The Marine Weather Program in North Carolina:
A Manual of Products and Services With Recommendations for Improvements

Jerry M. Davis

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Recommendations for Improvements

By Dr. Jerry M. Davis

Department of Marine, Earth and
Atmospheric Sciences

North Carolina State University

Raleigh, North Carolina 27650

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INTRODUCTION

The objective of my project was to develop and implement a real-time weather and sea information system specifically designed to meet the needs of the North Carolina fisheries industry.

The specific objectives were:

1. To determine the nature and format of specific weather and sea information required by the fishery interests to optimize their decision-making processes.

2. To identify on a state and national level current sources of weather and sea information, their format and contents, and to ascertain if and how such information is being used by the fisheries.

3. To investigate the means by which this information can be assessed on a real-time basis by fishery interests in North Carolina.

4. To develop a prototype real-time information delivery system for the fishery interests in North Carolina.

It is worthwhile to examine briefly the position of the U. S. in world fisheries markets and that of North Carolina in U. S. fisheries markets. Two of the most comprehensive volumes on North Carolina fisheries statistics were compiled by Chestnut and Davis (1975) and Easley and Sossamon (1975). More recent data are available from the U. S. National Marine Fisheries Service (1980). The following table shows live-weight (thousand metric tons) data for the world commercial catch of fish, crustaceans, mollusks, and other aquatic plants and animals (except whales and seals) for 1978.

	Country	Live Weight (Thousand Metric Tons)
1.	Japan	10,752
2.	USSR	8,930
3.	China (PRC)	4,660
4.	U. S.	3,512
4.	Peru	3,365

These countries accounted for about 43% of the total (72,380) live-weight catch netted in 1978.

United States commercial landings for 1979 are given below. Landings are reported in rounded weights for all items except univalve and bivalve mollusks, such as clams, oysters, and scallops, which are reported in weight of meats (excluding the shell):

	State	Thousand Pounds
1.	Louisiana	1,529,081
2.	Alaska	898,539
3.	California	728,406

	State	Thousand Dollars
1.	Alaska	597,034
2.	California	227,473
3.	Louisiana	198,508

	State	Thousand Pounds		State	Thousand Dollars
4.	Virginia	572,707	4.	Massachusetts	175,544
5.	N. Carolina	390,472	5.	Texas	160,200
6.	Mississippi	382,632	6.	Florida	124,002
7.	Massachusetts	374,706	7.	Washington	115,959
			11.	N. Carolina	58,454

Of the total pounds caught (6,267,152), the seven states listed above accounted for 78% of this amount. In terms of total dollars ($2,233,679), these seven states accounted for 72% of the total. In terms of pounds landed, 1979 was a record year for North Carolina (390,472). For the period 1976-79, Beaufort-Morehead City ranked sixth among major U. S. ports in commercial fishery landings.

These data clearly establish the importance of the fisheries business to North Carolina. Efforts within the state and the federal governments should be directed at helping that industry maximize productivity and reduce operating expenses. The fisheries business is extremely sensitive to both the state of the sea and the state of the atmosphere. Any advisory service which provides more of the information needed in the right format, at the right place, and at the right time, should be considered.

PART 1: THE PRESENT PROGRAM

This part of the report documents the present sources of weather and climatic products and services for marine users. The information in this section has been drawn together from NOAA publications and is intended to serve as a manual or catalog of existing products and services. For additional details on programs discussed in this section and on other programs not covered here, the interested reader is referred to the original source material.

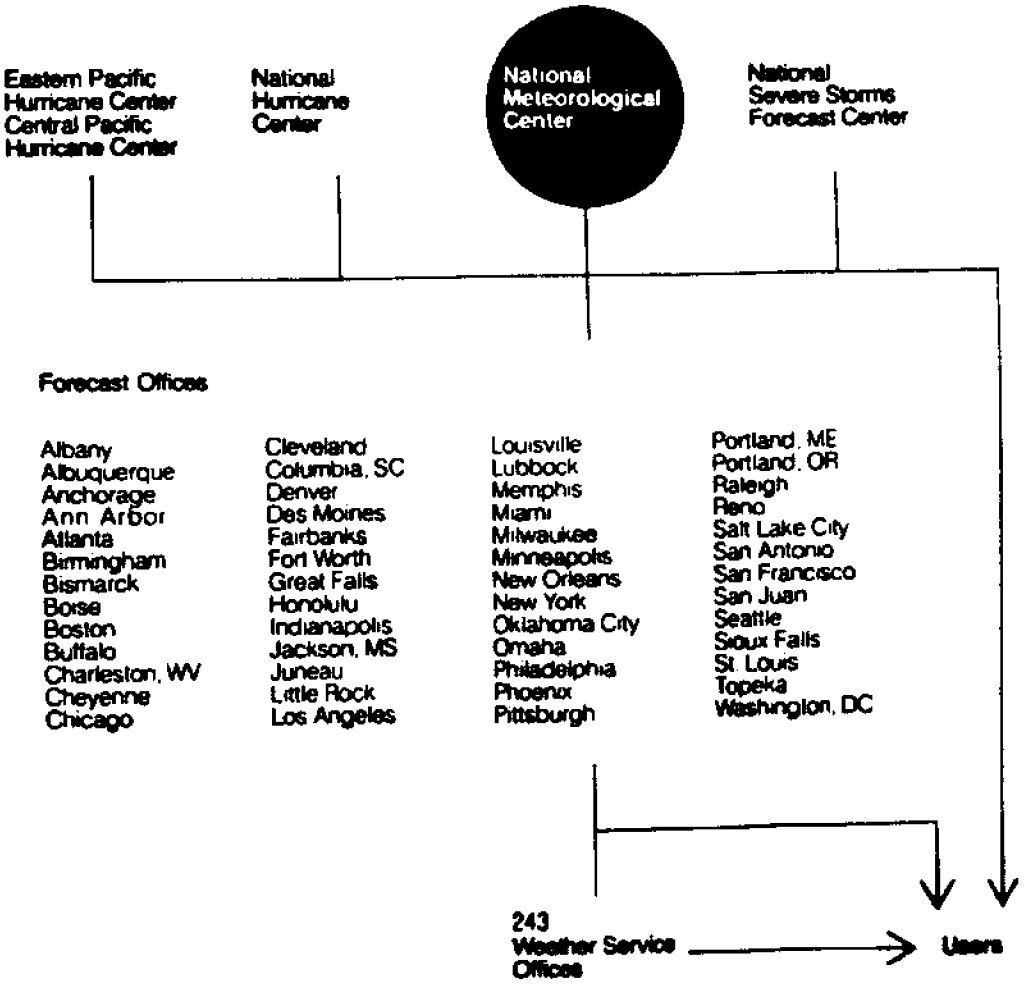
The information contained in this report is current up to the end of April 1981. Readjustments of many of these programs may be required in the near future.

I. THE ADMINISTRATIVE STRUCTURE OF THE U. S. NATIONAL WEATHER SERVICE

From an administrative point of view, the National Weather Service (NWS) is under the National Oceanic and Atmospheric Administration (NOAA), which in turn is part of the U. S. Department of Commerce. A list of acronyms can be found in Appendix A.

This structure of the NWS forecast program is shown in Figure 1, which was taken from U. S. National Weather Service (1979c). The mainstay of the entire operation is the National Meteorological Center (NMC) located in the World Weather Building near Washington, D. C. Much of the material used by the Weather Service Forecast Offices (WSFO) and Weather Service Offices (WSO) to prepare forecasts is provided by NMC. Also at the same level are the National Severe Storms Forecast Center (NSSFC) at Kansas City, the National Hurricane Center (NHC) at Miami, and the Hurricane Warning Centers at San Francisco and Honolulu. The WSFOs are found at the next operational level, followed by the WSOs.

Taken from Operations of the National Weather Service



Structure of Forecast Organization

Figure 1

To fulfill NMC's mission of providing weather analyses and forecast guidance to field offices as well as its commitments to the world weather watch programs of the World Meteorological Organization (UNESCO), NMC is organized into three divisions and a group. The Forecast Division produces weather analyses and prognoses for up to ten days into the future. Computer and communication operations are handled by the Automation Division, while the Development Division is responsible for conducting research designed to improve the NMC products. Climate-sensitive problems lie within the domain of the Climate Analysis Center. The Center prepares the monthly and seasonal (90-day) weather outlooks.

In the broadest sense, the NSSFC has the responsibility to prepare and release messages concerning the occurrence of severe local storms, including tornadoes. These messages are called watches, and they are issued as needed rather than on a regularly scheduled basis. Warnings of tornadoes and thunderstorms are issued by the local offices.

In general, the term watch means that severe weather is possible in and close to the watch area, while a warning means that severe weather is imminent or occurring. For additional information on the NWS Hurricane and Severe Local Storm Warning Services, see U. S. National Weather Service (1979c).

Three hurricane forecast centers (the National Hurricane Center (NHC), the Eastern Pacific Hurricane Center, and the Central Pacific Hurricane Center) divide the responsibility for hurricane forecasting. NHC has delegated part of its public warning responsibility to the hurricane warning offices (collocated with WSFOs) at Boston, Washington, and San Juan. The hurricane forecasting centers are managed by their respective NWS regions. Only the facility at Miami (NHC) has a hurricane research and development staff to study theoretical aspects of hurricane development, movement, and forecasting.

In North Carolina the NWS maintains two types of offices, the Weather Service Forecast Office (WSFO) and the Weather Service Office (WSO). The WSFO is located at the Raleigh-Durham Airport (RDU) while the WSOs, which in addition to the WSFO are most directly involved in the Marine Program, are located at Cape Hatteras (HAT), Wilmington (ILM), and Norfolk, Virginia (ORF, which is not administered out of RDU).

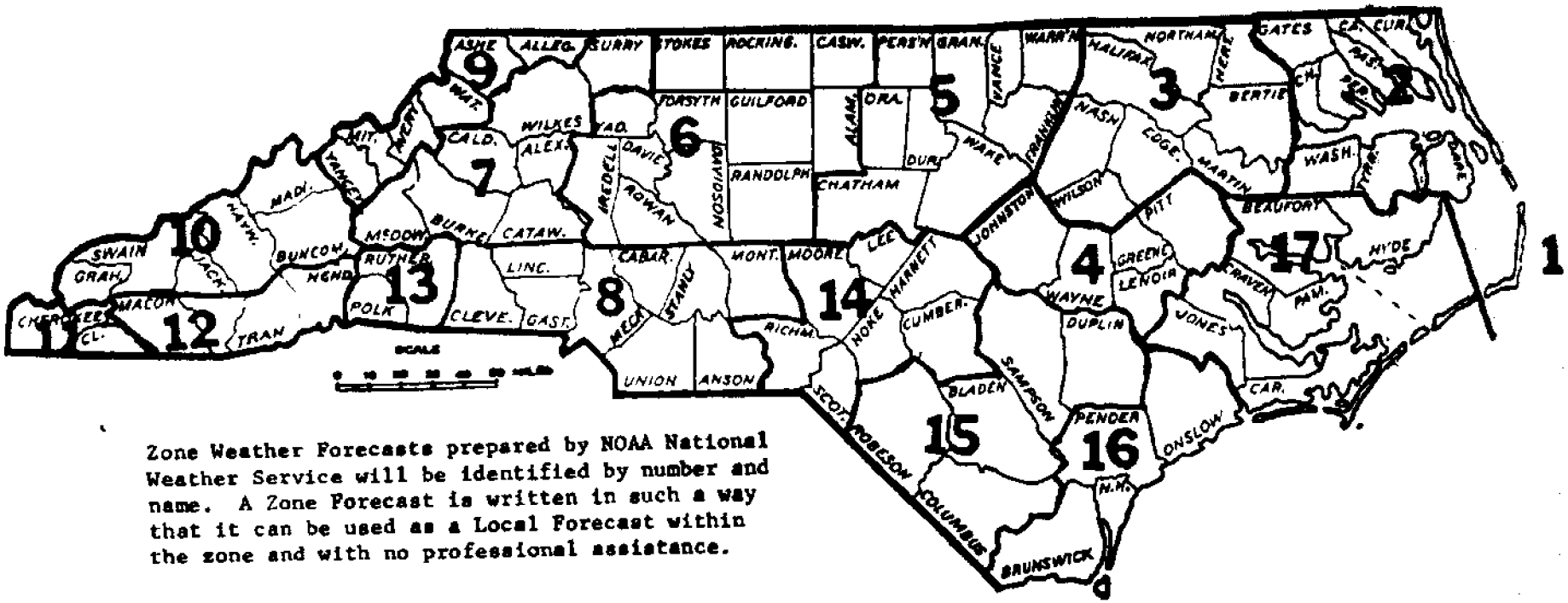
The WSFO furnishes the public with general weather conditions expected for about 48 hours over its area of responsibility. It also gives an extended outlook over the area up to five days. The WSFO issues what are called zone forecasts. A zone is defined as a region which has a sufficiently homogeneous climate so that an area forecast can be used as the local forecast for any community within the area. The forecasts include expected weather conditions, probabilities of precipitation, maximum/minimum temperatures, and wind speed and direction. Figure 2 shows the North Carolina zone forecast map.

In North Carolina, the weather stations at Asheville, Greensboro, Charlotte, Raleigh and Wilmington participate in the Local Forecast Program, which aims to provide the public with a detailed description of the weather expected in a town or city and its suburbs. These forecasts are prepared from the zone forecasts. Both the WSFO and WSOs have the responsibility for issuing weather warnings.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE – EASTERN REGION

PUBLIC SERVICE FORECAST ZONES

NORTH CAROLINA



Zone Weather Forecasts prepared by NOAA National Weather Service will be identified by number and name. A Zone Forecast is written in such a way that it can be used as a Local Forecast within the zone and with no professional assistance.

1. Outer Banks
2. Northern Coastal Area
3. Northern Coastal Plain
4. Central Coastal Plain
5. Northeast Piedmont
6. Northwest Piedmont
7. Northern Foothills
8. Southern Piedmont
9. Northern Mountains
10. Central Mountains
11. Extreme Southwest
12. Southern Mountains
13. Southern Foothills
14. Sandhills
15. Southern Coastal Plain
16. Southern Coastal Area
17. Central Coastal Area

Figure 2

Revised 1981

The NWS also maintains River Forecast Centers (RFC). The Atlanta RFC covers the coastal regions of North Carolina to near the Virginia state line. Areas to the north are the responsibility of the Harrisburg RFC. The basic product of these centers is the flood forecast. Many hydrological services are assigned to local WSFOs and WSOs. The NWS also provides many state and local hydrological services. In North Carolina, RDU is responsible for managing a river and rainfall reporting network. The WSFO/WSOs also disseminate the river forecasts and warnings prepared by the RFC, and can if necessary issue preliminary warnings.

Another aspect of the NWS hydrology program is concerned with flash floods. The WSFO/WSOs are responsible for issuing timely flash flood watches and warnings based on the NMC and RFC guidance, rainfall observations, and radar reports.

Also of interest to the marine weather user is the NWS program in disaster preparedness. Its objective is to develop plans and procedures to save lives and lessen the social and economic impact of natural disasters. The NWS has a Winter Weather Warning Service and, of particular interest to marine weather users, a Coastal Flood Warning Program. These warnings are issued by the WSFO and the WSOs in order to alert interested parties in coastal regions to unusually high water levels due to tides, waves, and surges associated with tropical and severe extratropical storms.

For information on other NWS programs, the reader is referred to U. S. National Weather Service (1979c). The marine program will be discussed in detail in later sections.

II. U. S. NATIONAL WEATHER SERVICE PRODUCTS AND SERVICES FOR MARINE USERS

A. Introduction

The responsibility of the NWS offices in North Carolina to the Marine Weather Service Program are documented in detail in U. S. National Weather Service (1979b). This publication is the NWS Operations Manual, Part D, Chapter 51 (Marine Services for Coastal, Offshore, and High Seas Areas and Coastal Flooding). Much of the information contained in this portion of the report is based on that manual.

Within North Carolina, the WSFO at RDU is responsible for issuing, disseminating, and coordinating marine forecasts and warnings for its forecast areas. These areas are:

1. South of Virginia Beach to and including Little River Inlet out 20 miles.
2. Albemarle and Pamlico Sounds.

The North Carolina WSFO is responsible for issuing coastal marine forecasts but does not issue either offshore or high seas marine forecasts. The offshore forecast affecting North Carolina waters emanates from the NWS WSFO in Washington, D. C. This same office issues the high seas marine forecast. The North Carolina WSFO also issues coastal watches and warnings as needed for the two areas listed above.

The North Carolina WFOs must promptly disseminate any watches or warnings received from the WSFO. Coastal WSOs must maintain a watch over their coastal and other nearby waters and harbors. WSOs may also be responsible for making arrangements for visual displays of small craft advisories and marine warnings. WSOs may also be responsible for providing local adaptive marine forecasts for nearby intracoastal waters, including bays, harbors, sounds, and coastal marshes. Even though the main responsibility for issuing coastal marine advisories and warnings rests with the WSFO, a local weather situation may require the issuance or change of an advisory or a warning by the WSO.

B. Coastal Marine Forecasts

The coastal marine forecast is issued for coastal waters by the WSFO. Coastal waters are defined as "that portion of the oceans and seas from the coast extending as little as 20 miles seaward to as much as 100 miles seaward." The two areas of responsibility for the North Carolina WSFO were listed in the previous section. Forecasts are given for wind, waves, thunderstorms, precipitation and significant weather, visibility, superstructure icing, and sea ice. Emphasis in the coastal marine forecast is placed on the marine weather information needs of small craft; however, the information is designed to serve the needs of other users.

The coastal marine forecast is issued four times daily:

Time (GMT)	Forecast Periods
0339	Tonight, Tomorrow, Tomorrow Night
0939	Today, Tonight, Tomorrow
1539	This afternoon, Tonight, Tomorrow
2139	Tonight, Tomorrow, Tomorrow Night

C. Offshore Marine Forecasts

The offshore marine forecasts are issued for offshore waters, defined as "that portion of the oceans and seas beyond the coastal waters out to a distance of 240 miles or more from the coast." The Washington, D. C., WSFO has the forecasting responsibilities for the waters off North Carolina. This WSFO forecasts for the "west central North Atlantic offshore waters between 32N and 40N and west of 65W to the coast." In these forecasts, the emphasis is on the marine weather information needs of commerical fishing vessels; however, the needs of other users are met as well.

The offshore forecast provides forecasts of winds, waves, thunderstorms and significant weather, and superstructure icing. The form of the offshore forecast is quite similar to that of the coastal forecast. The forecast heading identifies the type of product, the time of issuance, and the office that issued it. The forecast contains a synopsis of the general weather situation that is expected during the forecast period. When required, warning information and procedures to be used in conjunction with tropical cyclone advisories are included.

In the contiguous forty-eight states the offshore marine forecast is issued four times daily.

Issuance Time (GMT)	Forecast Periods
0339	Tonight, Tomorrow, Tomorrow Night
0939	Today, Tonight, Tomorrow
1539	This Afternoon, Tonight, Tomorrow
2139	Tonight, Tomorrow, Tomorrow Night

Amendments to the forecast are issued whenever the marine weather and/or sea state is observed to or is expected to differ significantly from the forecast.

D. Adaptive Marine Forecasts

The National Weather Service Office in Wilmington prepares a forecast for the North Carolina waters between Cape Hatteras and Little River Inlet extending offshore 100 miles. This forecast is issued at 6 AM and 6 PM every day and is a composite of the coastal waters forecast and the forecast for the west central North Atlantic. It is disseminated by the Wilmington Office on NOAA Weather Radio stations in Wilmington and New Bern. A recording is also available through a phone line into the Wilmington office.

E. High Seas Marine Forecasts

For the majority of commercial fishermen in North Carolina, the high seas marine forecast covers a geographical area outside their operational interests. High seas is defined as "major ocean areas for which warnings and forecasts are issued under agreements within the World Meteorological Organization" (WMO). The forecast is issued by the Washington, D. C., WSFO and covers the North Atlantic Ocean north of 32N and west of 35W. The rest of the North Atlantic is covered by forecasts issued from Miami. The forecasts are designed to meet the needs of all users; however, emphasis is placed on the marine weather information needs of ships making ocean transits. Forecasts concentrate on the major weather systems and resulting sea state that will affect ocean-going vessels. Major shipping routes receive the most attention in the forecasts.

Forecast issuing offices have agreed to adopt the WMO format for the radio weather broadcasts. This format is:

Part 1	Warnings
Parts 2 and 3	Weather synopsis and forecast
Part 4	Coded Analysis and/or prognosis (optional)

Forecasts are issued for wind, waves, thunderstorms and significant weather. The North Atlantic forecasts from Washington and Miami are issued at 0400, 1000, 1600, 2200 (GMT). Amendments are issued as required.

F. Marine Warning Program

When wind and wave conditions warrant small craft advisories (for coastal areas only), gale and storm warnings will be issued between scheduled marine broadcasts. As outlined in previous sections, these conditions will then be incorporated into the next scheduled forecasts.

In certain instances, marine conditions require that special marine warnings or more weather statements be issued. These issuances cover hazardous weather not adequately handled by routine marine forecasts and warnings. The majority of these unscheduled warnings and advisories are for coastal regions where there is a large volume of weather-sensitive activity. In these special statements, the emphasis is placed on weather events of short duration for which there is insufficient lead time to incorporate them into the routinely scheduled marine forecasts.

Only a brief discussion of these special products will be given here. More detailed information is contained in U. S. National Weather Service (1979b). The special marine warning is defined to be "a warning for hazardous weather conditions, usually of short duration, not adequately covered by existing marine warnings. Such weather conditions include sustained winds or gusts of 35 knots or more with a duration of 2 hours or less." The marine weather statement is designed to be "used in weather situations not otherwise covered in existing marine forecasts and warnings. [It is] used to keep marine users updated on significant weather events, such as fog, strong winds, etc. [and] to cancel any marine advisories or warnings in effect. These statements are normally issued every three hours or more frequently as required until the weather event described in the statement is ended or may be adequately covered within a regularly scheduled marine forecast."

U. S. National Weather Service (1979b) also outlines procedures to be used in conjunction with severe local storm watches and warnings and with heavy surf advisories.

G. Coastal Flood Watches and Warnings

According to the NWS operations manual, coastal flood warnings and watches have as their objective the alerting of interested parties in coastal regions to unusually high water levels and coastal erosion due to storm tides and waves that occur as a result of tropical cyclones and extratropical storms. Coastal flood watches are "unscheduled messages that alert users to significant wind-forced flooding to be expected along low-lying coastal areas if weather patterns develop as forecast." The WSFO at RDU is responsible for issuing the watches. The coastal flood warning is issued "when significant wind-forced flooding expected along low-lying coastal area is imminent." The warning is issued by the WSFO; however, the WSO may issue local statements within its county warning areas. The WSFO or WSOs can, during coastal flood warning situations, issue a supplement, known as a statement, to the warnings.

H. Forecast Dissemination

The responsibility for product dissemination rests mainly with the NWS regional headquarters and the local NWS offices. The various means of dissemination are outlined briefly below:

1. NOAA Weather Radio. This system is probably the primary means of getting marine forecasts and warnings to mariners.

2. NOAA Weather Wire (a teletypewriter circuit). This system is used to get marine forecasts and warnings to commercial radio and TV stations.
3. Telephones. Where the volume of marine users requires it, telephone recorder systems can be installed solely for marine purposes. In lieu of this system, normal public service telephones can be used to disseminate weather information to marine users.
4. Marine Radio Broadcasts. These are broadcasts by certain WSOs or persons under contract to the NWS.
5. National Telecommunications Circuits. Coastal and offshore forecasts are distributed on the Service C teletypewriter network. Marine coastal and offshore warnings are transmitted on the RAWARC teletype network.
6. East Coast Marine Circuit. Selected WSFOs and Coast Guard stations on the Atlantic and Gulf Coasts are connected by this circuit for the exchange of marine and tropical cyclone forecasts and warnings, and for input of coastal and ship observations to WSFOs and NMC.
7. U. S. Coast Guard, U. S. Navy and Commercial Marine Radio Stations. Marine warnings, analyses, and forecasts are distributed by NOAA Weather Wire and marine circuits to the agencies listed above for broadcast.
8. High Seas Marine Broadcasts. WSFOs with high seas marine responsibilities (e.g., Washington, D. C.) prepare scripts and charts for radio stations making marine high seas broadcasts. The information is disseminated mainly via: Radiotelegraph. All passenger ships, as well as cargo ships of 1600 tons or more, are required to carry a radio officer and have facilities for radiotelegraphy. Radiotelephone. Exclusive reliance for communications on radiotelephone by smaller vessels, including ocean-going tugs, barges, and fishing boats, is increasing. According to the NWS, it is likely that more users on the high seas can be reached by voice broadcasts than by the older code. Radiofacsimile. See the special section on radiofacsimile. High Seas Storm Information Service. Brief statements on major storm systems in the West Atlantic are broadcast by the Washington, D. C., WSFO hourly on the National Bureau of Standards time and frequency radio station WWV.

I. Special Marine Services

The NWS's special services include port service to mariners, the Oil and Hazardous Substances Pollution Contingency Plan, and marine visual warning displays. Details concerning these services can be found in the NWS Operations Manual.

III. COASTAL DATA-GATHERING NETWORKS

The purpose of this section of the report is to document the type and locations of the North Carolina coastal data-gathering stations. The main source of this information is Quayle (1979). According to Quayle, the principal types of networks are:

1. Coastal stations (weather, tidal, wave, environmental quality, seismic)
2. Ships
3. Buoys
4. Satellites
5. Aircraft and other remote systems.

information on the quality of these data sources, their periods of record, and their availability are all contained in Quayle.

Quayle points out that the majority of observations used in the coastal zone comes from the conventional networks. These major networks are:

1. Primary station. This network contains both civilian and military real-time digital stations.
2. MARS (Marine Reporting Stations) Network. This network consists of about 200 Coast Guard and other cooperating coastal stations. Most of these stations are real-time but non-digital.
3. NWS Cooperative Network. This network is not real-time; however, it is digital. The observations consist mainly of daily maximum and minimum temperatures and rainfall.

North Carolina primary and MARS coastal stations that were in operation in the mid-1970s are listed below.

1. Elizabeth City FSS
2. Coinjock CG
3. Dare Co. Range AF
4. Bodie Island CG
5. Oregon Inlet L/S CG
6. New Bern FSS
7. Hatteras WSO
8. Cape Hatteras CG
9. Hatteras Inlet CG
10. Ocracoke CG
11. Diamond Shoals L/S CG
12. Cherry Point MCAS
13. Cape Lookout L/S CG
14. Atlantic Beach CG.
15. Swansboro CG
16. Jacksonville MCAS
17. Topsail PD
18. Wilmington WSO
19. Wrightsville Beach CG
20. Carolina Beach CG
21. Oak Island L/S CG
22. Frying Pan Shoals L/S CG

Key to the type of station:

AF	Air Force
CG	Coast Guard
FSS	Flight Service Station (FAA)
L/S	Light Station
MCAS	Marine Corps Air Station
PD	Police Department
WSO	Weather Service Office

The AF, FSS, WSO and MCAS stations have hourly original records for the period 1975-1976 and digital data for the total period available (only if the period includes 1975-1976), stored at the National Climatic Center (NCC). Observations for CG and L/S stations were taken at 3-hourly intervals starting

at 0000 GMT each day. Information on the frequency of observations, the period of record, and the status of the stations after 1975-76 can be obtained from NCC. See Figure 3 (from Quayle) for station locations.

According to Quayle, the buoy data file is of high quality and easy to access. The data file begins in the early 1970s. See Figure 4 (from Quayle) for buoy locations. The National Ocean Survey Tide Observation Network maintains real-time data stations at both Avon and Duck (NC). Ship data are also available but are presently somewhat difficult to obtain. The National Oceanographic Data Center plans to begin storing the NOAA coastal wave data in its archives in 1980.

IV. COASTAL ZONE CLIMATOLOGICAL INFORMATION

At the present time, two major atlases of coastal zone climatology are available. The first is:

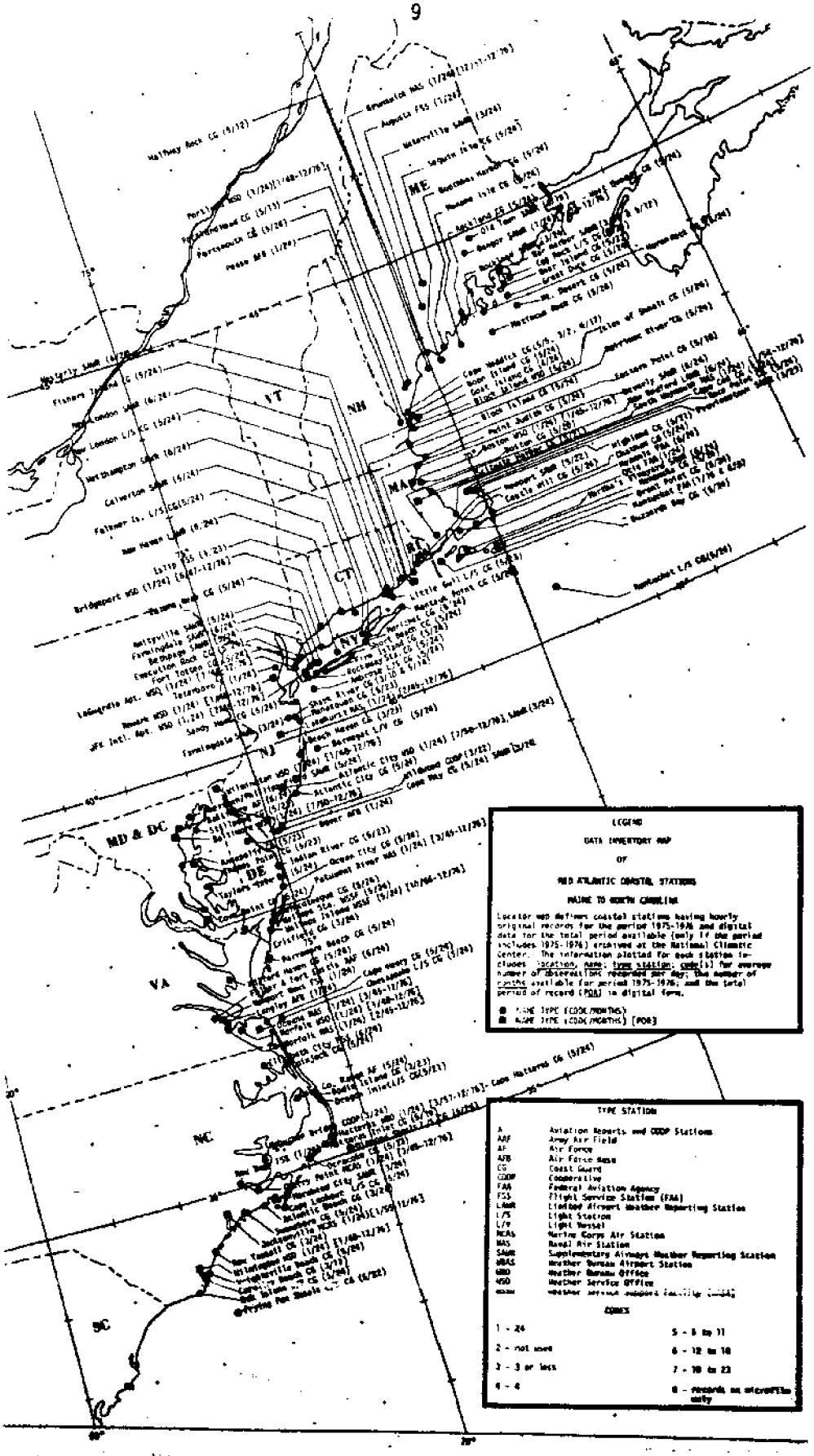
U. S. Navy Marine Climatic Atlas of the World (NAVAIR 50-1C-528) Volume I: North Atlantic Ocean (Meserve, 1974)

This atlas contains monthly data in the form of maps and graphs for:

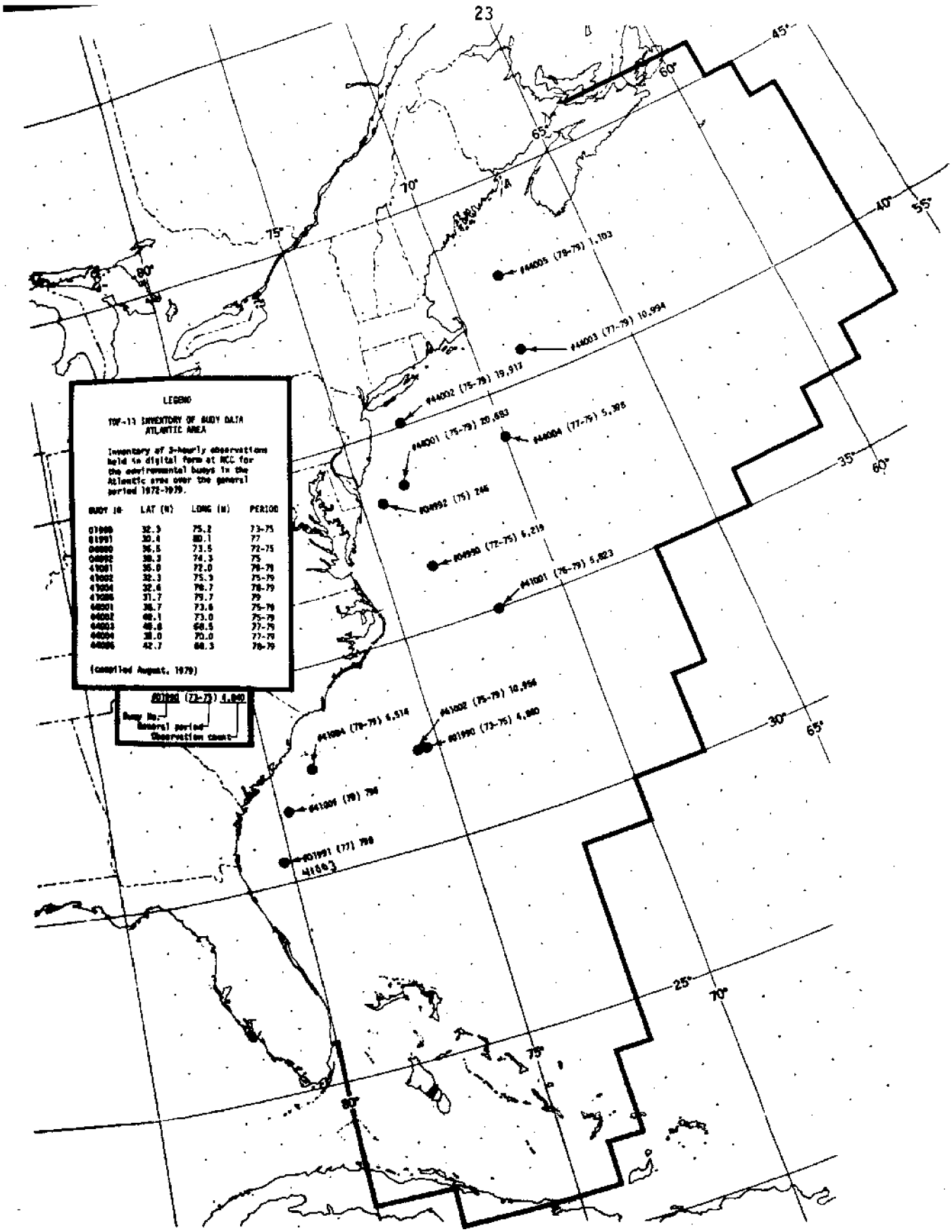
1. Surface winds - maps
2. Wind directions and speed - graphs
3. Surface air temperature - maps and graphs
4. Temperature extremes and T-H index - maps
5. Wind speed and air temperature - graphs
6. Sea surface temperature - maps and graphs
7. Humidity - maps
8. Wet bulb and relative humidity - graphs
9. Precipitation - maps and graphs
10. Visibility - maps and graphs
11. Cloud cover - maps and graphs
12. Wind-visibility - maps and graphs
13. Low cloud ceiling-visibility-wind - graphs
14. Sea level pressure and mean wind - maps
15. Sea level pressure - graphs
16. Waves (1.5 and 2.5 meters) - maps
17. Wave direction and height - graphs
18. Waves (3.5 and 6 meters) - maps
19. Wave period and height - graphs
20. Low pressure centers
21. Tropical cyclones
22. Tides
23. Currents
24. Ice

The entire North Atlantic Ocean is covered by the atlas, for which approximately 25 years of records were available. Details concerning the methods of data collection and analysis appear in the atlas. In the reference section, see Meserve, J. M. (1974).

The second major atlas is:
Climatic Study of the Near Coastal Zone--East Coast of the United



Taken from Coastal Data Networks and Sources



Taken from Coastal Data Networks and Sources

Figure 4

States. (U. S. Naval Weather Service Command, 1976)

This atlas was also prepared by the U. S. Navy. More detailed information about the coastal zone, however, is available in this atlas. Monthly data in the form of maps and tables are available for

1. Visibility
2. Ceiling height
3. Ceiling-visibility
4. Wind speed and direction
5. Air and sea temperature
6. Wave height
7. Surface currents

The coastal area covered by the atlas is 30N to 45N and 68W to 82W. In the reference section see U. S. Naval Weather Service Command, 1976.

U. S. Naval Weather Command (1975) contains a summary of synoptic meteorological observations for stations of interest to North Carolina mariners in the form of tables. Information is available on:

1. Percentage frequency (PF) of weather occurrence by wind direction
2. PF of weather occurrence by hour
3. PF of wind direction by speed and hour
4. PF of wind speed by hour
5. PF of total cloud amount by wind direction
6. PF of ceiling heights and occurrence by wind direction
7. Cumulative percentage frequency (CPF) of occurrence of ceiling height and visibility
8. PF of low cloud amount and PF of sky obscured
9. PF of wind direction vs. occurence or non-occurence of precipitation at observation time with varying values of visibility
10. PF of wind direction vs. wind speed with varying values of visibility
11. PF of ceiling heights and occurrence by hour
12. PF of visibility by hour
13. CPF of ranges of visibility and ceiling height by hour
14. PF of relative humidity by air temperature
15. PF of wind direction by air temperature
16. Means, extremes, and percentiles of air temperature
17. PF of relative humdiity by hour
18. PF of air temperature and the occurrence of fog vs. air-sea temperature difference
19. PF of surface wind speed and direction vs. sea height

U. S. Naval Oceanography Command (1980) contains information on weather summaries and climatic services. Part I of this volume describes published and unpublished climatological summaries available from the Naval Oceanography Command Detachment at the NCC. Part II is a catalog of published and unpublished climatological summaries arranged by continent-country-station. Several of the publications described in this report which would be of interest to mariners are:

1. U. S. Navy and Marine Corps Meteorological Station Climatic Summaries.
2. U. S. Navy World-Wide Airfield Summaries.

3, Director, Navy Oceanography and Meteorology, Summary of Meteorological Observations, Surface.

Additional information on surface marine climatic data products is contained in U. S. National Climatic Center (1979). This publication contains sample outputs of marine climatic data products produced from programs available at the NCC.

PART 2: AN EVALUATION OF THE PRESENT PROGRAM

I. LESSONS FROM THE FEDERAL PROGRAM IN AGRICULTURAL METEOROLOGY AND THEIR IMPLICATIONS FOR THE MARINE WEATHER PROGRAM

A. Introduction

Little work has been done on the evaluation of the weather services provided to the marine community. This was also the state of affairs in the agricultural weather services until a few years ago. Before suggesting changes or improvements, some evaluation of the existing procedures needs to be undertaken. Some lessons can be learned from the agricultural weather program in the United States. This chapter examines in some detail the structure of the present agricultural weather services and the problems the service encountered in meeting users needs.

B. The Structure of the Agricultural Weather Serivces

The two basic products of the agricultural weather program are forecasts and advisories. The forecasts are intended to provide guidance in managing farm operations. They include information on cloud cover, rainfall probabilities, wind speed and direction, dew duration and intensity, relative humidity, and maximum and minimum temperatures. The advisories are designed to evaluate the effects of past, present, and forecast weather factors on day-to-day farm operations. For example, if weather conditions appear to favor the development of certain plant pathogens, the farmer might be advised to spray his crop.

In 1973 the National Weather Service (NWS) established the first Environmental Studies Service Center (ESSC) at Auburn University in Auburn, Alabama. Its purpose was to develop and test methods for integrating the newest agricultural and meteorological technology into the existing agricultural weather program in the Southern Region of the NWS. The Auburn Center's area of responsibility covers Alabama, Florida, and Georgia, and extends to virtually all facets of agriculture. Its mission has three interrelated components: an agricultural weather advisory service, an applied research program in agricultural meteorology, and a program to expand and upgrade the agricultural meteorology observation program.

While most of the agricultural meteorologists in the ESSCs have weather forecasting experience, their forecasting function in the Centers is very limited. Forecasts used by ESSC personnel in their advisory function are issued by NWS Weather Service Forecast Offices.

The advisories issued by the centers are real-time interpretative statements designed to provide the agricultural community with meteorological and climatological information related to farming activities. Advisories cover such topics as planting and harvesting weather, plant disease potential, soil temperature forecasts based on NWS forecasts, poultry heat stress, and soil moisture. The ultimate objectives of the advisory service are to reduce weather-related agricultural losses and to increase food and fiber production.

The principal means of disseminating the advisories is the National

Oceanic and Atmospheric Administration (NOAA) Weather Wire Service, which is a teletype circuit, and NOAA Weather Radio. The unofficial motto of the ESSCs has come to be: "get the right weather information in the right form to the right farm at the right time."

An integral part of ESSC operations is the applied research program, whose main object is the improvement of the advisory function. Center personnel are also responsible for expanding the agricultural meteorology observation network by increasing the number of locations measuring parameters critical to the agricultural meteorology advisory, such as soil temperature, soil moisture, and leaf wetness. To date, ESSCs are operational in only four locations: Auburn, AL; Stoneville, MS; College Station, TX; West Lafayette, IN.

In addition to the four ESSCs, there are two fruit-frost forecast offices which have been in operation for many years. In contrast to the ESSCs, these offices at Brownsville, TX, and Ruskin, FL, retain their agricultural weather forecast function. Agricultural weather forecasts are also provided in some areas, mainly the upper midwest, which have no formal agricultural weather program. In the western part of the country there are still weather service offices active in providing fruit-frost forecasts.

Agricultural weather services are now available in some states from extension agricultural meteorologists who serve on the staff of the land-grant university. Private firms are also entering the business of providing agricultural weather services.

Examples of products issued as part of the agricultural weather service program are contained in U. S. National Oceanic and Atmospheric Administration (1977). In addition, see Jensen (1979) and Priddy and Marlatt (1978).

C. The Evaluation of Weather Services to Agriculture

In 1979 the U. S. General Accounting Office published the results of a survey it had conducted on the dissemination of agriculture weather information (U. S. General Accounting Office, 1979). It sent a questionnaire to approximately 1600 agricultural weather information users or disseminators. The target groups were farmers/ranchers, county agents, agribusiness, and radio and TV stations. Seventeen states with full agricultural weather service coverage and 31 states with limited or no agricultural weather service were included in the sample. The questionnaire covered five main topics: demographic characteristics of respondents, awareness of weather information sources, weather information needs, adequacy of services in covered areas, weather information disseminators--roles and restrictions.

The main conclusion derived from this study was that agricultural weather information was not being effectively communicated to users. Most users in the agricultural community felt that the general weather forecasts were at least "marginally" meeting their needs. The major user complaint was that the forecasts were not accurate.

The main federal agencies responsible for the agricultural weather program are the U. S. Department of Commerce and the U. S. Department of Agriculture. The report indicated that more coordination was needed between these two agencies in both the extension and research portions of the

agricultural weather program. The final recommendations in the report suggested that the Secretary of Commerce in cooperation with the Secretary of Agriculture clarify and strengthen the roles of their respective departments in the agricultural weather service program. This should include:

(1) improvements in the methods for publicizing and communicating weather information to users
(2) improved program coordination through updating the federal plan for a National Agricultural Weather Service (issued in 1971)

The interested reader should also see the recent report by the National Academy of Sciences (1980). This documents efforts by the National Academy of Sciences Board on Agriculture and Renewable Resources to assist the U. S. Department of Commerce and the U. S. Department of Agriculture in the design of agricultural weather and climate information systems. Many of the recommendations for improvements in the agricultural weather program should also be considered when evaluating the marine weather program. The Board's recommendations were to:

(1) strengthen cooperation on a federal level and renew commitments to maintain an agricultural weather program
(2) increase efforts to inform users about what weather information is available to them
(3) update forecasts more frequently and disseminate them on schedule
(4) improve NOAA Weather Radio Transmissions in quality, content, area coverage, and accessibility
(5) encourage commercial radio and television stations to maintain and improve their weather information services
(6) continue efforts to apply new technology to improve the accuracy, applicability, and site-specific timeliness of all forecasts
(7) increase the flexibility of observation and dissemination systems to handle new observations that might be required to meet user needs
(8) maintain the climatological network at least at its present level and add new special observations at selected locations
(9) evaluate new interactive systems (e.g. Green Thumb) to determine their effectiveness in disseminating weather information
(10) develop the formats to be used with such a system through consultation with NWS, USDA, users groups, and other interested parties to insure that users requirements are met.

D. Dissemination of Information

The NOAA Weather Wire Service and the NOAA Weather Radio are the main means of disseminating the products of the agricultural weather service. The most recent innovative approach to dissemination is called the Green Thumb system. A detailed description of this system was prepared by R. C. Scott and is contained in Appendix B. The Green Thumb system has been demonstrated in many parts of the country. Suchmann (1980), who documented the results of such demonstrations at five locations in Wisconsin, arrived at the following conclusions based on questionnaires distributed at the demonstration sites. First, approximately 90% of those responding to the questionnaire would use the system if it were available. Second, respondents preferred to purchase the Green Thumb box rather than to rent it, and $200 was the cut-off point for 93% of the respondents. Third, of the list of items available on the box, respondents thought that information on weather, agricultural advice and

markets would be the most useful.

Final cost figures for the Green Thumb system have not been worked out; however, some cost estimates are available:

- The state computer would cost about $65,000, plus 10% per year for a service contract. This computer would handle one to 50 counties served by the Green Thumb boxes.
- Money would have to be alloted for WATS line connection from the state computer to each county served.
- Each county cmputer would cost about $10,000, plus 10% per year service contract.
- Telephone lines out of each county computer to serve farmers with Green Thumb boxes would cost about $40 per line per month.
- Farmers would be required to purchase the Green Thumb boxes at about $200 per box.

E. Marine Weather Program

Conversations with people at NWS and NMFS in Washington, D. C., indicate that on a national level, little if any cooperative planning has been done in the interests of marine meteorological services. The cooperation that does exist is mostly on the local level.

On the East Coast, cooperation between the Virginia Institute of Marine Science and the NWS has produced the publication The Chesapeake: A Boating Guide to Weather (Lucy et al., 1979). In North Carolina, a close working relationship between the Sea Grant advisor and the NWS has produced improved weather services for fishermen. More extensive cooperation is needed by agencies that serve the coastal areas of North Carolina.

The West Coast marine weather program differs considerably from that on the East Coast. The Sea Grant Marine Advisory program in California, along with the NESS and NWS, has developed over the past four years a program which enables fishermen to use satellite imagery to help locate ocean temperature fronts where concentrations of fish are likely to be found. Consideration is currently being given to an improved distribution system for the satellite information, to collection of ground truth data to verify the accuracy of the satellite data, and to improved satellite technology for the future. Technical details on the determination of sea surface temperatures can be found in California Sea Grant Program (1979), U. S. National Oceanic and Atmospheric Administration (1976), Roy (1980), Vukovich and Crissman (1979), and in Stevenson and Kirkham (1977).

From information provided by M. W. Cummings, coordinator of the California Sea Grant Marine Advisory Program, in 1979 the satellite information will continue to be distributed through Sea Grant marine advisory personnel to key port locations by facsimile and telecopier from the NESS field office at Redwood City (CA). The use of satellite communication techniques is being considered to get pertinent information to offshore fleets, while television broadcasts are being considered for inshore fishermen.

It is proposed that before any major changes in the weather dissemination procedures are adopted, interested federal, state and university agencies cooperate to ascertain what current users and potential users would find most

useful in their work.

Appendix C contains a draft of a questionnaire that could be used to gather information on the attitudes of weather data users to the current delivery system. The collection and interpretation of such information should be jointly undertaken by NMFS, NWS, and the Sea Grant Program. At present the questionnaire makes no attempt to obtain data on any subject other than weather; however, information on the importance of market news and other items should also be gathered.

The National Marine Fisheries Serivce (NMFS) is considering ways to improve the dissemination of weather and other types of information to the fishing industry. NMFS is investigating a system named Fish Info box, which as presently conceived would operate in a manner quite similar to the Green Thumb box mentioned earlier. Raymond Tillery of NMFS is in charge of developing the system. Most consideration at this time appears to be directed at having the box near the shore where fishermen can use it--but not on board the boat. Location on the boat would be more expensive for several reasons. First, one land-wire system on shore could serve many ships using the same pier. If the system were located on each boat, each owner-operator would bear the total expense for his boat. Second, shore-based radio transmitter facilities and shipbased radio receiver facilities would be required at a considerable additional expense.

Tillery demonstrated the Fish Info box at the Boston Fish Expo. Those viewing the demonstration were asked to fill out a questionnaire (see Appendix D). The questions were designed to identify the respondent, the information they are presently obtaining or think that they need, and their attitudes toward the Fish Info box. Approximately two-thirds of those responding (roughly 200 individuals) were commercial fishermen. The results showed that:

(1) the overwhelming majority of respondents would use the Fish Info box even if some charges were involved; the amount of money that respondents were willing to pay is listed on the summary form in Appendix D.
(2) the three most popular types of information requested by the fishermen were (in order of popularity): market news report, weather information, and fisheries regulations.

II. A SYNOPSIS OF USER AND PRODUCER COMMENTS ON THE PRESENT PROGRAM AND RECOMMENDATIONS FOR IMPROVEMENTS

To arrive at some conclusions concerning the NWS Marine Weather Program in North Carolina, interviews with representatives of the following groups were conducted:

1. NWS personnel
2. NMFS personnel
3. Marine weather users
4. Sea Grant agents

While the sample lacked statistical rigor, these interviews produced some representative comments on the present weather information system. Some of the interviews were conducted in cooperation with the Sea Grant marine advisory agents at Kure Beach, Atlantic Beach, Manteo. Local commercial and charter boat fishermen were contacted and interviewed in person where

possible. A summary of the information obtained from each of these groups is given below.

1. NWS. Discussions were held with NWS personnel at the RDU WSFO and the WSOs at Wilmington, Cape Hatteras, and Norfolk. The general impression obtained from these interviews was that the NWS, within the bounds set by personnel and budget ceilings, was providing marine users with the best service possible. All the NWS people contacted demonstrated a strong desire to improve the existing programs for marine users; however, given the present restrictions on personnel and appropriations, these improvements cannot be implemented at this time. The same basic commitment to improved services was also evident during interviews with scientists at NWS and NOAA headquarters.

At both the local and national level, NWS personnel stated that one vital element necessary to improve meteorological services to marine users would be improved weather data collection facilities. A crucial element in this improved collection system would be ship-to-shore weather reports. Many of the local WSOs have attempted with only limited success to get fishermen to help them in this endeavor. Based upon interviews at the coast, it appears that the Sea Grant agent can serve as a very efficient middleman in the relationship between the NWS and the local fishermen, and would be very helpful in promoting the importance of ship-to-shore weather information. This information will become even more critical as the NWS explores the feasibility of the NOWCAST concept.

In NWS and NOAA several new programs are underway or are being planned which will help marine users. These are:

- Ocean Service Units. These units will become an integral part of existing WSFOs and are designed to provide improved meteorological services to marine users. The units will have a trained oceanographer assigned to them. A pilot unit is presently operational at the WSFO in Seattle. On the East Coast, units will be established at the WSFOs in Boston, Washington, and Miami.
- An oceanographic working group is presently assigned to NMC and has the responsibility of helping to prepare meteorological guidance for marine weather users.
- In 1986 the National Oceanic Satellite Service will be implemented. Information from this satellite system will be made available through the Ocean Service Units and other major port facilities.

Continued improvement to the marine weather observation program is also sought. Several new programs are being started and planned. These are:

- As its name implies, the Coastal and Offshore Observing Station Program aims at providing more basic observational information to the meteorologist. This network will be automatically interrogated by satellite and will replace much of the existing Coast Guard weather information now used by meteorologists. Plans are to establish 99 land-based stations while 10 navigational buoys and 15 platforms will be instrumented in the coming years.
- The SEAS (Shipboard Environmental Acquisition System) is designed to use satellites to automatically collect data at sea. Whether this system will provide the needed observational data in coastal waters is questionable.

NOAA and NWS have not at this time solved the problem of information dissemination to marine users. The evaluation of many different systems is underway.

NESS personnel in California are currently investigating ways of improving information delivery to marine users. Various schemes involving satellite data transmission, radiofacsimile, and commercial and public television are being considered. Conversations with these people revealed a strong desire to improve the situation, but little funding is available to carry out the ideas.

2. NMFS. On both the local and national level, NMFS is interested in improving the dissemination of information (including that of a meteorological nature) to fishermen. The NMFS has been investigating the possibility of using the Fish Info box to disseminate information (see the detailed discussion earlier in this report). Based on interviews with NWS and NMFS officials in Washington, D. C., there appears to be only limited cooperation between NWS and NMFS in efforts to improve information dissemination to marine users. Since both agencies are part of NOAA, the development of such cooperative efforts should be administratively less complex than many joint federal ventures and are essential to the improvement of services to the marine community.

3. Marine Weather Users. With the help of Sea Grant agents, commercial and charter boat fishermen were interviewed concerning their opinions on coastal weather support. For the most part, the fishermen are either satisfied with the existing state of affairs or are willing to make allowances based on their knowledge of the difficulties of forecasting weather. If one area of common concern could be stated, it would be that forecasts need to be updated more frequently. This criticism is based mainly on the experience of fishermen operating in a particular coastal area where existing and forecast conditions were not in agreement--within the large bounds of tolerance allowed for by the fishermen. In addition, it was stated that up-to-date reports on weather conditions in a given area would also be useful.

User comments on forecasts and reports are closely related to one of the main problems, as perceived by NWS, in improving these services: the need for improved ship-to-shore weather reports. If a fisherman is experiencing weather conditions in his operating area which deviate from the forecast, a timely weather report to the NWS could result in a revised forecast. The observational information could also be passed on to other interested users. NWS sources also expressed a need for more fixed coastal observation sites.

Many fishermen were not aware of some of the new weather products which have become routinely available over the past decade. When some of these new products were discussed with them, most thought that the information contained in these products could be useful to them in their work. This was particularly true of the satellite data pertaining to sea-surface temperatures and Gulf Stream location. Before many of these products can be of meaningful use to the fishermen, an educational program should be undertaken to teach them how to derive maximum benefit from the products.

Additional insights into the user's viewpoint can be gained from a paper by Austin (1979), who conducted informal interviews with the user community in New England. The problems brought to Austin's attention, and of relevance to

this study, were:

- problems exist with the forecast wind-speed range
- selected Coast Guard observations are made in the wrong location for maximum utility
- NWS weather information is broadcast to meet scheduling demands instead of user requirements.
- forecasts do not take into account the hazardous sea conditions which arise from opposing wind, tidal currents, and ocean curents
- more attention needs to be given to the movement of tides, which are a major influence on local wind and squall fog banks

4. SEA GRANT AGENTS. Trips to the three marine centers demonstrated the very close working relationships that exist between the agents and local fishermen. All three agents indicated that for the most part fishermen were satisfied with the NWS forecasts. See the previous section for more details on this aspect of the study.

The Sea Grant agents are ideal for serving as intermediaries between the NWS and the fishermen. Through them some of the problem areas that exist in coastal weather support could be explored. These include, for example:

- obtaining weather observations from ships at sea. Fishermen might be more willing to participate in a program to provide obeervations if they were dealing with individuals whom they know and with whom they have worked. The Sea Grant agent could be useful in emphasizing the importance of the observation deficiency problem to the fishermen.
- ascertaining precisely what information fishermen need, when they need it, and in what form it is most useful.
- disseminating information. Some of the NWS weather information which is received in chart or map form could be quite useful to fishermen. When an NWS Office is located near a Sea Grant agent (e.g., Wilmington), maps or charts deemed pertinent to fishermen could be made available by NWS to the agents for posting at piers. An example of such information might be sea surface temperatures or Gulf Stream location. It might be necessary to run pier-based short courses to teach fishermen how to use the information to make their operation more productive.

PART 3. FUTURE PRODUCTS AND SERVICES TO MARINE USERS

I. NEW AND IMPROVED INFORMATION DELIVERY SYSTEMS

There are many new information delivery systems on the market today. Both NMFS and NWS are considering the use of some of these systems to improve the flow of data and information to marine interests. Two systems which are presently in limited or experimental use appear to be promising for marine users.

The first is the concept behind the Green Thumb box. Many of the pertinent details concerning this system were discussed earlier.

It was envisioned that the Green Thumb system would operate through a series of state computers which would sort and direct data to minicomputers in county extension offices. The state computer would draw on sources such as NWS or USDA for much of the information put on the system. The local farmer would purchase a Green Thumb box which connects to a home TV set. By calling the county computer via the box, the home TV set will receive a table of contents of the information stored in the county computer. The farmer is able to store in his box the data he wishes displayed at his own convenience on the TV.

NMFS is exploring the possibility of using a system similar to the Green Thumb box to disseminate information to marine user groups, the Fish Info box. Information to be disseminated includes market reports, fishery regulations and closure information and weather information. At present NMFS has the option to participate in the USDA/NWS system or to develop a system of its own.

One way that NMFS is considering for the dissemination of weather information is to have information from the NWS computer fed into a NMFS regional center minicomputer. From the regional office, linkages to local NMFS offices would be established. Users would dial into the local NMFS office to obtain data for display on a TV via the Fish Info box. The TV and box could be located in the home or at a pier. It appears at this time that consideration is not being given to shipboard systems accessed via radio. A shipboard system would have many advantages; these were discussed in an earlier section of the report.

Because of the necessity of serving inland agricultural users, a joint NWS/NMFS dissemination system would likely be designed along the lines of the present Green Thumb system, i.e., a state-operated computer system. Marine users could be serviced by making special products available through the agricultural county agents offices that would also serve agricultural users. An improvement in this plan would call for minicomputers at the Marine Resource Centers which would be designed to serve the needs of marine users more effectively than channeling their calls through the county agricultural extension agent.

In the marine version, information useful to marine users would filter down to the Marine Resource Center from federal and state sources in much the

same way that agricultural information is disseminated by the Green Thumb box.

As outlined by Suchman (1980), the county computer in the Green Thumb system receives input from:

- NWS computer (world climate data, national agricultural markets). To this would be added NMFS market information.
- local NWS offices (state forecasts, county forecasts, agricultural forecasts, radar reports, weather warnings). To this would be added by the WSFO or WSOs any additional information needed for marine users (e.g., Gulf Stream location, sea surface temperatures, coastal waters forecasts).
- state extension bulletins and agricultural advice. Similar information for marine users would be added through the Sea Grant advisory service program in North Carolina.
- local weather observations (precipitation, temperature, current weather, etc.). Weather observations needed by marine users would be made available through the WSFO and WSOs.
- local market information. Similar material would be added to the system for marine users through the Sea Grant office.
- county extension office (home economics and 4-H information, local meetings, advice on pest and weed control, fertilization). Sea Grant agents would again be called on to meet the needs of marine users through their advisory services on a state and local level.

Even if NMFS developed a system on its own and designed it to operate through local NMFS offices at the lowest echelon of service, it would be to the operational advantage of such a program to involve the Sea Grant advisory program in both the preparation and dissemination of the information.

Extension of Fish Info box to boats at sea would require additional expenditures for the transmitting facilities. These facilities could be located at the Marine Resource Centers or at the local NMFS office. Information would flow to these offices as described in previous paragraphs; however, dissemination would then be accomplished by either telephone (as now envisioned by NWS and NMFS) or radio.

For the dissemination of weather information alone to ships on the water, consideration should be given to the radiofacsimile system. Background information on the delivery system is given in the following paragraphs.

Radiofacsimile Broadcasts

Meteorological maps prepared by forecasters and computer models of the atmosphere are transmitted from the NMC in the World Weather Building near Washington, D. C., to local weather stations across the U. S. via transmission lines. Detailed information on the products available on facsimile is contained in National Weather Service Forecasting Handbook No. 1 -- Facsimile Products. (U. S. National Weather Service. 1979a)

In addition to transmission by land, maps can also be broadcast via radio--the radiofacsimile system. These radiofacsimile (RAFAX) products are part of the worldwide marine weather broadcasts and, as such, are transmitted by many different agencies throughout the world. Transmissions of interest

to North Carolina fishermen are issued from Brentwood (NY), Norfolk (VA), and Washington, D. C. Only charts of interest to most mariners are listed in this section. The transmission speed is 120 scans per minute.

The Brentwood transmissions are beamed towards the Caribbean and Central and South America on a mean bearing of 165°. The information content of the transmissions is for the western North Atlantic. The transmission frequencies (carrier frequencies) and the hours (GMT) that a frequency is in use are:

9290	kHz	(0712-1212)
9389.5	kHz	(0712-1212)
11035	kHz	(0712-1212)
17436.5	kHz	(1950-2350)

The broadcast from Brentwood relies on data received via land line from the National Weather Service in Washington, D. C. The transmitter is operated by ITT World Communications. The map schedule for Brentwood is:

1.	Surface analysis	0750, 1950
2.	24-hour surface/sea and wind prognosis (sea height in meters)	1046, 2307
3.	36-hour wind wave/swell prognosis	1150
4.	24-hour/36-hour combined sea height prognosis (sea height in meters)	24 hours/day

Terms used in the schedule are defined below [taken from Worldwide Marine Weather Broadcasts (1979)]:

Analysis--A chart that shows existing sea-level pressure patterns, including centers of high and low pressure, and frontal systems. Plotted observational data may be included.

Prognosis--A chart showing forecast conditions at a specified future time.

Nephanalysis--Analysis of satellite photographs in terms of type and amount of clouds.

Significant Weather Depiction Chart--A chart that shows frontal systems with associated cloud patterns and precipitation or fog areas. These charts may show either recent conditions or forecast conditions.

Wave/Swell/Sea Condition Charts--These charts vary in content. In general, they show sea and/or swell heights, directions from which the sea and swell are moving, and/or periods. The charts may be either analyses or prognoses.

Sea-Surface Temperature Chart--An analysis of the temperature of the sea for a given ocean area.

The broadcast from Norfolk (VA) originates with the U. S. Navy Fleet Weather Facility. It covers the North Atlantic Ocean and is transmitted on (kHz): 3357, 4975, 8080, 10865, 16410, 20015. Transmission times are subject to change; however, a schedule is broadcast daily at 0000.

The broadcast from Washington, D. C., originates with the U. S. Air Force

and covers the North Atlantic Ocean. For each broadcast, two frequencies are selected each day depending on radio propagation conditions. The frequencies (kHz) are selected from: 4793.5, 6912.5, 10185, 12201, 13472.5, 14671.5, 15620.5, 17670.5, 19955, 23068.5. The products broadcast are :

1.	Surface Analysis	0636, 1836
2.	12/24-Hour Surface and Significant Weather Forecast	0700, 1900
3.	30-Hour Surface Prognosis	1200
4.	Weather Advisory	0336, 0900, 1545, 2000
5.	Extended Forecast (Mon., Wed., Fri.)	0530
6.	Test Chart	0500, 0515, 1708, 1730

The worldwide marine broadcasts also contain information transmitted via radiotelegraph, radiotelephone, and radioteleprinter. Details concerning these broadcasts are contained in U. S. National Weather Service and U. S. Naval Oceanography Command (1980).

A radiofacsimile service for the Great Lakes was established in December 1977 (see Waldman, 1980, for details). Two sets of prognostic weather maps from the WSFO in Chicago are being transmitted daily to Great Lakes ships equipped with the facsimile receivers; broadcasts to interested mariners are made by the Lorain Electronics Corporation at Lorain, Ohio. Transmitted charts depict current and future positions of storm centers and fronts. Wind barbs are added to indicate the observed winds and a 24-hour wind forecast.

RAFAX appears to have a promising future in providing visual weather information to users groups if certain basic problems can be resolved. The major problems appear to be:

1. From the schedules listed in previous paragraphs, it is evident that the present system draws upon many diverse agencies for its data and transmission facilities. This diversity could create serious problems for the user. An attempt to standardize the product and broadcasting facilities would help to solve the problem. Cooperative efforts on the part of all existing parties is required.

2. At present the system is geared primarily for the ocean-going user. Most commercial fishermen who operate in coastal waters would find it of little use at this time.

3. According to the NWS, the shipboard facsimile suffers from tuning problems and it frequently requires maintenance work.

4. The initial investment for purchasing the RAFAX receivers can be as much as and often more than $5,000. Efforts to reduce this price have failed, according to NWS. This price puts the equipment well beyond the reach of most commercial fishermen. Maintenance costs are also high.

RAFAX does have the potential to be very useful to all commercial fishermen provided certain requirements are met.

1. The cost to the individual user must be reduced to the point where

even small-scale commercial fishermen can afford the system. This reduction in price would most likely come through price competition resulting from a federal-level decision to expand the system for marine users. At present a $5,000 system is composed of two main components:

- SSB receiver $ 2000
- Recorder $ 3000

Most small commercial operators do not have an SSB radio on board. A possible alternative is to transmit via VHF radio, which most fishermen already have. The cost would then be reduced to the recorder and an interfacing system, still a substantial amount. The use of the VHF system as opposed to SSB results in a considerable reduction in range. The $3000 recorder does not have a signal activated on-off switch; this capacity would increase the cost.

2. The RAFAX broadcast system would have to be standardized in some manner. The NWS is the agency which produces almost all of the weather products needed for marine operations. It is recommended that the NWS formally investigate the possibility of upgrading the RAFAX system to serve all marine users.

3. The present RAFAX system should be modified in several ways. First, the interests of commercial fishermen who operate in coastal waters should be considered--products of particular interest to them should be made available on the RAFAX system. In addition the list of products to all users could be improved. In coastal waters, for example, radar maps, sea surface temperature charts, and Gulf Stream location should be considered for transmission.

4. The entire RAFAX system should be reviewed periodically by users and producers to make the necessary modifications to satisfy user needs.

5. Even as now constituted, the RAFAX system has several advantages over other systems. First, it is a visual display, which makes it superior to code or voice systems. Second, it provides a hard copy that can be referred to during ship operations at sea. The quality of many RAFAX products would permit their use in plotting ship positions and movements in relation to weather systems. The video (TV) display systems do not have the necessary resolution because of the small screen size, and making hard copies from the video display does nothing to improve the product. This last statement is true of the systems reviewed by the author.

Many of the fishermen contacted in coastal North Carolina had heard of and had seen RAFAX systems. In their estimation there were two major problems with the system. The first was cost, while the second centered on interpretation of the information on the charts, which are intended for use by professional meteorologists. The fishermen interviewed thought that it would help if more maps were transmitted with less information on each, rather than trying to put everything on the map. Depending on transmission schedules, it might be possible to transmit special maps for non-meteorologist marine users. Even if this approach is taken, a local educational program sponsored by NWS

and Sea Grant agents is recommended. Such an educational approach would have a far greater chance of success if carried out at the piers instead of at the Marine Resource Centers.

Many additional delivery system ideas are coming on the market each year as innovations in computer hardware are made available. Only two of the most viable systems have been considered in this chapter; however, if NWS and NMFS plan to upgrade their services to marine users, a more in-depth analysis by a team of experts, including potential users, producers, economists, and electronic engineers, is called for.

II. SPECIFIC RECOMMENDATIONS FOR IMPROVING SERVICES TO MARINE WEATHER USERS

1. To develop a viable marine weather program that meets the needs of users groups, there is no substitute for cooperative efforts on the federal level. The present program in agricultural meteorology owes its success to cooperative efforts between USDC and USDA. Invariably, the recommendations from various groups wanting to improve the program include a call for renewed cooperation at the federal level. Since both NMFS and NWS are part of NOAA, it is hoped that lines of cooperation could be easily established and nurtured. These two agencies should be charged with the task of developing a National Marine Weather Program. Only if such a federal level approach is taken will a marine weather program provide comprehensive solutions to some of the problems facing users.

2. Consideration needs to be given to the development of new methods of disseminating weather information to marine users. Evaluation of the Green Thumb box and the Fish Info box are currently underway. An evaluation of the RAFAX system is long overdue. The NWS, in conjunction with NMFS and other agencies currently involved in producing products for RAFAX or transmitting information via RAFAX, should determine the feasibility of developing a RAFAX system to serve the needs of all fishermen. If the decision is made to develop the RAFAX system for marine users, it is hoped that competition among potential equipment suppliers will result in improved products at lower prices.

3. At the national level, consideration should be given to the development of new products which would be more useful to fishermen than current products.

In relation to the development of new weather products, National Academy of Sciences (1980) contains some guidelines which can be applied to marine weather products:

- A survey should be made of the present and future needs of the marine user. A questionnaire designed to meet part of this need was discussed in an earlier chapter. While some interviews were conducted as a part of the present project, a statistically significant sample of marine users needs to be interviewed.

- New prototype marine weather products should be tested against existing products to determine if they are more effective in meeting user needs.

- New products should be oriented toward local weather needs and be designed to interface with emerging needs for energy conservation, production costs, and alternate energy use. For example, more detailed information on Gulf Stream location could cut fuel costs by helping fishermen to decide where to fish without costly search operations.

- It is more desirable that new product testing and evaluation be done by a disinterested third party.

- It is preferable that new product development precede the development of new dissemination systems.

4. The establishment of a National Marine Weather Program may be quite slow in materializing. This should not, however, inhibit North Carolina from acting on its own in certain key areas. Suggestions for action include:

   - Establish a Sea Grant project adequately funded to allow for a detailed assessment of present marine weather services and future needs through extensive interviews with marine weather users. These interviews should provide data for the following proposals.

   - Based on the interview results, develop new weather products more useful to marine users. Because of NWS funding and personnel constraints, these efforts could be enhanced by input from the N. C. State University (NCSU) meteorology faculty through standard grant procedures.

   - Review dissemination procedures for the current NWS products. Often small changes in content (e.g., improved definition of the Gulf Stream for the teletype report out of Washington, D. C.), transmission time, and updating procedures can be helpful.

   - Seed funding for testing some of the new product dissemination systems in North Carolina. NWS and NMFS officials would actively support such efforts. The Fish Info box could be tested as part of a local joint NWS, NMFS, Sea Grant, and NCSU meteorology faculty project similar to the Green Thumb box testing undertaken by Suchman (1980) at the University of Wisconsin.

   - Hold a regional conference specifically addressing the problems of marine weather users needs where ideas can be freshly exchanged. Both users and producers of marine weather information should be encouraged to attend.

   - Strengthen the professional ties among NCSU meteorology faculty members, local NWS personnel, and Sea Grant agents. Some ties already exist between individuals in these groups, but the NCSU meteorology faculty needs to be made aware of the problems facing the marine weather community, and resources to meet the challenge need to be committed.

   - Encourage cooperative efforts where feasible. In Wilmington local initiative between Sea Grant agents and NWS personnel has worked very well. Cooperative efforts have yielded better service to marine users

and in the future hold the promise of being areas where new products and procedures could be tested and cooperative educational projects undertaken.

It is recommended that a program started on the West Coast as a joint venture between NESS and Sea Grant agents be tested in the Wilmington area. It is proposed that weather maps from the NWS be made available to marine users at pier-side through the Sea Grant agent. The charts could be simplified surface analysis maps, sea surface temperature charts, maps showing Gulf Stream locations, etc. In some instances, duplicates of the FAX charts could be used, while in other cases new charts would have to be made up. The Sea Grant agent could obtain the charts from NWS in several ways. First, he could actually go to the NWS office and pick them up and deliver them pier-side. The maps could also be transmitted by telecopier to the Sea Grant agent for delivery or transmitted directly to the pier for display. If time (a highly critical item for NWS operations) permits, NWS personnel in conjunction with the Sea Grant agent could institute an informal educational program to make the information on the charts more useful.

It is further recommended that a debriefing program be tested by NWS personnel in conjunction with Sea Grant agents. The most useful way to obtain current coastal weather data would be ship-to-shore radio through a network efficiently organized for both data sender and receiver. Shore debriefing programs, however, can also provide useful information which may be quite recently obtained. Much of the debriefing effort might fall on the Sea Grant agent, depending on NWS time constraints. Agents could complete debriefing forms after interviews with returning fishermen. The information would then be sent to the NWS office for use in conjunction with the observation, forecasting, and warning programs. Other ways of setting up the debriefing program are also feasible. One of the additional benefits to the debriefing program would be the impression left with fishermen that current observational weather data is critically needed for service improvement.

Where time constraints hamper a portion of the above recommendation, grant money should be sought in conjunction with interested NCSU meteorology faculty members or in conjunction with private meteorology consultants to carry out some of provisions recommended above.

Two positive steps have been taken to implement the recommendations made in this report.

1. Through the efforts of the author of this report and the University of North Carolina Sea Grant College Program, Raymond Tillery (U. S. National Marine Fisheries Service, Washington, D. C.) conducted a demonstration of the Fish Info box in coastal North Carolina. Tillery displayed the system for the Sea Grant Site Visit Team and local fishermen at the Marine Resources Center in Atlantic Beach, North Carolina. Visitors to the display were quite interested in the system and felt that it could be very helpful in the decision making process connected with their work.

2. A special session on weather services to marine users will be held as a part of the annual national meeting of the National Weather Association (NWA), to be held in Raleigh on the 9th and 10th of November 1981. Both users and producers of marine weather

information will be invited to participate. The NWS is an organization of about 1500 professional meteorologists and others interested in meteorology. The association places strong emphasis on the applied or practical aspects of the discipline.

Part 4: ADDENDA

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APPENDICES

APPENDIX A

ACRONYMS

CAC	Climate Analysis Center
ESSC	Environmental Studies Service Center
GMT	Greenwich Meridian Time
NCC	National Climatic Center
NESS	National Environmental Satellite Service
NHC	National Hurricane Center
NMC	National Meteorological Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSSFC	National Severe Storms Forecast Center
NWA	National Weather Association
RAFAX	Radiofacsimile *
RAWARC	Radar Reports and Warning Coordination System
RFC	River Forecast Center
WMO	World Meteorological Organization
WSFO	Weather Service Forecast Office
WSO	Weather Service Office
AVL	Asheville WSO
HAT	Cape Hatteras WSO
CLT	Charlotte WSO
GSO	Greensboro WSO
RDU	Raleigh WSFO
ILM	Wilmington WSO
ORF	Norfolk WSO

* NWS uses RAFAX for radarfacsimile

APPENDIX B

GREEN THUMB SYSTEM

The "Green Thumb" Agricultural Weather Program

This is a SEA-Extension-NWS program being developed in cooperation with 13 State Extension Services. The major developmental work on the "Green Thumb" dissemination system is underway at the University of Kentucky.

This program is designed to provide farmers with the latest weather and agricultural information to be used in day-to-day decision making.

This program is designed to incorporate weather information into wide range programs conducted by State Extension Services and to provide localized weather information for farmers' use in day-to-day decisions. The program is composed of four parts:

1. Gathering weather data from volunteer observers.
2. Preparation of localized weather and agricultural recommendations utilizing weather data.
3. Dissemination of this information directly to farmers by a unique system which permits them to interact with a small computer located in county Extension offices.
4. A comprehensive educational program to teach farmers how to get maximum benefits from the information provided.

The "Green Thumb" system is designed to provide farmers with the latest localized weather, agricultural, market, and other information at a low cost.

The key to the system is a "Green Thumb Box" which will be purchased or leased by farmers. One set of wires will connect to the antennae of the home television receiver, and the other will plug into the telephone lines. In effect, this will turn the television receiver into a computer terminal.

To access the dissemination system, a farmer will call a special number at his local county Extension agent's office which will give him access to a small computer. He will then choose up to eight screenfulls from a wide range of information that will be available on the computer. The information will then be loaded at high speed into the memory of his "Green Thumb Box." At this point, the telephone connection will be terminated and the farmer can view the information at his leisure. If he wants another set of information, he will have to call the county computer again.

For example, if the farmer wanted weather information, he would enter a certain number on his "Green Thumb Box." This would provide him with the latest state and county forecasts, extended outlook, and special weather element forecasts, local weather observations, and radar showing precipitation and its intensity and movement.

Similarly, he might receive agricultural recommendations such as the latest guidance on soil preparation, insect control, irrigation scheduling, disease control, and other highly perishable information.

The county computer which feeds the user's "Green Thumb Box" can be readily updated by the county Extension staff according to local needs. It will also be updated hourly on a dial-up basis by the state computer with state and national information.

The state computer would serve as a "post office" for the state. It would be loaded by the state Extension staff, the National Weather Service Forecast Office in the state, and on a dial-up basis by a computer at the National Meteorological Center near Washington, D. C. This national computer will call the state computer on an hourly basis and provide information such as radar and certain weather information specific to that state.

The importance of better weather information and the potential benefits of this program arise from the fact that agriculture is a part of the biological system which is driven by weather. A potential exists for reducing farmers' risks by better utilization for specific weather information in the wide range of decisions involved in the production process. Some examples of benefits from this program are:

-- Entomologists know insects require certain weather conditions for development. By monitoring weather where crops are grown, it is possible to model an insect's development and predict when it can be present. Therefore, if weather conditions show an insect cannot be present at the stage of development that causes damage, scouting may be reduced or the control program postponed. Thus, by combining weather information with agricultural knowledge, the use of pesticides and other controls can be reduced. This program has a tremendous potential for increasing the effectiveness of the Integrated Pest Management Program.

-- Weed control with herbicides requires certain weather conditions for maximum effectiveness. It is estimated that about one-fourth of the herbicides applied are less effective because of unsuitable weather conditions at the time of application or immediately thereafter. Better weather information would permit farmers to make more effective use of herbicides.

-- Work at a major university shows that use of better weather data and monitoring of moisture levels permit more effective irrigation scheduling which can reduce irrigation water needs by as much as one-third. This program will provide data essential for more effective irrigation scheduling.

-- Crop maturity is closely tied to weather. Localized weather information can be used to predict when a crop will reach maximum quality. This information, in addition to its value to farmers, can be used in scheduling processing operations.

Various phases of this program are currently underway in 13 states. The intensive tests of the "Green Thumb" dissemination system have been funded under a cooperative agreement between the USDA and the University of Kentucky, utilizing SEA-Extension and NWS funds. SEA-Extension has provided $200,000 and NWS $100,000 to help fund this pilot program which will be carried out in two counties with 200 farmers. The Kentucky Cooperative Extension Service is contributing a significant part of the cost of this project. Staff have

already been assigned by the University of Kentucky to carry out this project. Equipment should be delivered by early winter and the program is expected to be in full operation by the 1980 growing season.

This Kentucky project is an outgrowth of a pilot program which has been underway in Maryland since the 1976 growing season. The Maryland project demonstrated the need for more specific weather information in the Integrated Pest Management Program. It further demonstrated that weather information specific to the communities in which the program was conducted could be provided at low cost by a system of volunteers using a "touch-tone" system to enter their information into a central computer. This information was then available to weather forecasters and Extension specialists. The information proved to be of great value in the Integrated Pest Management Program and also provided NWS forecasters with "ground truth" of moving weather patterns which helped them to improve their forecasts. Word of this project spread rapidly to other states. NWS provided incoming WATS lines to enable the collection of this weather information on a limited basis in 11 other states. The state Extension Services recruited volunteer reporters, arranged for purchase of touch-tone pads, trained observers, and was given access by NWS to the data for use in their programs. NWS forecasters in those states have utilized this information in their weather forecasting activities.

In March 1979 an agreement was completed with the North Carolina Extension Service to establish the first statewide network of volunteer weather observers. This weather information will be utilized by North Carolina Extension Service and the state NWS Forecast Office to develop specialized weather and agricultural information formatted for eventual use on the "Green Thumb" dissemination system and begin work on the educational package for farmers to teach them how to use this information in making day-to-day decisions.

Prepared by R. C. Scott
SEA, Extension, USDA (447-4087)
3/28/79

APPENDIX C

MARINE WEATHER QUESTIONNAIRE

SECTION I: IDENTIFICATION OF THE PARTICIPANTS

(1) **Question:** Which category below best identifies your employment?
Response: (Check one)

a. Commercial fisherman
b. Commerical/Sport fisherman (Charter)
c. Sport fisherman

(2) **Question:** What is the size of your boat?
Response: (Check one)

a. Less than 20 feet long
b. 20 to 39 feet
c. 40 to 59 feet
d. 60 feet or greater

(3) **Question:** Where do you do most of your fishing?
Response: (Check one)

a. Coastal waters (out to 20 miles)
b. Offshore waters (beyond 20 miles)
c. Rivers and sounds

(4) **Question:** How long do you usually remain on the water during fishing operation?
Response: (Check one)

a. less than 1 day (24 hours)
b. between 1 and 3 days
c. more than 3 days out, but less than a week
d. a week or longer

(5) **Question:** At what time of the year do you carry out most of your fishing operations?
Response: (Check one)

a. Spring (April, May, June)
b. Summer (July, August, September)
c. Fall (October, November, December)
d. Winter (January, February, March)

(6) **Question:** What types of fisheries do you have a particular interest in?
Response: (Check one or more)

a. Oyster
b. Clams
c. Scallops
d. Shrimp
e. Flounder
f. Trout
g. Menhaden
h. Other (specify)

SECTION II: EVALUATION OF WEATHER INFORMATION

(7) Question: What is your main source of weather information?
Response: (Check one)

a. Commercial radio
b. Commercial television
c. Telephone to National Weather Service
d. Newspaper
e. NOAA Weather Radio
f. Sea Grant agent
g. Coast Guard
h. Other (specify)

(8) Question: What are the most important types of weather information for your operations?
Response: (Check one or more)

a. Chance of precipation
b. Amount of precipitation
c. Humidity
d. Air temperature
e. Sea surface temperature
f. Wind direction and speed
g. Wind chill factor
h. Wave information
i. Direction of swells
j. Sea level pressure
k. Barometric changes
l. Number of hours of sunshine
m. Location of storms at sea
n. Location of weather system
o. Gulf Stream location
p. Salinity
q. Other (specify)

(9) Question: Are certain of your commercial fishing operations more sensitive to weather than others?
Response: (Check one)

a. No
b. Yes (specify)

(10) Question: Are you familiar with the weather information provided on NOAA Weather Radio?
Response: (Check One)

a. Never heard of it
b. Believe I have heard about it
c. Listened to it once
d. Listened to it several times
e. Frequently listen to it

(11) **Question:** How often do you use the National Weather Service general public forecast in your work?

Response: (Check one)

a. Seldom if ever
b. At least a few times
c. Frequently

(12) **Question:** How would you rate the adequacy of the general public forecast to meet your operational needs?

Response: (Check one)

a. Inadequate
b. Adequate
c. More than adequate

(13) **Question:** How often do you use the coastal waters forecast from the National Weather Service in your work?

Response: (Check one)

a. Seldom if ever
b. At least a few times
c. Frequently

(14) **Question:** How would you rate the adequacy of the present form of the National Weather Service coastal waters forecast to meet your operation needs?

Response: (Check one)

a. Inadequate
b. Adequate
c. More than adequate

(15) **Question:** If you think the coastal waters forecast is inadequate, indicate below why.

Response: (Check one)

a. Essential data is missing from the forecast
b. The forecast does not cover the right time periods
c. The forecast does not cover the right geographical areas
d. The forecast is inaccurate

(16) **Question:** How often do you use the offshore forecast from the National Weather Service in your work?

Response: (Check one)

a. Seldom if ever
b. At least a few times
c. Frequently

(17) **Question:** How would you rate the adequacy of the present form of the National Weather Service offshore forecast to meet your operational needs:

Response: (Check one)

a. Inadequate
b. Adequate
c. More than adequate

(18) Question: If you think the National Weather Service offshore forecast is inadequate, indicate below why.

Response: (Check one)

a. Essential data is missing from the forecast
b. The forecast does not cover the right time periods
c. The forecast does not cover the right geographical areas
d. The forecast is inaccurate

(19) Question: What additional information would you like to see added to the National Weather Service coastal waters and offshore forecasts?

Response: (List additional information desired)

a.
b.
c.
d.
e.

(20) Question: If you have trouble receiving weather information on NOAA Weather Radio when you are on the water, indicate below those geographical areas of coastal North Carolina that are affected.

Response: (Check one)

a. Between Cape Hatteras and Cape Henry
b. Between Cape Lookout and Cape Hatteras
c. Between Cape Fear and Cape Lookout
d. South of Cape Fear

(21) Question: Do you think there are enough NOAA weather radio transmitters in operation to cover the coastal areas of North Carolina in which you fish?

Response: (Check one)

a. Yes
b. No. If no, where are additional transmitters needed?

(22) Question: What effect would more accurate and reliable weather information have on your business?

Response: (Check one)

a. Little if any improvement
b. Moderate improvement
c. Very great improvement

SECTION III. IMPROVED WEATHER INFORMATION SERVICE

Consideration is being given to developing an improved weather information delivery system for the fisheries industry. For the fisherman, this system would consist of a television display screen and a small information receiving box. This equipment could be located on shipboard if desired and used while the fisherman is at sea.

Detailed weather data along with other forms of data would be transmitted by radio to the information box for storage. The stored information could then be displayed on the television whenever desired. A greater variety of more detailed weather information than is currently available would be availabe to the fisherman at sea. The proposed information system could be used to provide the fisherman with timely visual data on such things as:

Radar data on storm locations
Gulf Stream position
Satellite views of major weather systems
Sea surface temperature

Other information, for example market quotations, could also be made available. This mean of delivery is presently being called the Fish Info box.

(23) Question: Would visual information on such factors as storm location, Gulf Stream location, etc., help you to run a more profitable fishing business?

Response: (Check one)

a. No
b. Yes
c. Not sure

(24) Question: If the Fish Info box were available at no cost to you, would you use it?

Response: (Check one)

a. No
b. Yes. If yes, would you prefer that the television-type display screen and information-receiving box be located:
(Check one)
1. On land at the pier
2. On shipboard

(25) Question: Are you aware of the radiofacsimile methods of disseminating weather information?

Response: (Check one)

a. No
b. Yes. If yes, do you think the information provided for your operations by this sytem would justify its cost to you ($2,000 to $5,000)?
1. No
2. Yes
3. Not sure

APPENDIX D

FISH INFO BOX QUESTIONNAIRE RESULTS

Short Questionnaire

1. Would you use a FISH INFO BOX, if they were available?

170 Yes 11 No 4 No Ans.

2. Would you use a FISH INFO BOX, if it were made available to you free, in a place where the commercial fishing industry congregated, e.g., in an office, on the dock, in a home, or in a Market News Office?

171 Yes 5 No 9 No Ans.

3. If the FISH INFO BOX is given to you free, but you are charged for the information services, would you buy the service?

154 Yes 20 No 11 No Ans.

If yes, would you be willing to pay:

	Yes	No
Over $100 per month for the service	11	
Between $100 and $75 per month for the service	7	
Between $75 and $50 per month for the service	14	
Between $50 and $25 per month for the service	23	
Between $25 and $15 per month for the service	40	
Between $15 and $10 per month for the service	25	
Between $10 and $5 per month for the service	32	5

4. Would you buy a "BOX" if it sold for:

(You must pick one or more ranges)

	Yes	No
(A) Over $750	11	24
(B) Between $750 and $650	4	
(C) Between $650 and $450	6	
(D) Between $450 and $350	17	
(E) Between $350 and $300	14	
(F) Between $300 and $250	19	
(G) Between $250 and $200	16	
(H) Between $200 and $100	58	13

5. If FISH INFO BOXES were available, what type of information should be provided?

List 121

No Ans. 14

Market News Report 142

Weather and tailored weather forecasts 136

Environmental data 77

Oceanographic data 88

Recreational fishing data 55

Fisheries regulations 118

6. Name some types of fish information you get now:

List Information: _____ Source: _____

_____ _____

_____ _____

_____ _____

_____ _____

7. Are you a commercial fishermen?

117 Yes 57 No 11 No. Ans.

If no, what is your occupation?

_____

_____

8. Do you have any comments on what you have seen today?

105 answered (generally in favor)

2 answered (not in favor)

78 no answer

Please, print your name in our Daily Log Book.

THANK YOU!!!