	% CHANGE	NUMBER	NET REGISTERED TONS
1956	1848	(2)	8,655,132	(1)	209	1,302,954
1957	1889	2	8,714,281	2	214	1,242,131
1958	2039	8	9,836,926	13	123	891,215
1959	2141	5	10,548,203	7	110	747,552
1960	2278	6	11,287,593	7	59	287,323
1961	2188	(4)	10,607,874	(5)	48	226,543
1962	2119	(3)	10,441,829	(2)	38	137,856
1963	2038	(1)	10,754,109	3	48	186,318
1964	2064	(2)	10,955,684	2	26	120,230
1965	2154	4	11,968,373	10	59	298,729
1966	2312	7	12,979,677	(15)	39	188,116
1967	2478	7	13,947,802	(51)	19	84,447
1968	2427	(2)	14,151,947	36	26	125,803
1969	2417	(4)	14,487,839	2	27	114,639
1970	2452	2	14,660,942	1	17	76,953
1971	1759	(29)	11,368,562	(22)	50	229,338
1972	2215	26	15,803,803	39	26	127,723
1973	2319	4	17,915,920	13	12	59,680

1973 TOTAL ARRIVALS 2331
1973 TOTAL NET REGISTERED TONNAGE 17,975,600

SAILINGS

YEAR	NUMBER	%CHANGE	NET REGISTERED TONS	% CHANGE	NUMBER	NET REGISTERED TONS
1956	1865	(1)	8,561,666		222	1,308,210
1957	1888	1	8,707,921	2	200	1,148,264
1958	2023	7	9,724,572	12	130	913,453
1959	2133	5	10,524,727	8	108	740,716
1960	2272	7	11,231,826	7	59	287,005
1961	2171	(4)	10,552,665	(6)	47	204,365
1962	21[illegible]	(3)	10,394,132	(2)	39	150,377
1963	2093	(1)	10,763,003	4	48	186,490
1964	2055	(2)	10,972,841	2	26	116,800
1965	2142	4	11,869,322	8	65	332,646
1966	2304	7	12,948,633	(17)	39	189,118
1967	2469	7	14,020,851	(54)	18	83,091
1968	2444	(1)	14,109,781	44	26	125,803
1969	2399	(2)	14,306,566	1	26	114,552
1970	2470	3	14,696,701	3	15	56,755
1971	1740	(30)	11,220,181	(24)	49	233,909
1972	2127	22	15,801,579	41	29	121,779
1973	2324	9	17,937,473	14	11	50,436

1973 TOTAL SAILINGS 2335
1973 TOTAL NET REGISTERED TONNAGE 17,987,909

AVERAGE SIZE OF COMMERCIAL VESSELS
IN NET REGISTERED TONS (M.S.C. not included)

YEAR	TONS	% CHANGE
1968	6708	2
1969	5099	(24)
1970	5954	17
1971	6463	9
1972	7134	10
1973	7725	8

1973 ANNUAL REPORT - Vessel Movements

ARRIVALS

AREA FROM	FLAG	STEAM	MOTOR	TANKER	TOTAL
ORIENT	American	111		6	117
	British		38	2	40
	Chinese		4		4
	Cyprus		1		1
	Danish		2		2
	Dutch		1		1
	French		1		1
	German		13		13
	Greek		31		31
	Indian		3		3
	Irish		3		3
	Japanese		312	3	315
	Korean		8		8
	Liberian		241		241
	Norwegian		83		83
	Pakistan		1		1
	Panamanian		53		54
	Somalia		1		1
	Singapore		5		5
	Russian		35		35
	Taiwan		1		1
	Yugoslavian		8		8
					968
CENTRAL AND SOUTH AMERICA	American	25	1		26
	Argentine		4		4
	Belgium		3		3
	Brazilian		8		8
	British		11		13
	Colombian		6		6
	Dutch		19	1	20
	Ecuador		2		2
	German		11		11
	Greek		6	1	7
	Honduras		2		2
	Indian		2		2
	Japanese		2		2
	Liberian		3	6	9
	Norwegian		22	1	23
	Pakistan		1		1
	Panamanian		1		1
	Peru		9		9
	Philipoine		1		1
	Somalia		1		1
	Swedish		5		5
	Yugoslavia		2		2
					159
MEDITERRANEAN	British		1		1
	French		1		1
	Indian		1		1
	Italian		16		16
	Liberian		2		2
	Norwegian		8		8
	Panamanian		1		1
	Yugoslavian		1		1
					31
ASIA, SOUTH AND EAST AFRICA	American	104		1	105
	British		3	1	4
	Chinese		4		4
	Cyprus		1		1

.973 [illegible] REPORT - Vessel Movements

ARRIVALS (cont.)

AREA FROM	FLAG	STEAM	MOTOR	TANKER	TOTAL
ASIA, SOUTH AND EAST AFRICA (cont.)	Dutch		15		15
	Greek	1	6		7
	Indian		24		24
	Italian		2		2
	Iran		1		1
	Japanese		4		4
	Korean		6		6
	Liberian	2	15	14	31
	Norwegian		12		12
	Pakistan	1	3		4
	Panamanian		1		1
	Philippine		2		2
	Singapore		21		21
	Yugoslavian		2		2
					246
UNITED KINGDOM	British		25		25
	Danish		14		14
	Dutch		13		13
	French		10		10
	German		13		13
	Greek		1		1
	Irish		1		1
	Liberian		3		3
	Norwegian		21		21
	Russian		1		1
	Singapore		1		1
	Swedish		31		31
					134
AUSTRALASIA AND PACIFIC ISLANDS	American	9			9
	Australian		1		1
	British		27		27
	Cyprus		2		2
	Danish		1		1
	Dutch		2		2
	German		16		16
	Indian		1		1
	Japanese		3		3
	Liberian		8		8
	Norwegian		4		4
	Singapore		2		2
	Swedish		5		5
					80
HAWAIIAN ISLANDS	American	40			40
	German		1		1
	Japanese		1		1
	Liberian		1		1
	Panamanian		1		1
					44
ALASKA	American	115	84	14	203
	British		1		1
	Indian		1		1
	Japanese		4		4
	Liberian		1		1
					210

1973 ANNUAL REPORT - Vessel Movements

ARRIVALS (Cont.)

AREA FROM	FLAG	STEAM	MOTOR	TANKER	TOTAL
INTERCOASTAL & GULF	American	20		2	22
	Greek		1		1
	Liberian		6	4	10
	Norwegian		1		1
	Swedish			1	1
					35
COASTWISE	American	104		221	325
	Argentine		2		2
	British	2	9	5	16
	Canadian			3	3
	Chinese		4		4
	Colombian		1		1
	Dutch		3		3
	Danish		1		1
	German		4		4
	Greek		7		7
	Indian		4		4
	Japanese		3		3
	Liberian		20	1	21
	Norwegian		10	2	12
	Panamanian	1			1
	Philippine		2		2
	Swedish		1		1
	Yugoslavian		2		2
					412

SUMMARY OF ARRIVALS

COUNTRY	NET REGISTERED TONNAGE	STEAM	MOTOR	TANKER	TOTAL
American	6,579,318	528	74	245	847
Argentine	39,422		6		6
Australian	7,134		1		1
Belgium	7,688		3		3
Brazilian	13,525		8		8
British	1,086,045	2	115	10	127
Canadian	5,865			3	3
Chinese	55,647		12		12
Colombian	29,534		7		7
Cyprus	23,834		4		4
Danish	170,379		18		18
Dutch	287,683		52		53
Ecuador	4,212		2		2
French	55,205		12		12
German	309,834		58		58
Greek	336,238	1	52		54
Honduras	5,252		2		2
Indian	205,838		36		36
Iran	3,006		1		1
Irish	31,450		4		4
Italian	182,881		19		19
Japanese	2,534,966		329	3	332
Korean	76,933		14		14
Liberian	2,769,636	2	300	25	327
Norwegian	1,192,751		161	3	164
Pakistan	30,084	1	5		6
Panamanian	452,047	2	57		59
Peru	50,974		9		9
Philippine	23,835		5		5
Russian	197,271		36		36
Singapore	228,763		29		29
Somalia	11,178		2		2
Swedish	409,213		42	1	43
Taiwan	6,108		1		1
Yugoslavian	88,091		15		15
TOTAL	17,915,920	536	1491	~~262~~ 241	2319
N.S.C.	59,680				12
GRAND TOTAL	17,975,600	536	1491	~~262~~ 292	2331

SAIL[illegible]S

AREA FOR	FLAG	STEAM	MOTOR	TANKER	TOTAL
ORIENT	American	90		3	93
	British		36	2	38
	Colombian		1		1
	Chinese		5		5
	Danish		2		2
	Dutch		2		2
	German		10		10
	Greek		25		25
	Indian		6		6
	Japanese		321	4	325
	Korean		5		5
	Liberian		240		240
	Norwegian		57		57
	Panamanian		48		48
	Pakistan		1		1
	Philippine		1		1
	Russian		38		38
	Singapore		5		5
	Swedish			1	1
	Taiwan		1		1
	Yugoslavian		6		6
					510
CENTRAL AND SOUTH AMERICAN	American	27			27
	Argentine		6		6
	Belgium		3		3
	Brazilian		8		8
	British		11	3	14
	Colombian		6		6
	Danish		3		3
	Dutch		19	2	21
	Ecuador		2		2
	French		1		1
	German		13		13
	Greek		6		6
	Honduras		2		2
	Indian		4		4
	Italian		1		1
	Korean		1		1
	Liberian		3	7	10
	Norwegian		23		23
	Peru		3		3
	Philippine		1		1
	Somalia		1		1
	Swedish		6		6
					162
MEDITERRANEAN	Greek		1		1
	Italian		17		17
	Liberian		2		2
	Norwegian		3		3
	Panamanian		1		1
	Yugoslavian		5		5
					29
ASIA, SOUTH AND EAST AFRICA	American	121		2	123
	British		9		9
	Chinese		2		2
	Cyprus		1		1
	Dutch		22		22
	German		5		5
	Greek	1	14		15
	Indian		19		19
	Iran		1		1
	Italian		2		2
	Japanese		4		4
	Korean		4		4
	Liberian	3	28	4	35
	Norwegian		34		34

-6-

1973 ANNUAL REPORT - Vessel Movements

SAILINGS (cont.)

AREA FOR	FLAG	STEAM	MOTOR	TANKER	TOTAL
ASIA, SOUTH AND (Cont.) EAST AFRICA	Pakistan		1		1
	Panamanian		10		10
	Philippine		2		2
	Singapore		17		17
	Swedish		1		1
	Yugoslavian		1		1
					307
UNITED KINGDOM	British		28		28
	Danish		14		14
	Dutch		13		13
	French		11		11
	German		19		19
	Greek		1		1
	Indian		1		1
	Irish		3		3
	Liberian		2		2
	Norwegian		27		27
	Swedish		33		33
					152
AUSTRALASIA AND PACIFIC ISLANDS	American	10			10
	Australian		1		1
	British		20		20
	Cyprus		2		2
	Danish		1		1
	German		11		11
	Liberian		6		6
	Norwegian		5		5
	Pakistan		1		1
	Panamanian		1		1
	Swedish		3		3
					61
HAWAIIAN ISLANDS	American	40		4	44
					44
ALASKA	American	114	79	23	216
	Indian		1		1
	Japanese		2		2
	Korean		1		1
	Liberian		1		1
	Pakistan		1		1
					222
INTERCOASTAL & GULF	American	19		5	24
	British	1	3		4
	Liberian		3	2	5
	Norwegian		1		1
					34
COASTWISE	American	105		210	315
	British		10	5	15
	Canadian			3	3
	Chinese		2		2
	German		5		5
	Greek		6		6
	Indian		1		1
	Irish		1		1
	Italian		1		1
	Japanese		3	2	5
	Liberian		17	8	25
	Norwegian		11	2	13
	Panamanian			1	1
	Peru		2		2
	Singapore		2		2
	Somalia		1		1
	Swedish		1	1	2
	Yugoslavian		3		3
					403

1973 ANNUAL REPORT - Vessel Movements

SUMMARY OF ARRIVALS

COUNTRY	NET REGISTERED TONNAGE	STEAM	MOTOR	TANKER	TOTAL
American	6,732,023	526	79	247	852
Argentine	32,500		6		6
Australian	7,134		1		1
Belgium	7,688		3		3
Brazilian	13,525		8		8
British	1,061,604	1	117	10	128
Canadian	5,055			3	3
Chinese	67,647		12		12
Colombian	20,534		7		7
Cyprus	16,874		3		3
Danish	164,000		20		20
Dutch	285,052		56	2	58
Ecuador	4,212		2		2
French	55,205		12		12
German	306,120		59		59
Greek	327,057	1	50		51
Honduras	5,252		2		2
Indian	196,589		32		32
Iran	3,086		1		1
Irish	40,569		4		4
Italian	185,147		21		21
Japanese	2,970,823		333	6	339
Korean	58,282		11		11
Liberian	2,666,016	3	302	21	326
Norwegian	1,213,059		161	2	163
Pakistan	30,084		4		4
Panamanian	455,866		60	1	61
Peru	50,974		5		5
Philippine	23,835		4		4
Russian	181,411		38		38
Singapore	194,517		24		24
Somalia	11,178		2		2
Swedish	388,559		44	2	46
Taiwan	6,108		1		1
Yugoslavian	97,073		15		15
TOTAL	17,937,473	531	1499	294	2324
M.S.C.	50,436				11
GRAND TOTAL	17,987,909	531	1499	294	2335

$$4783\ X + 8786\ Y + 9135\ Z = 9{,}200{,}552$$
$$X + Y + Z = 1499$$

or

$$4003\ Y + 4352\ Z = 2{,}030{,}835$$

or

$$Y + Z = 486$$

$$X = 1013$$

$$Y > 151$$

$$Z < 335$$

Arbitrarily, put X = 302, Z = 184, then, for the tonnages,

Tanker	292	X	15470	=	4517240	→	13,398,680
Container	528	X	7951	=	4198128	→	9,200,552
Breakbulk	1013	X	4783	=	4845179	→	4,355,373
Bulk	302	X	8786	=	2653372	→	1,702,001
Passenger	184	X	9135	=	1680840	→	21,161

it was decided to add

1 Breakbulk	4783
2 Bulk	17572
	22355
	21161
	1194.

Thus, the breakdown chosen was

Breakbulk	1014
Container	528
Dry Bulk	304
Tanker	292
Passenger	184
Other	12
TOTAL	2334.

This increases the number of ships by three, but approximates the tonnage.

Port of Long Beach, California

Data was supplied by the port in the following letter. The data was combined with that of the port of Los Angeles as follows for the port.

	Los Angeles	Long Beach	LA/LB
Breakbulk	1,522	910	2,432
Container		508	508
Dry Bulk	150	320	470
Tanker	806	936	1,742
Passenger	193		193
Other	357		357
Total	3,028	2,674	5,702

The Port of Long Beach
"America's most Modern Port"
P O BOX 570 · LONG BEACH, CALIFORNIA 90801 · TELEPHONES: (213) 437-0041 · (213) 775-3469 · TELEX: 65-6452 PORTOBEACH LGB

March 7, 1975

Econ, Inc.
419 North Harrison St.
Princeton, New Jersey 08540

Attention: Mr. Kenneth Hicks
Staff Systems Scientist

Gentlemen:

This is in reply to your letter of February 25, 1975 by which data on the total number of ship arrivals and breakdown of cargo carrying categories was requested.

The following shows the number of ships by commodity breakdown and the total tonnage for each category for the fiscal year 1973-74. (July 1, 1973 through June 30, 1974):

Commodity	Liquid Bulk	Dry Bulk	Container & RO-RO*	Breakbulk General	Total (Vessels) All Cargo
No. of Ships	936	320	508	910	2,674
Tonnage in Revenue Tons	17,891,265	4,988,218	3,961,486	2,944,762	29,785,731

*RO-RO traffic consists mainly of automobiles. Tonnage for this category was 123,643 tons. General RO-RO is scheduled to start later this year.

Barge traffic consists of lumber, newsprint, liquid bulk and dry bulk. The greater percentage being lumber and newsprint categorized as general cargo.

Passenger traffic is negligible.

Econ, Inc.
March 7, 1975 - Page Two

Projections of port tonnage and traffic beyond 1985 would be greatly influenced by a number of factors beyond our control. Inflation, the high cost of money, food and raw material shortages along with the developing recession and environmental pressures, can completely change any projections made at this time. It should be noted, however, that port tonnage has increased almost 150 per cent in the past ten years.

We trust the foregoing will be helpful in your study.

T. J. Thorley
General Manager

Lee Sellers
Director of Port Operations