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SYSTEM PLANNING CORPORATION

# SHIPBOARD FISHERIES MANAGEMENT TERMINALS

**DRAFT FINAL REPORT**

**SPC 635**

October 1980

Robert G. Nagler
Earl V. Sager

Prepared for
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

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# I EXECUTIVE SUMMARY

The work reported on in this document was undertaken by System Planning Corporation (SPC) as a result of the combined interests of the National Marine Fisheries Service (NMFS), the National Weather Service (NWS), and the National Aeronautics and Space Administration (NASA) in (1) improving the quality and quantity of fisheries and environmental data available in coastal ocean regions through the Fisheries Observer Program, and (2) decreasing the collection, transfer, and accessing costs associated with upgrading the program The primary improvements would be realized through the use of observers on both foreign vessels fishing within our Fisheries Conservation Zones (FCZs) and on domestic vessels participating in mammal protection efforts in the Yellowfin Tuna Regulatory Area Since much of the law enforcement function is carried out cooperatively with the United States Coast Guard (USCG), and since the Coast Guard had already begun to develop and test some preliminary shipboard data terminals covering part of the data needed (per Ref 1), their participation in the effort would also be mandatory

The data of interest to the fisheries would provide both compliance information to support law enforcement and quota management functions and detailed biological, environmental, and catch technique data to support stock assessments, fisheries development, and biological research This observer data collection capability would provide the National Weather Service an opportunity to increase the density of weather and sea state data available in coastal regions Data collection hardware of a related nature is presently under investigation in their Shipboard Environmental Data Acquisition System (SEAS) effort For NASA, the study provided an opportunity to utilize NASA-developed technology and to provide some of the new concept research services under discussion between NASA and the National Oceanic and Atmospheric Administration (NOAA)

## A PURPOSE AND APPROACH

The combined purpose of the SPC work was to

- Evaluate the need for additional data collection and relay capability to support law enforcement efforts and biological and environmental data users in the NMFS, NWS, and USCG
- Establish an integrated set of requirements for such a support capability
- Provide a preliminary design on the major options sufficient to allow the development of a realistic set of comparative costs

The approach used in this effort is shown in Figure 1 SPC analysts assessed the available program documentation and the published data requirements that were related to NMFS, NWS, and USCG needs The results of this assessment and the possible hardware options for shipboard terminals and for transfer and processing mechanizations that SPC had identified during the course of the study were integrated into a preliminary match between needs and options That preliminary assessment was reviewed with the three program sponsors (NASA, NMFS, and NWS) and with the Foreign Fisheries Observer Program Office and members of the Fisheries Review Team who were coincidentally reviewing the observer program at that time SPC then prepared a revised presentation, which was shown to staff at each of the Regional Foreign Fisheries Observer Offices. SPC analysts met with many of the functional elements (e g , Law Enforcement, Quota Management, Stock Assessment, Fisheries Development, and Biological Research) during their visits to the regional offices In addition, SPC staff visited some of the regional Coast Guard personnel who participated in the observer programs, and also met with the NMFS Mammal Protection Observer Program Office in the Interamerican Tropical Tuna Commission (IATTC) jurisdiction to assess their unique needs In addition, phone contacts were made with major users of such data who were located in fisheries facilities remote from those originally visited These meetings, visits, and contacts allowed the needs assessment to be broadly based and allowed SPC staff to establish the details of the existing data processing and handling systems in each region. Even the NMFS Millar Freeman research vessel was visited to ascertain the views of operations personnel on requirements and constraints All in all, 15 NMFS facilities were visited or contacted, representing people in 33 separate organiza-

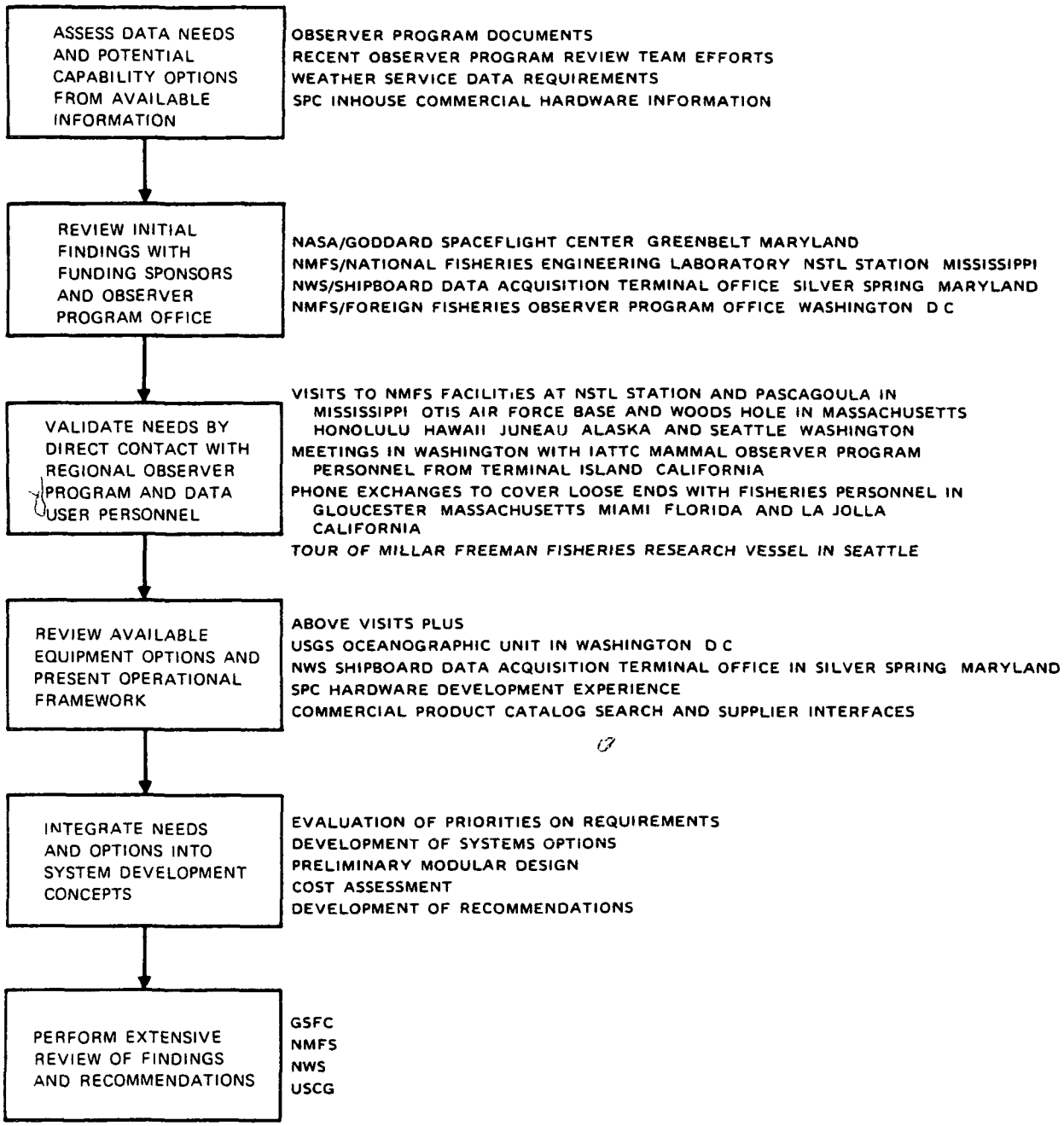



**FIGURE 1**
**FLOW DIAGRAM FOR STUDY APPROACH**

tions Additional Coast Guard and Weather Service contacts were also made Specific locations and organizations are listed later in Table 6, and interview records documenting the meetings and the personnel in attendance were provided in a separately bound Interim Report Before publication the participants reviewed all interview records for veracity

In parallel, SPC analysts reviewed terminal equipment options, ongoing terminal development programs, and the present and projected data networks and data storage and accessing systems to upgrade their knowledge of existing systems and components. The knowledge was integrated into system concepts to satisfy the needs, under priorities developed in the study, and the concepts were costed to provide a perspective on the choices Recommendations were developed as well, and an extensive review was initiated.

## B NEEDS SUMMARY

Efficient data acquisition and transfer mechanizations to meet NMFS, NWS, and USGS program requirements for timely data require both near-real-time (daily or more often) and non-real-time (as convenient, within a week to a year depending on the user) data These needs and the expected benefits are summarized in Table 1 Essentially, the Coast Guard is legally responsible for vessel surveillance and rendezvous logistics. The surveillance is necessary to support rendezvous logistics and to assess whether foreign vessels are limiting their fishing activities to the areas assigned in their permits Shipboard terminals will potentially benefit the Coast Guard by providing improved coverage and reducing the surveillance cost as compared to aircraft coverage Some of the five aircraft now used in the northwest region to support fisheries vessel surveillance might not be needed--for that function at least--and the large aircraft buy presently proposed by the Coast Guard to support fisheries surveillance in the 200-mile Fisheries Conservation Zone might be substantially reduced if unattended vessel locators were placed on all permit vessels In addition, improved knowledge of vessel location on a more continuous basis would reduce steaming time for rendezvous activities in support of compliance boarding, observer transfers, injured personnel pickups, etc These

# TABLE 1

## RFSULTS OF NEEDS ASSESSMENT

| | Coast Guard | | National Marine Fisheries Service | | National Weather Service | |
|---|---|---|---|---|---|---|
| | Need | Benefit | Need | Benefit | Need | Benefit |
| Some near-real time data transfer needs | • Locations for vessel rendezvous | • More efficient rendezvous operations | • Cumulative catch data on near quota species | • Improved quota management | • Synoptic time weather and sea state data | • Improved national weather and sea state forecasts |
| | • Locations and activity indicators for area compliance | • Better monitoring of of permit area compliance at lower cost | • Information on gear technique misutilization and restricted species disposition | • Improved species conservation | | |
| | | | • Observer safety beacon | • Lowering the probability of threat to the observer | | |
| | | | • Portability | • Practicality | | |
| No real time data transfer needs | | | • Detailed species exploration and catch techniques | • Development of domestic fisheries | • Increased density of coastal weather and sea state data | • Improved coastal atmospheric and oceanic research and improved forecast model development |
| | | | • Improve quantity and quality of detailed biological and environmental data | • Improved fisheries assessment and biological research at lower cost | | |
| | | | • Portability | • Practicality | | |

data are needed reasonably often for the surveillance function and could eventually be interrogatable, on request, to support the rendezvous function

The National Marine Fisheries Service needs near-real-time data to support quota management decisions on near-quota species and to ensure timely boarding when vessel personnel are flagrantly violating laws and regulations on gear and technique usage or on restricted-species disposition Quantitative values for these quota management and species conservation benefits were not established in this study due to the magnitude of the effort involved A near-real-time capability for observer safety should also be included in any observer-attended shipboard terminal Although no real violence has yet erupted, observers in the southeast and northwest regions have been subjected to threat situations The observer-controlled communications capability would allow the observer to inform the Coast Guard of witnessed confrontation situations between foreign and domestic vessels over gear destruction or restricted-area usage The Coast Guard should then be able to act quickly to relieve the situation. Any terminal to be used by the observer to provide these data services must be easily portable in order to be practical in application

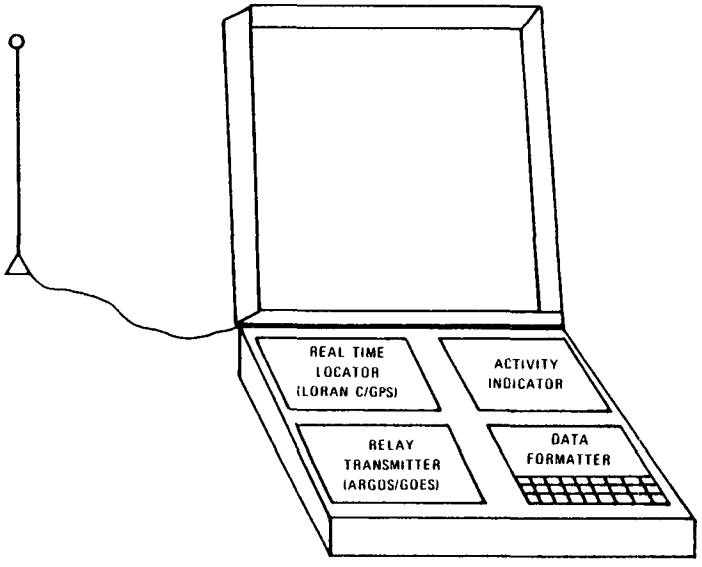
The fisheries have extensive non-real-time needs for detailed data on catch techniques and on the biological and environmental background information related to the catch These data are important for teaching domestic fisheries how to develop underutilized fisheries and to provide improved data bases for stock assessments, maximum sustainable yield determinations, and better understanding of biological growth processes Again, the impact from improved data was not quantifiable within the funding of this effort and is indeed so variable, depending on the assumptions made, that it is difficult to broadly validate any calculation What are quantifiable, however, are shipboard systems to directly digitize data during the collection process These systems will save labor costs for key punching and for one of the two verification steps normally taken back at the regional center This savings could be as low as $50,000 per year in the northwest region alone based on present data-form volume, if the key punchers could clearly read all of the forms turned in. Since natural handwriting variability and the exposure factors in collecting data on fishing vessels preclude easy

reading, multiplication factors of 2 to 10 can easily be applied based on different estimates of potential legibility Portability is again the key to practical observer utilization

The National Weather Service has somewhat different near-real-time needs It needs weather and sea state data for operational forecasting activities at the four synoptic times relative to daily forecast model runs. The data must be taken and transferred plus or minus 10 minutes around these four synoptic times if they are to be of any value for this use The accuracies desired by the operational users are also quite stringent, so that the observer might be required to carry somewhat bulky instruments, if such a capability is not available on the ships already or are not accessible by him. On the other hand, environmental data from all times of the day are needed to support environmental research and the development of new forecast models. These data are especially interesting when events like atmospheric and oceanic fronts, current and upwelling boundaries, etc , can be accurately located at the specific time they are witnessed Although the weather service has not stressed portability in its present shipboard terminal developments, portability would improve practicability in terms of observer utilization Again, benefits for the synoptic data are difficult to quantify without before and after experience The larger data base for research uses benefits from the same shipboard digitization, thereby saving several shore-based labor steps at future times.

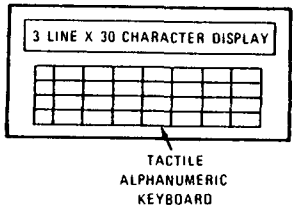
## C. MULTIPLE TERMINAL IMPLEMENTATIONS WITH DIVIDED RESPONSIBILITIES

SPC concluded that three separate capabilities are needed to meet unique requirements and responsibilities rather than one "catch-all" capability These three different capabilities are shown in Figure 2 A terminal that locates a vessel and indicates what fishing activity it is engaged in is the responsibility of the Coast Guard Such a facility would have to make the location and activity indication often enough to follow normal fishing vessel changes in direction and fishing activities,, which vary widely from fishery to fishery Such information should be passed on to appropriate authorities at least once a day A terminal could be designed to carry out this function



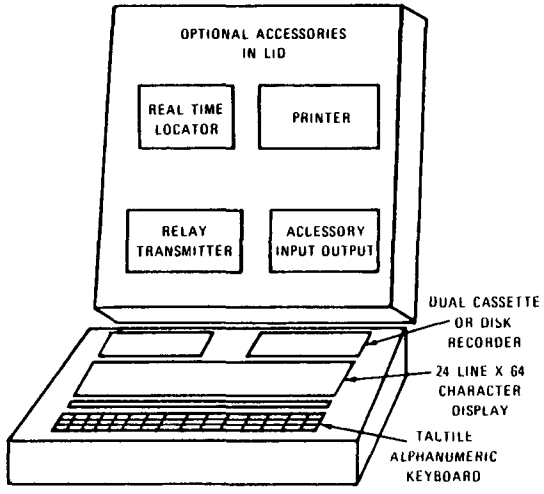

LOCATION AND
ACTIVITY TERMINAL

- COAST GUARD RESPONSIBILITY
- LOCATES VESSEL AND DETERMINES FISHING ACTIVITY HOURLY
- RELAYS LOCATION ACTIVITY QUOTA AND COMPLIANCE DATA AT LEAST ONCE A DAY
- ATTENDED/UNATTENDED CAPABILITY




COMPLIANCE AND QUOTA
MANAGEMENT TERMINAL

- MARINE FISHER ES SERVICE RESPONSIBILITY
- INITIALLY FORMATS DATA FOR COMPLIANCE AND QUOTA MANAGEMENT MESSAGES
- EVENTUALLY USED AS REPLACEMENT FOR CLIPBOARD AND PENCIL IN DATA COLLECTION
- PROBABLY WRIST MOUNTED
- OBSERVER EQUIPMENT




BIOLOGICAL/ENVIRONMENTAL
DATA TERMINAL

- LOCAL RESPONSIBILITY OF MARINE FISHERIES AND WEATHER SERVICES
- INITIALLY USED TO DIGITIZE DATA ON BOARD SHIP FROM DATA SHEETS USED ON DECK
- EVENTUALLY USED TO EDIT DATA FROM SMALL TERMINAL TO MERGE IT WITH OTHER DATA ( g LOCATION) TO DO CALCULATIONS AND SUMMATIONS AND TO PREPARE DATA FOR RELAY
- GENERALLY NOT REAL TIME
- OBSERVER AND RESEARCH VESSEL EQUIPMENT

**FIGURE 2**
**SHIPBOARD FISHERIES MANAGEMENT TERMINAL OPTIONS**

unattended The foreign fisheries agreements allow for such a "black box" capability In fact, the Coast Guard has already developed a terminal that has the first level of capability of interest and has demonstrated it in attended operation

The second capability recommended is a hand-held or wrist-mounted data input terminal that can accumulate and format data to pass through the Coast Guard terminal in support of law enforcement and quota management needs for near-real-time information Eventually, the unit memory capacity can be expanded to allow replacement of the clipboard and pencil Data can thus be entered and digitized at the work area. Multiple data forms could be entered before the data would have to be dumped into a cassette for storage and later analysis The data might also be transferred into a suitcase-packaged smart terminal, where it could be further edited and manipulated or merged with other data such as location and environmental measurements From this suitcase terminal, the data would then be placed in storage for manual transport back to the regional center after the cruise

Finally, a complex suitcase-packaged smart terminal with a 24-line by 64-character liquid crystal display instead of a television-like CRT tube could be produced Initially, it could digitize data from the clipboard sheets after fishing hours (or in real-time with more people available on research vessels) Eventually, however, it could be used in conjunction with the wrist-mounted terminals for editing, manipulating, merging, and formatting data before storing the data for transport back to the regional center Optional accessories for lid installation, on somewhat heavier suitcase implementations include real-time locators, a data relay transmitter, an input/output bus for automated inputs from environmental or biological sensors, and a printer to provide record copies of transferred information as a courtesy to the ship's captain

Figure 3 provides further perspective on the use of these terminals and some of the peripheral inputs As shown, the Location and Activity Terminal might be mounted on the crow's nest and a wire run down the mast so that the observer can access that terminal with his wrist-mounted data unit, when he is

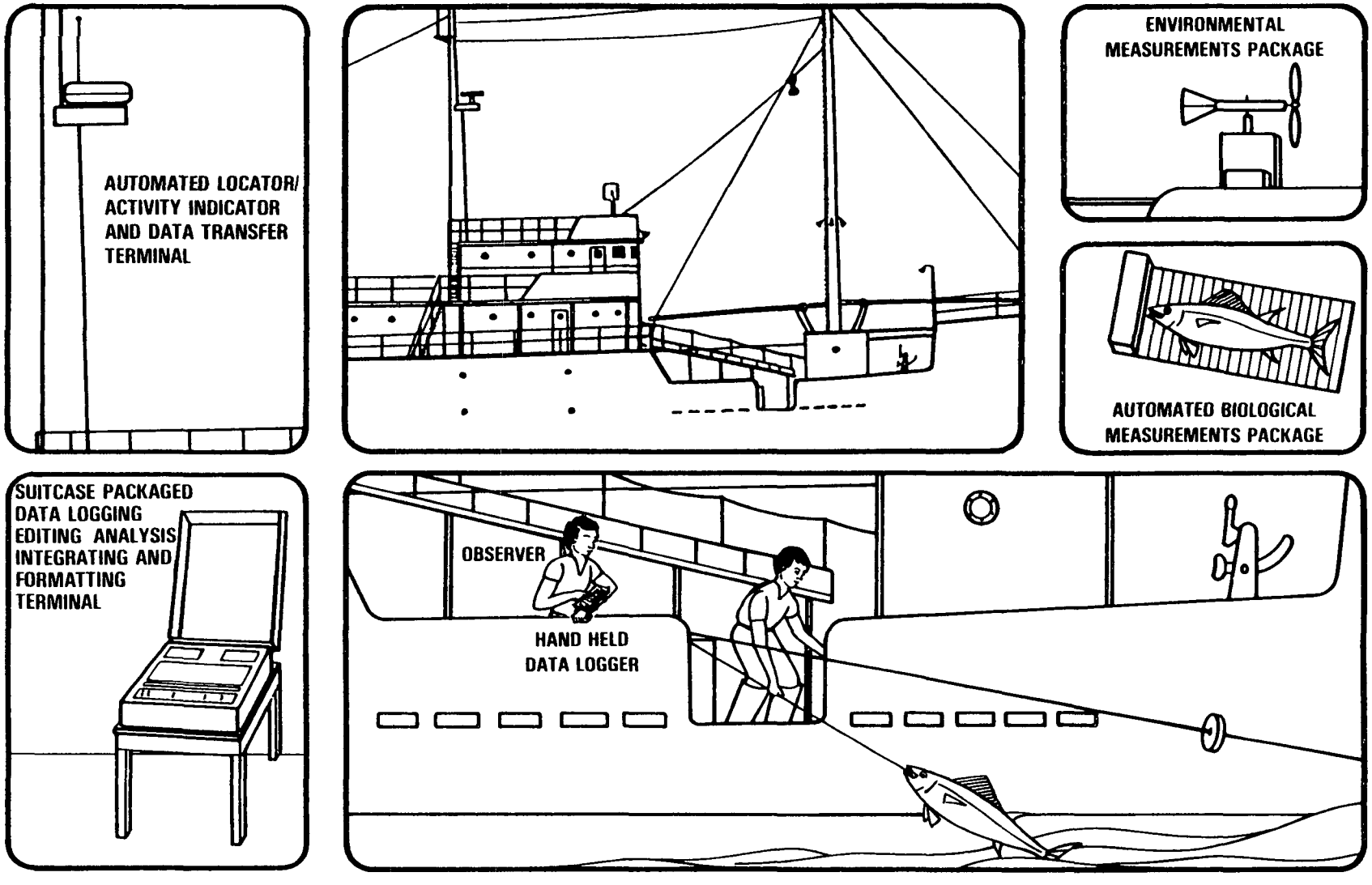



FIGURE 3
OPERATIONAL USE OF SHIPBOARD FISHERIES MANAGEMENT TERMINALS

on board Otherwise, the terminal would operate unattended, after installation, as part of the permit agreement The home office of the foreign vessels might also want to use the terminal when the vessel is not in our waters in order to track vessel movements for their own needs The wrist-mounted data unit works out on the deck or in the fish-processing area with a tactile keyboard unaffected by gurry and sea spray The plug-in mechanism for attaching it to the other terminals is expected to be the most difficult design problem The suitcase-packaged, high-capacity data terminal could be operated inside, possibly from the vessel's power source It could be used both for data handling functions, as earlier suggested, or as a source of entertainment (depending on the type of display implemented) Some of the observer cruises are long and very tedious for observers who are outsiders to the normal social life of a ship

## D NATURAL GROWTH FROM EXISTING CAPABILITIES

Three of the existing units directly involved with elements of the observer and weather programs are shown in Table 2 In addition, many commercial data collection terminals exist for fixed land locations that operate with TIROS-N, GOES, or MARISAT Part of one such system is included in the Coast Guard terminal

The Coast Guard has successfully developed and demonstrated a terminal that provides position location from the TIROS-N ARGOS data collection system approximately 2 to 4 times a day [see Ref. 1] Fisheries and environmental data are inputted by the observer through a series of multiposition thumbwheel switches on the cover of the box that just match the data capacity of the ARGOS system. This system acts as an excellent demonstration of the concept, could be operated unattended, and is ready to "go operational" within the limits of its capability The most important additional capability needed is the ability to track vessels often enough to ensure permit area compliance and to allow weather and biological events to be specifically located

The Texas Instruments (TI) SILENT 700 used by the fisheries research personnel on the Millar Freeman research vessel has provided an appreciation of the value of digitizing data at its source Data are digitized as they are

TABLE 2

PRESENT FISHERIES/ENVIRONMENT-RELATED DATA TERMINAL DEVELOPMENTS

| | Coast Guard Fishing Vessel Transmitting Terminal (FVTT) | Northwest and Alaska Fisheries Center Research Data Logger (TI SILENT 700) | National Weather Service Shipboard Environmental Data Acquisition System (SEAS) |
|---|---|---|---|
| PRO | • Meets Coast Guard requirements for location data<br>• Observer safety capability<br>• Meets much of the data collection requirements for marine fisheries, quota management, and law enforcement in some regions<br>• Inexpensive | • Could be used to log all observer data onto cassette tapes<br>• Saves keypunching and one verification step back at regional center<br>• Data quality improved over clipboard and pencil<br>• Inexpensive | • Could be used to log all observer data onto cassette tapes<br>• Saves keypunching and one verification step back at regional center<br>• Data quality improved over clipboard and pencil<br>• Self-contaned real-time data relay (Marisat or Goes) |
| CON | • Tells where data relayed, not where species caught or where noncompliance event occurred<br>• Argos data relay capacity can be exceeded in Alaska fisheries<br>• Amount of input data too restrictive for some regions<br>• Dials can get clogged from salt and gurry buildup<br>• Awkward for observer to carry | • Observer must still use clipboard in real time and input data later during lulls<br>• For many fisheries the observer workday already exceeds 8 hours just with clipboard recording<br>• No self-contained location or data relay capability<br>• Not packaged for portability or rough handling | • Observer must still use clipboard in real time and input data later during lulls<br>• For many fisheries the observer workday already exceeds 8 hours just with clipboard recording<br>• No self-contained location or data relay capability<br>• Not packaged for portability or rough handling<br>• Relatively expensive |

developed in the work areas by one man calling out inputs as he measures them and another man entering them into the SILENT 700 Dual cassette recorders internal to the SILENT 700 allow storage for easy transport in cassette form Data are then immediately available for research without extensive interim steps Again, this demonstrates the utility, but some adaptation will have to be made to allow use by a single observer

The SEAS terminal concept under development by the Weather Service has been similarly demonstrated in shipboard use [Ref 2] No serious attempt has yet been made to make it easily portable. Later versions are to include continuous position location capability

In addition, many commercial hand-held data terminals are available with alphanumeric input capability, one to four lines of display, recall and edit capability, and interface buses for programmable read-only memories (PROMs), cassette and disk recorders, radio transfer, etc These terminals range in cost between $400 and $2,000 and are readily adaptable for the data collection requirements of the NMFS and NWS

From these starting points, we generated the development progression shown in Figure 4 This progression assumes that it is appropriate to split the responsibility for the two functions of the present Coast Guard terminal into two portions one the Coast Guard responsibility and the second the Marine Fisheries Service responsibility In step one, the Coast Guard could initially operate its terminal unattended on as many permit vessels as is practical in order to keep track of vessel traffic and provide assessment of permit-area compliance The fisheries portion in step one would change to a small portable hand-held unit (possibly an existing unit), which can be carried easily by the observer from vessel to vessel and which inputs and formats compliance and quota management data for transfer back to fisheries authorities via the in-place Coast Guard unit. This eliminates the present problem of observers carrying bulky terminals In addition, if the dial system is left on the Coast Guard system, then it acts as a backup in case the smaller terminal is "accidentally" destroyed or dropped overboard These are easy adaptations that can be quickly accomplished to be of service during the coming winter fishing season

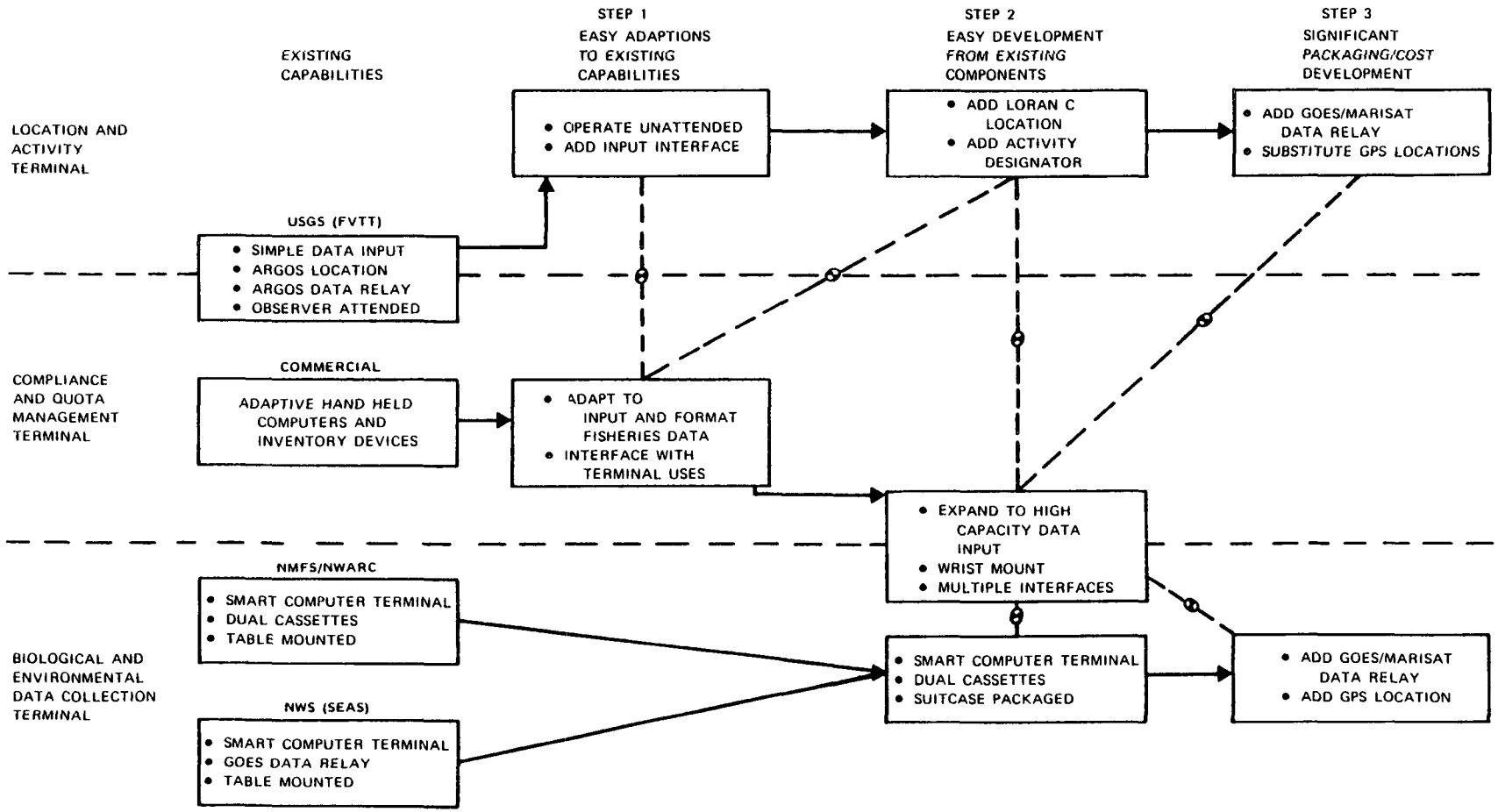



**FIGURE 4**
**POTENTIAL DEVELOPMENTAL PROGRESSION**

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own location, data relay, and even hard copy printing capability and yet remain suitcase portable This portable suitcase capability appears to be most appropriate as a NMFS, NWS, and NASA joint development

The three development steps shown in Figure 4 represent differing investment risks In our opinion the first step has no risk, the second step has a small risk, but the packaging problem inherent in the third step could provide a considerable risk under today's technology We stress today's technology since 2 years ago, the second step would have been a high risk

## E ACHIEVEMENT OF BENEFITS IN STEPS

The progression in benefit achievement assumed by following the proposed steps is shown in Figure 5 The existing Coast Guard terminal capability satisfies most of the Coast Guard needs and many of the fisheries law enforcement and quota management needs It probably cannot be efficiently used in the Alaska region during high density observer periods and continues to provide a portability problem Step 1 adds some capability but primarily sets the stage for the later steps No accumulation of benefits in the detailed biological and environmental data collection is shown from present or step 1 options, since lack of portability prevents observer use of this capability The big step in capability comes from achieving step 2, and step 3 only ties up the remaining loose ends.

## F DATA TRANSFER, PROCESSING, STORAGE, AND ACCESS

The data system downstream of the shipboard terminals was also evaluated. For most situations, the transfer process through satellites appears most practical The progression in increased capability from the low earth orbit TIROS and NOSS systems to the geostationary GOES and MARISAT systems will come naturally as a function of demand versus cost The single-sideband radio option has some appeal, but the relatively high power requirement on board the vessel makes it difficult to implement without utilizing vessel power The need to license operators makes it impractical for some regions It is possible, however, that in the Pacific Island region where obsevers may

| | USGC | MARINE FISHERIES SERVICE | | | | | | WEATHER SERVICE | |
|---|---|---|---|---|---|---|---|---|---|
| | LAW ENFORCEMENT | OBSERVER PROGRAM | LAW ENFORCEMENT | QUOTA MANAGEMENT | FISHERIES DEVELOPMENT | STOCK ASSESSMENT | BIOLOGICAL RESEARCH | OPERATIONAL FORECASTING | ENVIRONMENTAL RESEARCH |
| **LOCATION & ACTIVITY TERMINALS** | | | | | | | | | |
| RENDEZVOUS LOGISTICS LOCATIONS | ● | | | | | | | | |
| LOCATION COMPLIANCE (LOCATION AND ACTIVITY INDICATION) | 1 | | 1/2 | 1/2 | | | | | |
| EVENT ORIENTED LOCATION RECORDS | | | | 2 | 2 | 2 | 2 | 2 | 2 |
| INTERROGATABLE EVENT ORIENTED LOCATIONS AND OBSERVER SAFETY | | 3 | | | | 3 | 3 | | 3 |
| **COMPLIANCE AND QUOTA MANAGEMENT TERMINALS** | | | | | | | | | |
| GEAR/TECHNIQUE COMPLIANCE | | | ● | | | | | | |
| NEAR QUOTA SPECIES MANAGEMENT | | | ● | ● | | | | | |
| RESTRICTED SPECIES DEPOSITION | | | ● | ● | | 1/2 | | | |
| SYNOPTIC WEATHER SEA STATE DATA INPUTS | | | | | | | | 3 | |
| DIRECT DIGITAL DATA COLLECTION AT WORK STATION | | | | 2 | 2 | 2 | 2 | ● | 2 |
| EASY PORTABILITY (HAND HELD OR WRIST MOUNTED) | | 1/2 | | | | | | | |
| **BIOLOGICAL AND ENVIRONMENTAL DATA TERMINAL** | | | | | | | | | |
| DETAIL SPECIES CATCH DATA DIGITALIZATION ON VESSEL | | | | 2/3 | 2/3 | 2/3 | 2/3 | | |
| DETAIL GEAR AND TECHNIQUE DESCRIPTIONS DIGITIZED ON VESSEL | | | | | 2/3 | 2/3 | 2/3 | | |
| DETAILED WEATHER AND SEA STATE DATA DIGITIZED ON VESSEL | | | | | 2/3 | 2/3 | 2/3 | | 2 |
| SUITCASE PORTABILITY | | 1/2 | | | | | | | |

N A ● STEP 1 (1) STEP 2 (2) STEP 3 (3)

**FIGURE 5**
**TRANSLATING TERMINAL DEVELOPMENTS INTO ACHIEVEMENT OF BENEFITS**

have to go out for 6 to 9 months, a ham radio capability would be both practical and useful in retaining the observer's perspective

The data processing and storage functions appear to be best split into two parts The near-real-time data are still best implemented in the existing EMIS system operated jointly by the Coast Guard and the fisheries specifically for the enforcement function Biological data are best stored regionally, since that is where they are primarily used. Most regions either already use such a data storage facility for this purpose or are evaluating suitable alternatives. We believe that most alternatives under consideration in the regions are not cost effective Memory storage capacity is generally used as a sizer for the computer capability For this data-cataloging and library-accessing use, the computational power of the computer is not a driver Simple microprocessor networking concepts tied to floppy disk systems could handle all of the data efficiently at low cost Profit-motivated environmental forecast companies use this kind of technique for their data storage, but the government tends to use the latest concepts, whether they are needed or not

## G COSTS AND RECOMMENDATIONS

Comparative costs for the three-step development of the three terminal types are shown in Table 3 The engineering costs quoted include system design and assembly, in-shop demonstration, and enough descriptive specifications to support a purchase request for multiple buys from manufacturers [1] The costs do not include field testing support The unit costs represent estimates of the manufacturer's price for an initial purchase of 500 units or more or for units built on an existing assembly line If the manufacturer is asked to develop the unit from scratch and use the applicable military specifications, then unit costs of 2 to 10 times those shown might appear (for example Navy LORAN C units vs commercial units of equivalent sensitivity) All these costs appear to be within reasonable developmental budgets In fact, the third step--the suitcase-packaged, Biological and Environmental Data

[1]SPC is not a manufacturer but does hardware prototyping for research

## TABLE 3

## COMPARATIVE TERMINAL COSTS

| | STEP 1 | | STEP 2 | | STEP 3 | |
|---|---|---|---|---|---|---|
| | Engineering | Unit Cost | Engineering | Unit Cost | Engineering | Unit Cost |
| Location and Activity Terminal | $10 000 | $2 500 to $3 500 | $50 000 | $5 000 to $6 000 | $100 000 | $7 000 to $12 000 |
| Message Cost | | $8 20/platform/ day | | $8 20/platform/ day | | $6/minute |
| Compliance and Quota Management Terminal | $30 000 | $400 to $1 000 | $50 000 | $500 to $2 000 | | |
| Biological and Environmental Data Terminal | | | $50 000 to $100 000 | $9 000 | $100 000 to $200 000 | $12 000 |
| Accumulated Software Development | $25 000 to $50 000 per region | | $50 000 to $100 000 per region | | $50 000 to $100 000 in general plus $50 000 to $100 000 per region | |

Terminal is a factor of 2 less than the SEAS estimates for equivalent but table-mounted terminal capability Our price is for major off-the-shelf components packaged appropriately and tied together by a system-unique interface base (which meets NWS needs, but not their system specifications)

These cost perspectives lead to specific developmental recommendations for the three terminal types These recommendations are summarized in Table 4 The first step Location and Activity Terminal could and should be implemented through the ongoing Coast Guard terminal development effort Since the step 2 and step 3 extensions of this first-level capability allow greater application of high-technology space electronics, it appears appropriate that the Coast Guard and NASA combine forces to see to it that practical civilian terminals evolve from present military and NASA investments in the general area

The step 1 Compliance and Quota Management Terminal is the observer adjunct to the Coast Guard terminal Since existing commercial units can probably be adapted to fit the ongoing needs, these terminal development costs should probably come from operational fisheries funding The wrist-mounted extension of this capability requires more of a design study, but it is still an application of existing commercial technology Joint funding by NMFS and NWS appears appropriate due to its wide application for many programs in both organizations The Biological and Environmental Data Terminals make use of more advanced technology in order to achieve the packaging constraints in portability and to move towards satellite relay and location implementation NASA could thus appropriately create this focus for a joint NASA and NOAA funding.

Schedules for these developments are included in Chapter VI Essentially, even the most complex design and development study for step 3 implementations can be done within 9 months from an approval "go ahead" date The pre-procurement process within the Government for multiple buys can vary from 1 to 6 months, but deliveries could proceed 3 to 6 months after that if the design and development phases are appropriately done In somewhat over a year from approval, the system shown in Figure 3 could become a reality

TABLE 4

RECOMMENDED IMPLEMENTATION

| | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| Location and Activity Terminal | USCG Implementation | Joint USCG and NASA Development with Planned Modular Evolution | |
| Compliance and Quota Management Terminal | MNFS Law Enforcement and Quota Management Implementation | Joint NMFS and NWS Development | |
| Biological and Environmental Data Terminal | | Joint NMFS, NWS and NASA Development with Planned Modular Evolution | |

## II FISHERIES OBSERVER PROGRAMS--BACKGROUND

The two major fisheries observer programs investigated in this study were the program observing foreign fishing activities in our 200-mile Fisheries Conservation Zone (FCZ) and the program observing mammal protection practices of domestic fisheries in the Interamerican Tropical Tuna Commission (IATTC) jurisdiction The first of these evolved from The Fisheries Conservation and Management Act of 1976 and the second from the Mammal Protection Act of 1972 Both programs are administered by the National Marine Fisheries Service The broad national objectives of the foreign fisheries observer program are "the collection of data that describe the size and species composition of the foreign catch and the prevention of violations of the foreign fishing regulations." The objectives of the IATTC-related mammal observer program are to collect "biological information for the purposes of increasing and maintaining the number of animals within species and the populations of marine mammals at the optimum carrying capacity of the habitat" and to prevent violations of marine mammal regulations.[1]

### A. FISHERIES AND REGIONS COVERED IN PROGRAMS

The regions covered in the observer programs are very broad (see Figs 6 and 7) The observer program in the Northeast region primarily covers the Atlantic groundfish and squid fisheries The Southeast region program covers the longline fisheries in the Gulf of Mexico, the Caribbean, and the Atlantic all the way up to New England The Northwest region has three major areas the Bering Sea and Aleutian Islands, the Gulf of

[1]Internal National Marine Fisheries Service documents

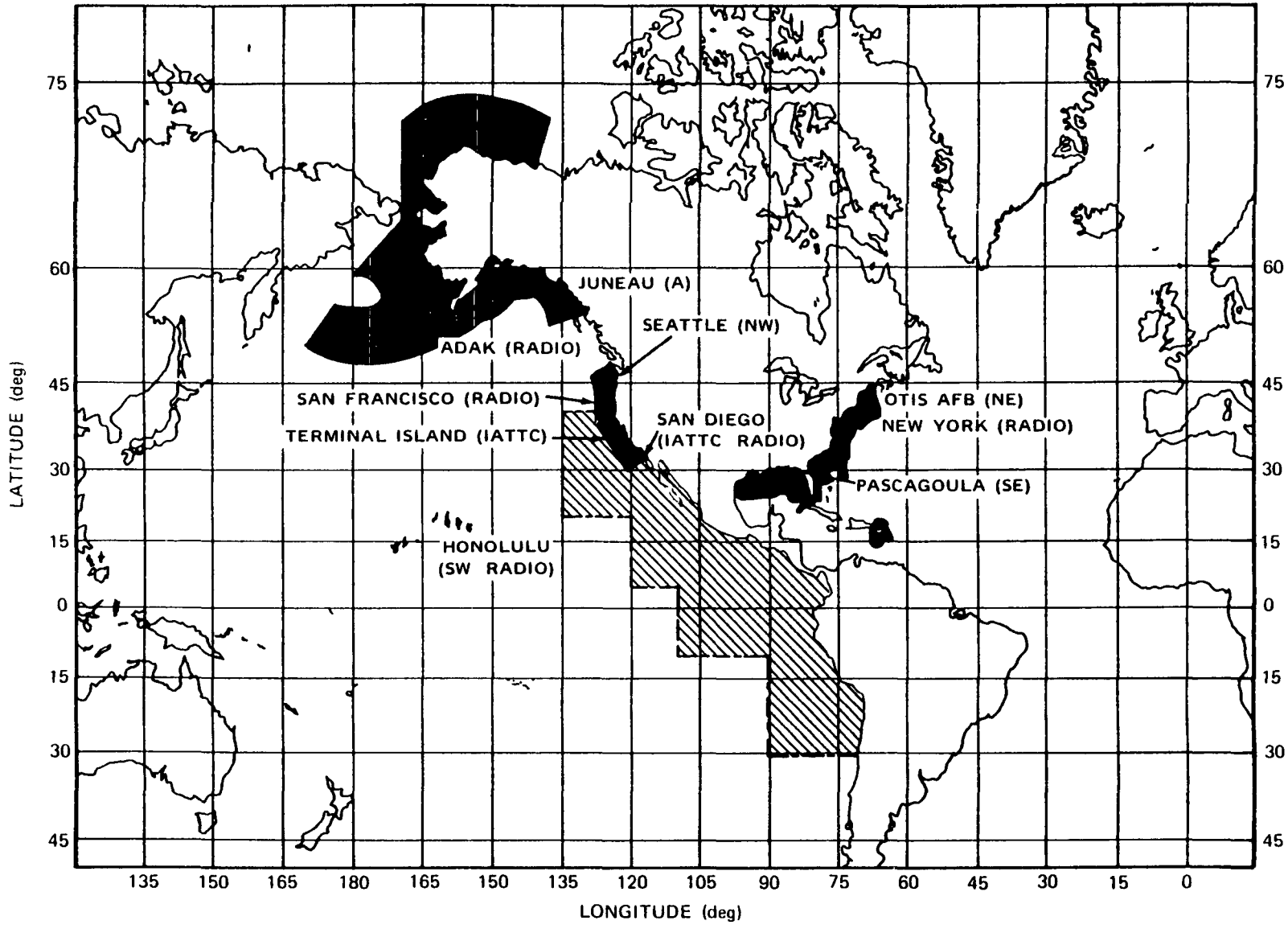


**FIGURE 6**
**U S FISHERIES OBSERVER PROGRAM AREAS ON THE NORTH AMERICAN COASTS**

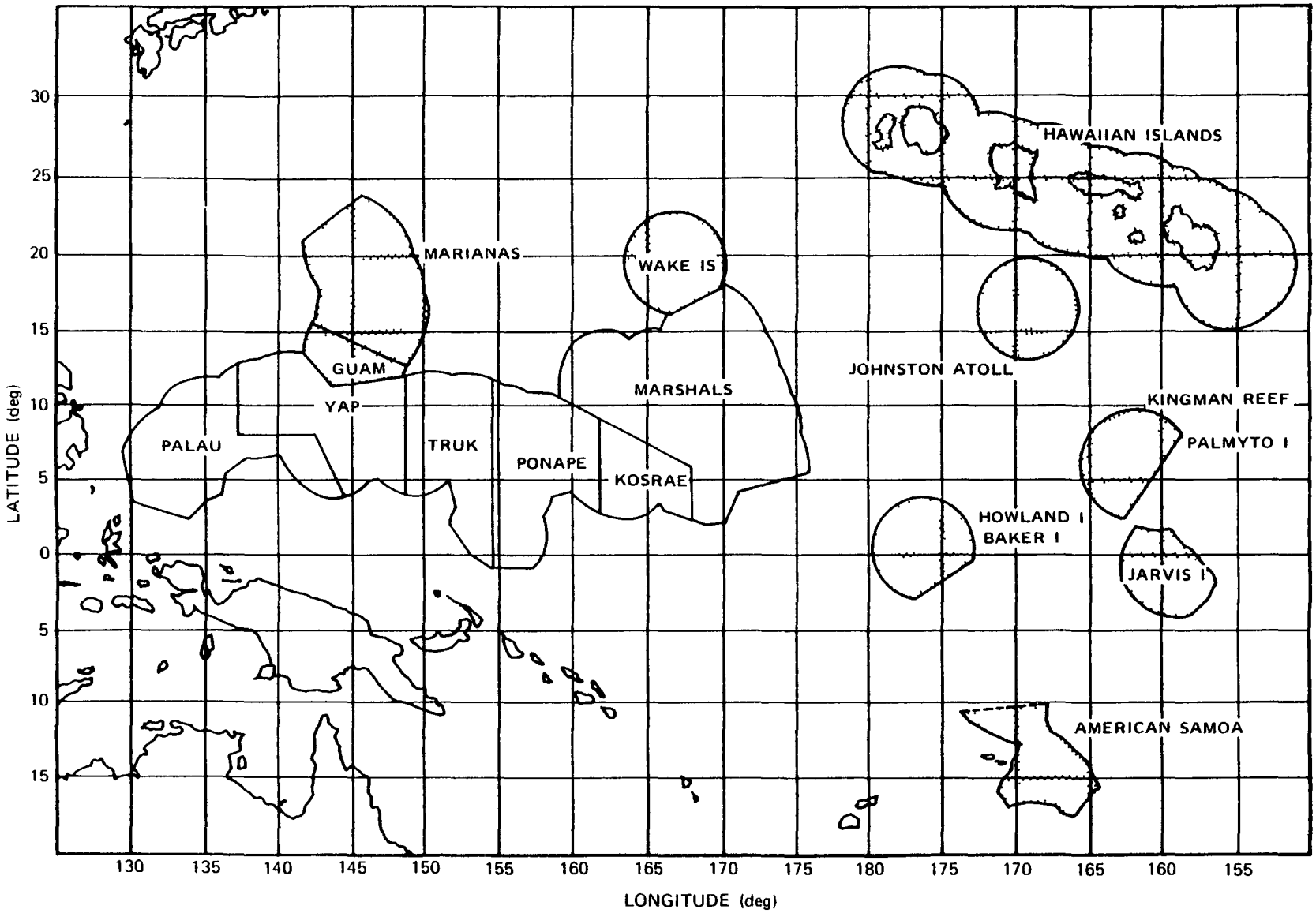


**FIGURE 7**
**U S FISHERIES OBSERVER PROGRAM AREA IN THE PACIFIC ISLAND FCZs**

Alaska, and the Washington/Oregon/California coast The programs primarily deal with groundfish fisheries, although some longline, squid, snail, and crab fisheries also have allocations The Southwest region has observers on the seamount groundfish fisheries, in billfish and shark longlining, and under consideration for the spiny lobster and coral fisheries Some of the species that are either quota managed or actively protected are listed in Table 5 Most of the regions have had some domestic observer experience, but this has been strictly on a voluntary basis Note the placement of Coast Guard radio station capabilities to support observer communications and the locations of the various offices managing the program or utilizing the data from the program in Figure 6

The mammal protection observers support the Eastern Tropical Pacific region under IATTC jurisdiction The radio station in San Diego services these observers. It is not Coast Guard operated as in the other regions

Within all of these regions, there are further areal limitations due to specific allocations to a particular foreign fishery or to restrictions on the types of gear and fishing methodology allowed. Because of these complex combinations of fish and area allocations, keeping track of individual ships and determining whether their activities are proper to their allocations is a challenging job Most of the regions only keep track randomly through Coast Guard vessel patrols or sightings by observers or U.S. fishermen, etc The Northwest region supplements this with regular patrols by aircraft equipped with radar and other surveillance capability

## B MAJOR STUDY PARTICIPANTS AND DIFFERENCES IN REGIONAL EMPHASIS

The various organizational elements visited or contacted in this study are listed in Table 6 This effort was funded jointly by NASA's Office of Space and Terrestrial Applications, the NMFS, and National Weather Service, the work was coordinated with their representatives at Goddard Space Flight Center, the National Fisheries Engineering Laboratory, and the Environmental Data Collection Terminal portion of the National Weather Service

# TABLE 5

## FISHERIES IN FOREIGN OBSERVER PROGRAM

| | NE | SE | SW | NW | Alaska |
|---|---|---|---|---|---|
| Alfonsin (201) | | | Q | | |
| Armorhead (200) | | | Q | | |
| Billfish | | | | | |
| Blue Marlin (260) | | | Q | | |
| Striped Marlin (261) | | | Q | | |
| Swordfish (264) | | | Q | | |
| Sailfish (252) | | R | Q | | |
| Black Marlin (253) | | | Q | | |
| Butterfish (212) | (Q) | | | | |
| Cod | | | | | |
| Atlantic (101) | | | | | |
| Pacific (702) | | | | | Q |
| Coral (682) | | | (Q) | | |
| Dolphin (Mahimahi) | | | | | |
| Pacific (237) | | | Q | | |
| Atlantic (237) | | | | | |
| Pompano (230) | | | Q | | |
| Flounder | | | | | |
| Greenland Turbot (118) | | | | (Q) | Q |
| Arrowtooth (721) | | | | (Q) | Q |
| Yellowfin Sole (720) | | | | (Q) | Q |
| Hake | | | | | |
| Silver (104) | Q | | | | |
| Red (105) | Q | | | | |
| Pacific (704) | | | | Q | |
| Halibut | | | | | |
| Pacific (722) | | | | R | |
| Herring | | | | | |
| Pacific (209) | | | | | Q |
| River (309) | (Q) | | | | |
| Blueback (334) | (Q) | | | | |
| King Crab | | | | | |

| | NE | SE | SW | NW | Alaska |
|---|---|---|---|---|---|
| Mackerel | | | | | |
| Atlantic (204) | Q | | | | |
| Atka (207) | | | | | Q |
| Jack (208) | | | | Q | |
| Mammals | R | R | | R | R |
| Pollock | | | | | |
| Walleye & Alaska (701) | | | | | Q |
| Rockfish | | | | | |
| Pacific Ocean Perch (780) | | | | (Q) | Q |
| Other (849) | | | | (Q) | Q |
| Sablefish (703) | | | | (Q) | Q |
| Salmon | | | | | |
| Pacific (210) | | | | R | R |
| Sharks | | | | | |
| Dogfish (459) | | | (Q) | | |
| Atlantic Sharks (469) | R | | | | |
| Requiem (263) | | (Q) | | | |
| Thresher (265) | | (Q) | | | |
| Mackerel (266) | | (Q) | | | |
| Hammerhead (267) | | (Q) | | | |
| Snails (673) | | | | | Q |
| Spiny Lobster (698) | | (Q) | | | |
| Squid (502 504 509) | Q | | | | Q |
| Steelhead Trout (211) | | | | R | R |
| Tanner Crab (610 509) | | | | | Q |
| Tuna | | Q | Q | | |
| Wahoo | | | | | |
| Pacific (255) | | | Q | | |
| Other Finfish (499) | (Q) | | | | |

Q Quota R Restricted ( ) Inactive

# TABLE 6

## FUNCTIONAL ACTIVITIES CONTACTED ON A REGIONAL BASIS

| | Management & Planning | Observer Management | Observers | Law Enforcement | Resources Management | Fisheries Development | Biological Research | Data Systems | Environmental Sensors |
|---|---|---|---|---|---|---|---|---|---|
| National Marine Fisheries Service | | | | | | | | | |
| Headquarters Washington D C | V | V | | | | | V | | |
| Northwest and Alaska Region | | | | | | | | | |
| Northwest and Alaska Fisheries Center Seattle Wash | | V | | | | | V | V | |
| Northwest Regional Office Seattle Washington | | | | V | V | V | | | |
| Milar Freeman Research Vessel Seattle Washington | | | | | | | V | | |
| Alaska Regional Office Juneau Alaska | | | | V | V | V | V | | |
| Northeast Region | | | | | | | | | |
| Northeast Regional Center Otis Air Force Base Mass | | V | | V | | | | | |
| Woods Hole Laboratory Woods Hole Massachusetts | | | | | | | V | | |
| Northeast Regional Office Glouster Massachusetts | | | | | P | P | | P | |
| Southeast Region | | | | | | | | | |
| Pascagoula Laboratory Pascagoula Mississippi | | V | V | | | | | | |
| National Fisheries Engineering Laboratory NSTL Station Mississippi | V | | | | | | | | |
| Southeast Regional Center Miami Florida | | | | | | | | P | |
| Southwest Region | | | | | | | | | |
| Honolulu Laboratory Honolulu Hawaii | | V | | V | | | V | V | |
| Southwest Regional Office Terminal Island California | | | | V | | | | | |
| Interamerican Tropical Tuna Commission | | | | | | | | | |
| Southwest Regional Office Terminal Island California | | V | | V | | | | | |
| Southwest Fisheries Center La Jolla California | | | | | | | P | | |
| National Weather Service | | | | | | | | | |
| Headquarters Silver Spring Maryland | V | | | | | | | | V |
| United States Coast Guard | | | | | | | | | |
| Headquarters Washington D C | | | | V | | | | | |
| Oceanographic Unit Washington D C | | | | | | | | V | |
| Thirteenth District Seattle Washington | | | | V | | | | | |
| Seventeenth District Juneau Alaska | | | | V | | | | | |
| National Aeronautics and Space Administration | | | | | | | | | |
| Goddard Space Flight Center Greenbelt Maryland | V | | | | | | | V | |

Note V Visited P Phoned

In addition, considerable coordination was established with a parallel study within NMFS assessing the value of the foreign observer programs in each of the regions

Study participants visited the observer program managers at fisheries headquarters and at each of the regions with specified responsibilities In one area, an active observer was also interviewed, and in some of the regions members of the program management team with observer experiences were interviewed. Visits were also made to the four other classes of Government users of observer data--law enforcement (compliance decisions), resource management (quota close down decisions), technology development (education of domestic fisheries), and biological research (primarily improving assessment techniques--to assess what portions were actually used and what formats would aid their use of these data Data system personnel were visited to evaluate present capabilities and system interfaces in each region The Weather Service facility developing shipboard environmental sensors was visited to assess accuracy and sizing constraints The Coast Guard was visited to review their ongoing dial-on-a-suitcase fisheries-observer data collection terminal development, this terminal was developed by the Coast Guard from off-the-shelf Government stock components, based on the suggestion in our original proposal [Ref. 3] Personnel in the Coast Guard District Offices interfacing with the observer program were also visited to obtain aditional data operational constraints Discussions and observations from these visits are documented in a separately bound Interim Report [Ref 4]

The Northwest and Alaska region had the largest observer activity in 1979, with 138 observer cruises in the Alaska region and 25 in the Washington-to-California region The program is managed out of the Northwest and Alaska Fisheries Center in Seattle and primarily used observers contracted from the University of Washington and Oregon State University Only a small fraction of the observers made more than one trip. The program is managed by personnel from the biological research area and emphasizes extensive biological data collection Observers report weekly, using

Morse-coded messages, through Coast Guard radio stations at Kodiak and San Francisco This information is telexed to Juneau and Seattle for distribution to the proper authorities

The Northeast region observer program is currently involved with the squid and hake fisheries only The program is managed out of an office at Otis Air Force Base in Massachusetts, which also has a Coast Guard unit Sixteen part-time permanent observers are presently in the program, they average about 20 percent coverage, as in all of the programs Law enforcement personnel from NMFS provide program management, which results in considerably more attention to the compliance side of the two program objectives originally stated The Northeast observers are not enforcement officers, but they are encouraged to take an active role in warning vessel personnel of inappropriate actions Observer placement leans towards those vessels with a past history of infractions or toward those nearing their quotas of target species or of incidental-catch species

The Southeast region presently observes only on the Japanese longline fishery vessels These vessels fish for tuna and have fairly severe restrictions on the handling of billfish and sharks caught incidentally Longline sets take from 11 to 20 hours Observer Program management is biologically oriented, and the observers are strictly prohibited from making vocal note of infractions witnessed A domestic observer program involved with the protection of sea turtles is also managed in this region and has somewhat similar interests and requirements

The Southwest region program deals with the Hawaiian Islands and the U S Pacific Island protectorates shown in Figure 7 The Marianas FCZ is also a possible region that might be U S managed The diverse areas covered in this region make logistics a problem Coast Guard cutters and radio stations are situated only at Hawaii, Wake Island, Guam, and American Samoa Observers must be flown to the nearest point where the foreign vessel can pick them up Only two observer cruises have been held so far In one of these, the observer was flown to Japan and returned from Japan after staying on board during the entire cruise Both of these observer cruises were involved with the seamount fisheries, which specialize in two fish species

considered a delicacy in Japan The Pacific billfish and shark fishery has recently been opened, but how many of the over a thousand applicants will actually use the fishery is not yet known This could saturate the program resources even at the 20-percent coverage level The spiny lobster and coral fisheries are also under consideration for opening to foreign fisheries

In all of the regions, there are related data collected by the states from domestic fisheries on entry to port These data are of variable quality, but there is some interest in making such data available in the same format or a compatible format The Southeast already archives some of this state data (three states only) in the same computer system, the western states are presently setting up a joint system with limited support from the NMFS Sample data sheets and description of the data systems in these efforts were collected for comparison Incorporation of this information into the concepts described below would not significantly impact upon them

The mammal observer program emphasizes biological data collection, but the information can be used to shut down the tuna fishery if mammal kill quotas are exceeded This program has 83 full-time observers operating to the similar 20-percent coverage goal A single radio station is operated by the program at San Diego to support the observer reporting activities. Enforcement only takes place when the ship returns to U S port.

## III POTENTIAL BENEFITS FROM IMPROVED OR LOWER COST OBSERVER-PROGRAM-BASED BIOLOGICAL OR ENVIRONMENTAL INFORMATION

Five major areas relative to the observer program appear to provide potential for benefit to marine fisheries and National Weather Service activities. These five areas are observer safety, vessel location logistics, fisheries quota management, improved biological data, and improved environmental data Specific potentials in each of these areas are discussed below

### A OBSERVER SAFETY

Assurance of observer safety was the benefit most widely recognized in all of the foreign fishery observer regions It was also the most difficult benefit to quantify Generally, most of the fisheries personnel interviewed felt that it is only a matter of time until an observer in one of the regions experiences a situation in which some sort of self-directed violence is involved Threat situations have already been experienced in the Southwest and Northwest programs Conservation policies do tend to make fishing less efficient economically When the fisheries are operating at only a marginal profit, the volatile fisherman personality can erupt toward the individual whose presence tends to enforce compliance

The requirement in observer safety is to provide the observer with his own communication and location capability--one that is separate from the host vessel capability This equipment would essentially provide a search and rescue function in that the observer would activate the system when a threat situation appeared and the system would provide a locational reference to guide rescue operations to the vessel The threat situation may

directly involve the observer or an observer-witnessed confrontation between foreign and domestic vessels over area rights or gear damage Immediacy of action would have value, so it would be preferable to have instantaneous communication capability rather than being restricted to periodic satellite overpasses or specific radio scheduling sequences Immediate action on the part of the observer would provide the maximum time for response by Coast Guard or other potential rescue operations Location within 2 km would be very helpful and location to within 0 5 km would be preferred by some The distance to the nearest rescue vessel and the speed of the vessel with the observer on board would tend to hold the obtainable locational accuracy between these two values for most situations

It is difficult to quantify the value of human life Is the death of one or more observers a year an acceptable cost? Since there are no statistics, there is little basis for inferring that such a death will happen, except that it is a risk most people would prefer not to assume Is the value the $10 to $50K paid out in life insurance or some potential reduction of insurance premiums if a communication capability were provided? Is it the cost of the rescue vessel operations and personnel cost during the rescue? If so, what is the multiplier cost to represent the number of expected false alarms answered, either due to equipment malfunction, observer misunderstanding or misinterpretation of the threat situation, or observer boredom, homesickness, or other factors Average steaming hours for rendezvous can be established for each of the observer efforts and these could be combined with estimations of expected threat events and false alarms On the other hand, the Coast Guard vessels are often out on a fixed or semifixed patrol with return to port periods relatively fixed They will be steaming on some errand or another during that full time, on surveillance or other missions, with occasional boardings How much additional fuel or other expendables might be spent on this operation beyond that which would have spent anyway is difficult to quantify The cost then might be in terms of what they did not do in order to perform the rescue mission, and even that cost might be alleviated if it can be made up in future cruises

In summary, it is concluded that

- Observer safety is a real, though potential, problem
- Improved capability involves a portable capability for real-time communication of the threat and location of the vessel to within about a kilometer
- The quantitative values related to the value of lives saved and the operations cost for the rescue are not determinable at this time.
- The NMFS and the Coast Guard have shared responsibility for implementing this rescue capability

## B VESSEL LOCATION LOGISTICS

The benefits from knowledge of fishing vessel location comes from (1) monitoring compliance with areal restrictions on the fishing catch and (2) locating the vessel for rendezvous operations The need for a rendezvous may be for compliance boarding, observer transfer, injured person transfer, or search and rescue Generally, both of these logistics functions are Coast Guard responsibilities

Most foreign fisheries permits are granted for specific limited areas within a region, for specific target and incidental fisheries quotas, and for the utilization of specific gear or gear use practices. The mammal protection observer program, similarly, has areas with differing gear restrictions The first level of desirable information is thus a continuous or near continuous monitoring of the vessel location as it goes in and out of the FCZs, the more restrictive assigned fishing areas, and the areas of differing gear restrictions within the assigned areas In addition, it would be helpful to have an indication of the specific activity being engaged in at the location time It is important to know whether the vessel is fishing or just cruising between hauls or sets This might be accomplished by analyzing velocity differences inferred from the location data or by measuring lateral or angular inertial references on board the vessel to infer fishing activity from velocity and/or pitch and roll differences

The benefit from this type of monitoring is also difficult to quantify It is a deterrent to overexploitation of fisheries resources Loss

of a fisheries resource can involve millions or even billions of dollars, depending on the fishery and the time span of the loss estimate Presently, in the Northwest region, which has the largest foreign fishery activity, this location service is provided by the Coast Guard The Coast Guard flies five planes with radar on systematic patrol to keep track of permit vessels and to identify non-permit activities These planes patrol the heavy activity areas and sample the other areas with sufficient density to act as a reasonable deterrent to unlawful activities Locational and inertial references on board the vessels could replace some of this aircraft-based service, providing more than an order of magnitude more density of data at a fraction of the cost

The benefit from locational information for vessel rendezvous comes potentially from reducing the time for rendezvous when threat or injured personnel situations are involved and from the reduction of steaming time (and subsequent operational costs) for all rendezvous The threat response time reduction was already discussed in an earlier section. Coast Guard services to foreign vessels with injured personnel problems are not well defined, steaming time reduction is also difficult to quantify Although some saving might be realized if the highest fuel-using velocities are used for rendezvous, typically this is not so The unplanned rendezvous activity just replaces other activities, and the total expenditures per cruise tend to be similar regardless of how many unplanned rendezvous actions are taken

In summary, we conclude that

- High-density and lower cost locational information can provide an improved capability to monitor and enforce compliance with the areal restrictions on fishing vessel activities
- Improved capability involves a portable, non-manned capability to locate the vessels to within 0 5 to 2 km at 1- to 6-hr intervals and to determine qualitatively the type of activity being pursued
- Benefits in terms of improved fisheries management cannot be quantified at this time.
- Benefits in terms of reduced steaming time are not judged, for the most part, to be real based on present Coast Guard vessel practices

- Benefits in terms of replacement of aircraft surveillance capability are considered important, but specific reductions in aircraft are difficult to quantify when there is already more demand for aircraft support in other Coast Guard programs than can be supported with existing aircraft, even if they are relieved from some fisheries specific activity Benefit has to come then from improved coverage, for which there is no experience to base quantitative dollar values
- The Coast Guard has the primary responsibility for this capability

## C QUOTA MANAGEMENT

Quota management is essentially involved with keeping a running tabulation on the total catch quantity in each species and comparing it to either the maximum sustainable yield (or optimal yield) values or to the portions of these yields assigned to the foreign fishery In addition, monitoring the size and age distribution may alter these sustainable yield estimations downward if signs of reduced stock viability are identified When quotas are not being approached, these data have no time urgency and the data can be returned manually by the observer after the cruise When quotas are being approached or sudden changes in stock viability are noted, it becomes very important to have a real-time capability to keep track of catches on the near-quota species It would also be important to have the capability to get back to the observer and vessel captains to ensure rapid shutdown of the threatened-species fisheries

An additional compliance problem related to quota management is the management of gear utilization In trawling, the size of the net holes may be restricted to allow escape of an appropriate quantity of young In longlining, the size and number of hooks may be limited, and the mechanism for removing hooks from restricted fish, which must be returned to the waters, is usually prescribed It is sometimes important for observers to report this type of quota management compliance in order that enforcement officers can have the opportunity to board the vessel while the restricted gear is still being utilized and before the restricted species that were retained can be devoured or made into fish meal, or in order to halt flagrant gaffing or hook yanking on restricted species

The capability to support this type of activity is a simple data input system for approximately five species (only those nearing quota need to be reported in real time) plus some special inputs for size and age distribution measures of stock viability or for gear usage and catch practices This limited information would then be transferred at least daily to support quota management on near-quota species and to support catch practice compliance

Benefits are again hard to quantify Since quotas are not perfectly determined, it is difficult to quantify the effect of exceeding the quota Because so many environmental factors affect stock viability, next year's stock may or may not be directly related to the quotas It is believed, though, that species managed by quotas, especially when supplemented with additional information on stock viability (size and age distribution), are less likely to suffer from overfishing How much of the potential loss of future fishing income should be assigned to the possibility of inadequate quota-management policies and how much to environmental vagrancies is difficult to determine

In summary, it is concluded that

- Without some form of species quota management and catch technique restrictions, one or more species over the next few years are likely to drop out of the commercially viable status
- Improved capability involves a portable data-input and data-transfer mechanism for species data on 5 to 10 species, for age and size distributions, and for catch technique compliance
- Benefits to the foreign fisheries come from retention of a continuing stock for exploitation
- Benefits to the domestic economy come from preservation of species, in case domestic demand for those species increases Possible negative benefits come if removal of the fish eliminates a food level for the species the domestic fisheries are interested in or if removal allows more territory for growth in fisheries species of interest to domestic fisheries
- The Law Enforcement and Quota Management portions of the NMFS have the primary responsibility for this capability

## D IMPROVED BIOLOGICAL DATA

Improvement in biological data comes both from improved quality of the data and from reduction in the cost of obtaining the data Data collection terminals do not affect the accuracy of the specific measurement technique for determining size, weight, age, and so on, but its design and operation methodology can have an impact on the density of transcribing and transforming errors and can reduce the total manpower costs necessary to put the data into computer-analysis-compatible formats

Presently, observers record all data on special forms by filling in blanks Observers also prepare limited summations of species catch information either on the forms or on radio message worksheets to aid reporting The majority of the data is hand-carried back to the observer program office Portions or all of the data are verified through careful examination by program office personnel with the observer in attendance This verified data set is sent out for keypunching, re-verified on return, and is then ready for digital storage or use in computer analysis efforts Potential error sources in the train of events come from the initial recording process, from damage to the record sheet from gurry or rain, from later interpretation of poor handwriting, and from keypunching errors The verification steps reduce this problem but do not remove it Provision of a mechanism for digitizing the data directly during the initial data-taking stage eliminates the need for the keypunching stage (and subsequent keypunching verification) completely, while still allowing verification procedures Done correctly, the keyboard data input capability would have immediate display of the input data, would allow recall of any portion of the data for editing or updating (e g , after better identification of the species), and would automatically provide summations and averages All data would be recallable and readable with no handwriting interpretation problems and no arithmetic errors The cost of obtaining the data would also be reduced Less observer time would be needed, since some of the general data would only need to be taken once and, for many repetitive measurements, the button tapping time is potentially shorter than the handwriting time

Quantifying these benefits is also difficult Improvements in data quality translate into improved assessments and research in ways not easily quantifiable in dollars Savings due to reduction of keypunching and verification time can be quantified An example might be taken from the Northwest region. Eleven different types of forms were used in this region, and data on about 163 cruises were obtained last year If one conservatively estimates 30 days of fishing per cruise and one haul or set per day fished, then more than 200 forms could be generated per cruise This is of the order of 15,000 forms for that year Once a keypunch operator has made up a program card, these forms can be punched out at 1 or 2 minutes per form depending on the handwriting difficulty Verification can take 5 to 10 minutes a form depending on whether errors are found or not Assuming $10 per hour for keypunching and $15 per hour for verification (including 100 percent overhead), then the cost per year would run $20,000 to $50,000 per year for digitizing last year's observer forms in the Northwest region. With considerably less activity in the other regions and with a slight allowance for errors, $50,000 per year could easily be justified as savings in keypunching and verification efforts assuming last year's form productivity and full digitization of all forms This is especially true if the keypunching and verification is less efficient than the idealized numbers, used here, or if non-professional keypunchers, like observers and biologists, do the punching, as is presently done in some regions Less conservative estimates could generate numbers twice to ten times this amount depending on assumptions of actual data readability, if data is not readable, this extends keypunching costs rapidly Even so, this puts the degree of savings in the $100K per year class rather than implying savings in the millions Such a benefit is interesting, but it is not an overwhelming justification for the on board digitization effort

The research effort in the Northwest region already utilizes SILENT 700 smart terminals for on-ship data logging. People are paired, one measuring, one recording Such pairing is not practical for observers, but technology is available to wrist mount the equivalent data input capability on the person doing the measuring so that he can record as he goes even more simply than by utilizing a pencil and clipboard The Northwest region

researchers have found the logger concept to be very cost effective in accuracy, researcher time saving, and quickness in getting the data in a form to do significant analysis There is no reason these techniques cannot be adapted for a one-man operation

Merging and blending of the working data with automated or manual location, environmental, or other data is also important, as is editing the data and formatting a selected portion of the data for real-time transfer for law enforcement and quota management needs A suitcase-packaged equivalent of the Northwest region data logger would provide this additional capability

In summary, it is concluded that

- Present techniques of data recording and translation into digital form useful for computer analysis are inefficient and costly in manpower and funding
- Wrist-mounted digital data inputs could be produced that simplify the data recording process during the high catch periods while providing improved potential for better data accuracy
- A suitcase-packaged minicomputer system with appropriate display and recording capability can provide the needed additional capability to blend in data from other sources, to edit and correct data, and to prepare summations and special displays
- A semicontinuous location monitoring capability is desirable to support this effort This might be supplied by the Coast Guard location unit suggested earlier or by a separate module supplied by NMFS
- This combination of capabilities can save a considerable amount of NMFS manpower and make the data available for analysis in a more timely fashion
- The NMFS has the primary responsibility for this capability, which is shared between several data user functions

## E IMPROVED ENVIRONMENTAL DATA

Improved environmental data are of interest to both the weather service and the fisheries For the weather service, the coastal ocean areas provide important short-time precurser notice of weather expected to impact the high-population-density coastal land regions The Bering Sea and Gulf

of Alaska regions provide a longer range indication of major North American weather patterns Typically, much of our weather originates in Siberia, modulates north or south depending on the position of ocean thermal anomalies in the North Pacific, and, subsequently, are directed either east or west of the Rocky Mountains depending on this modulation The Bering Sea and Gulf of Alaska regions experience these variations prior to passage of the weather over the major land mass. Higher density environmental measurements in these coastal fisheries regions can thus provide major impact for long- and short-term forecasting capabilities

The fisheries also can benefit from the data, although only a few laboratories are presently capable of analyzing weather and sea state effects on fisheries populations Many fish species follow thermoclimes or restrict their activity to narrow bands of ocean temperature Prevailing winds and subsequent upwellings affect temperature and nutrient distributions For fisheries, like shrimp, larva stages are transported by the wind-blown surface layers Weather, sea state, and ocean chemistry are thus important parts of many species assessment activities There are too few fisheries or other research vessels to gather adequate quantities of such important data, and utilization of observers to gather such data would significantly improve the data base and, hopefully, the subsequent understanding NOAA Fisheries Service and Ocean Survey ships already furnish the weather service with much of the _in situ_ ocean temperature data used in developing new analysis concepts

The requirements for the two users are somewhat different, this fact impacts the perspective on potential benefits The weather service needs its real-time data taken and transmitted in the 20-minute period just around the four Greenwich-Mean-Time-based synoptic times daily in order that it may be inserted into the two weather forecasting computer runs made each day These location data need to be fresh and accurate or there is no benefit Other parts of the weather service and the fisheries are more research oriented and have few real-time needs It is more important to make sure the data are accurate and properly time and location tagged The benefit comes as much from knowing where and when as from knowing that an anomaly happened or a boundary or discontinuity was crossed

Again, we can offer no quantitative estimates of the specific benefits achievable There have been no sensitivity studies with weather models, to our knowledge, showing the effects of increased data density in these regions on improving forecast accuracy Reference 5 delineates an extensive study of the potential benefits from improved weather and sea state forecasts to marine fisheries and transportation and a wide variety of coastal activities The benefits from general improvement in the availability of such data on fisheries research was also addressed, including an assessment of integrated biological growth models, but such efforts are still too far from operational status to generate justifiable projection of specific dollar benefits It is fairly obvious though that the potential benefits are in the billions of dollars category if full environmental monitoring and accurate forecasting could be achieved Most of the marine industries, including the fisheries industry, participated actively in the study described in Reference 5

In summary, it is concluded that

- Significant benefits could accrue from increasing the density of in situ atmospheric and oceanic measurements taken in the coastal ocean regions of the U.S
- Potential benefits come both in improvement of national and local weather forecasting capability from real-time monitoring of dynamic processes and in terms of research directed toward improving our understanding of atmospheric and oceanic processes and our understanding of the marine biological growth processes that are modulated by these variations
- Accurate location and time tagging is particularly important to all of these data uses
- The weather service has primary responsibility for providing this capability, but the fisheries service is potentially a very important user of such data

## IV SYSTEM REQUIREMENTS FOR AN OBSERVER-PROGRAM-BASED BIOLOGICAL AND ENVIRONMENTAL INFORMATION SYSTEM

Each of the regional observer programs has requirements unique to that region Often there are peculiarities in each fishery that dictate the research and compliance data required on vessel, gear, catch statistics, and environmental status In addition, the importance and difficulty in obtaining real-time communication of law enforcement and quota management information vary This chapter briefly reviews the need for specific information and information timeliness and the operational constraints for obtaining that information Generalizations are then made as to several sets of requirements that increasingly provide the benefits discussed earlier

### A DATA TO BE COLLECTED

Some 20 types of data forms were identified that are used by the four regional foreign fisheries observer programs and the IATTC mammal protection observer activity Other forms were also identified (and collected) from other mammal protection observer programs (Southwest region), volunteer domestic NMFS observer programs (Southeast and Southwest regions), NMFS research vessels programs (Northwest region), and from local and state landing statistics used for tax purposes (Southwest and Northwest regions) The forms closely tied to this effort are listed in Table 7 The first nine listed in the table are most used and have been further compared in five groups (as indicated in the last column of Table 7) This combination is used to assess program-to-program variations in the data needed and to establish priorities in the importance of particular data elements Most of the forms provide small spaces for simple numerical (or sometimes word) fill-in of data Essay and diagrammatic information is generally limited, with some exceptions. Most forms, in addition, have a remarks or comments section at the end Many of the mammal forms require some essay response

## TABLE 7

## DATA FORMS USED IN REGIONAL OBSERVER PROGRAMS

| Form Type | Research | Observer Program | | | | Mammal | Form Comparison |
|---|---|---|---|---|---|---|---|
| | NW | NW | NE | SE | SW | IATTC | |
| Weekly Radio Report Worksheets | | X | X | | X | X | X |
| Daily Catch Summaries | | XXX | | X | X | | X |
| Daily Haul Form | | X | X | | X | | |
| Set Logs | | | | X | X | | X |
| Haul Logs | X(2) | | X | | | | |
| Size-Frequency Form/Log | X | XXX | X | X[a] | X | | X |
| Basket Composition Forms | | XX | | | X | | |
| Marine Mammal Sighting | | X | XX | X | | XX | X |
| Marine Mammal Catch | | X | X | X[a] | | | |
| Marine Mammal Set Log | | | | | | X(8p) | |
| Schoolfish and Flotsam Log | | | | | | X | |
| Maturity State Logsheet | | | X | | | | |
| Stomach Contents Form | X | | | | | | |
| Specimen Form | X | | Cetecean X | | | X | |
| Otolith or Scale Forms | | X | X | X[a] | | | |
| Fish Tagging Form | X | | | X | X | | |
| Product Recovery Rates | | X | | | | | |
| General Vessel and Trip Data | | X | X | | X | X | |
| Gear Description Forms | | | | | XX | X | |
| Fishing Vessel Sightings | | X | | | | | |

[a]Part of more general form

The eight-page Marine Mammal Set Log is almost entirely essay and diagrammatic descriptions of the sighting itself and the mammal escape and release situations at various stages in the fishing operations

In the foreign fishery observer program, the Department of Commerce (DOC) regulations require or suggest daily catch logs and weekly catch reports These reports must eventually be submitted by the observers to the NMFS Regional Office having jurisdiction over their fisheries Weekly radio reports are made to keep reasonable track of progress towards the overall fisheries quota, as well as that portion of it assigned to the particular foreign country Table 8 shows the information that the DOC regulations suggest the vessel management submit In addition, the worksheets are shown which are provided the observers to make their weekly reports (every 3 days suggested for the Southeast observers) In the Northwest, the vessel and observer data are considered identical In the Northeast, a comparison is made between vessel log and observer-generated data The Southeast, Southwest, and IATTC activities assume observer estimates only and hope eventually to compare them to vessel-furnished data This is generally difficult, since the reporting periods are usually different (7 days, Sunday through Saturday, vs 7 days, Wednesday through Tuesday) For this reason, weekly or monthly summaries often do not match It is important to note that these relatively time-important data include identifiers, effort indicators, and specific simplified catch data Compliance code messages also are often included in some regions, but these are not shown

Comparisons of the Daily Catch/Haul Summaries and Set/Haul Logs are shown in Tables 9 and 10 The logs represent a somewhat more detailed document of a more biological emphasis (compared to the summaries) in terms of how and what is done In both types of form, the standard identifying and fishing-effort data are expanded to include a considerable amount of information on how the fishing is done (fisheries technology transfer), the conditions of the environment and biological species during catch (biological modeling and yield assessment), and specific details of the catch (quota management) Some of the differences between the various forms can

# TABLE 8

## COMPARISON OF WEEKLY RADIO WORKSHEETS

| | OOC Regulations | | NW | NE | SW | SE | IATTC |
|---|---|---|---|---|---|---|---|
| | Daily Catch Log | Weekly Catch Report | Weekly Work Sheet | Weekly Catch Report | Weekly Radio Message | 3 Day Radio Messages | Radio Report Worksheet |
| Vessel - Name | X | X | | X | X | X | |
| - Code | | | X | | | X | |
| Permit Number | X | X | | X | X | | |
| - Cruise Number | | | X | | | | |
| - Call Sign | X | | | | | | |
| - Representative | | X | | | | | |
| Observer | | | | X | X | X | |
| Date | X | X | X | X | X | | X |
| Per Area | 1 | (14) | 1 | | | | |
| Area Code/Location | X | X | X | | X | X | |
| Days Fished | X | X | | | X | X | |
| Number of Hauls | | | | | X | | |
| Number of Hooks | | | | | X | | |
| Vessel Log | | | | | | | |
| Daily/Weekly Per Specie | D | W | D/W(22) | W(4) | | | |
| Name | X | | X | | | | |
| - Code | X | X | | X | | | |
| - Sample Weight | | | X | | | | |
| - Catch Weight | X | | | | | | |
| Disposition | X | | | | | | |
| Total Weight | X | X | X | X | | | |
| Daily/Weekly Total | D | | D/W | | | | |
| - Sample Weight | | | X | | | | |
| Catch Weight | X | | X | | | | |
| Observer Estimates | | | | | | | |
| Daily/Weekly Per Specie | | | | W(4) | W(3 13) | 3D | 2/W |
| Name | | | | X | X | X | |
| Code | | | | X | | | X |
| Sample Weight | | | | | | | |
| Total Weight | | | | X | X(TR) | | |
| Total Number | | | | | X(LL) | X | X |
| Disposition | | | | | | X | |
| Daily/Weekly Total | | | | | | | |
| Sample Weight | | | | | | | |
| Total Weight | | | | | | | |
| Comments | | | | | X | X | |

# TABLE 9

## COMPARISON OF DAILY CATCH/HAUL SUMMARIES

| Observer Area | NW | | | NE | SW | | SE |
|---|---|---|---|---|---|---|---|
| Form | 1 Mother Ships | 1L Long Line | 2 Stern Trawler | 77 01 | Trawler | Long Line | Long Line[a] |
| Vessel Name | | | | X | X | X | X |
| Code/ID | X | X | X | X | X | | |
| Captains Name | | | | | | | X |
| Fishery | | | | X | | | |
| Tonnage | | | | | | X | |
| Permit No | | | | X | X | X | |
| Cruise No | X | X | X | | | | |
| Report Period | X | X | X | X | X | X | X |
| Observer | | | | X | X | | |
| Days/Hours Fished | | | | X | | | |
| Observed No Hauls/Sets | | | | X | | | |
| Total No Hauls/Sets | | | | X | | X | |
| Per Vessel Haul/Set | | | | | | | |
| Vessel Type Serviced | X | | | | | | |
| No of Tows | X | | | | | | |
| Haul/Set/Tow No | X | X | X | X | | X | |
| Date | X | X | X | | X | X | |
| Time | | | | | X | X | |
| Latitude | X | X | X | | X | X | X |
| Longitude | X | X | X | | X | X | X |
| Permit Area/Octant | | | | X | X | | |
| Gear Utilized | X | X | X | | X | | |
| No of Baskets | | X | | | | | |
| No of Hooks/Basket | | X | | | | | |
| No of Hooks | | | | | | X | X |
| Average Fishing Depth | X | X | X | | X | | |
| Average Bottom Depth | | | | | X | | |
| Average Duration of Tow | X | X | X | | X | | |
| Average Speed of Tow | X | | X | | X | | |
| Direction of Tow | X | | X | | X | | |
| Surface Water Temperature | X | X | X | | X | X | |
| Fishing Depth Temperature | | | | | X | | |
| Bottom Water Temperature | X | X | X | | | | |
| Weather Code | X | X | X | | | | |
| Sea State/Code | X | X | X | | | | |
| Vessel Log Data | | | | | | | |
| Per Specie Name | | | | X(30) | | | |
| Code | | | | X | | | |
| No of Fish | | | | | | | |
| Total Weight | | | | X | | | |
| Product Code | | | | X | | | |
| Total Catch Weight | X | X | X | X | | | |
| Observer Estimates | | | | | | | |
| Per Specie Name | | | | X(30) | X(15) | X(20) | X(18) |
| Code | | | | X | | | X |
| No of Fish Caught | | | | | | X | X |
| No of Fish Rel | | | | | | | X |
| No of Fish Alive | | | | | | | X |
| Total Weight | | | | X | X | | X |
| Product Code | | | | X | | | |
| [a]Per Shark Code | | | | | | | |
| Sex | | | | | | | X |
| Length | | | | | | | X |
| Girth | | | | | | | X |
| Weight | | | | | | | X |
| Total Catch Weight | | | | X | X | | |

[a]Atlantic Billfish and Shark

# TABLE 10

## COMPARISON OF SET/HAUL LOGS

| | NW | | | | | | NE | SW | | SE | NW Research | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Form Desi ato | Basket Compositio | Incidence CH&S[a] | Summa y I c CH&S[a] | Summary L th CH&S[a] | Spec e Wt & Lnth[a] | Le gth Freque cy | | Size Frequency | Basket Composition | See Set/Haul | Length F eque cy | Specimen Form |
| Form No | 3 | 3(1) | 4 | 5 | 6 | 7 | 77 02 | | | | | |
| Vessel | | | | | | | | | | | | |
| Name | | | X | X | X | | | X | X | | | |
| Code | X | X | X | X | X | X | | | | | X | X |
| Permit No | | | | | | | | | X | | | |
| Cruise No | X | X | X | X | X | X | | X | | | X | X |
| Report Period | | | | | | | | | | | | |
| Observer (ID) | | | X | X | X | | X | | | | | |
| Date | X | X | X | X | X | X | X | X | X | | | |
| Pe Haul/Set/Tow/Sample | 3 | 3 | | | 51 | X | | | 5 | | | |
| Haul/Set/Tow/Sample No | X | X | | | X | X | X | | X | | X | X |
| Time | X | | | | | | X | | X | | | |
| Latitude | | | | | | | | X | | | | |
| Longitude | | | | | | | | X | | | | |
| Permit Area/Octant | | | | | | | | X | | | | |
| No Baskets/Sample | X | | | | | | | | X | | | |
| No Hachi | X | X | | | | | | | X | | | |
| Gross Weight | | | | | | | X | | | | | |
| Basket Weight | | | | | | | X | | | | | |
| Net Weight | | X | | | | | X | | | | X | |
| Record Code | | | | | | | | | | | X | X |
| Sampling Mechanism | | | | | | | | | | | X | X |
| Specimen No | | | | | | | | | | | | X |
| Per Specie | 27 | 5 | | | 1 | X | 21 | 1 | 19 | | | |
| Specie Name | X | X | | | | X | X | | X | | | |
| Specie Code | X | X | | | | X | X | X | | | X | X |
| Number | X | X | | | X | | | X | X | | | |
| Weight | X | X | | | X | | X | | X | | | |
| Average Weight | | X | | | | | | | | | | |
| No Measured | | X | | | X | X | X | X | | | | |
| Per Fish | | | | | | | X | 60 | | | | |
| Standard Length | | | | | | | | X | | | X | X |
| Total/Fork Length | | | | | | | | X | | | | |
| Weight | | | | | | | | X | | | | X |
| Weight Determ Code | | | | | | | | | | | | X |
| Sex | | | | | | | | X | | | | X |
| Maturity Code | | | | | | | | | | | X | X |
| Age | | | | | | | | | | | | X |
| Age Structure Code | | | | | | | | | | | | X |
| Age Determ Code | | | | | | | | | | | | X |
| Sum of Lengths | | | | | X | X | | | | | | |
| Average Length | | | | | | | | | | | | |
| Size Groups/Length Type | | | | | | 7 | | | | | X | |
| Frequency | | | | | | 7 | | | | | | |
| Viability | | X | | | | | | | | | | |
| Sex | | | | | X | X | | | | | | |
| Biological Samples | | | | | X | | X | | | | | |
| Summary of Samples | Daily | | Da ly/ 33D | Daily/ 34D | | | | | | | | |
| Per Specie | 27 | | 4 | 8 | | | | | | | | |
| Specie Name | X | | X | | | | | | | | | |
| Specie Code | X | | | | | | | | | | | |
| Number | X | | X | X | | | | | | | | |
| We ght | X | | X | | | | | | | | | |
| Average We ght | X | | | | | | | | | | | |
| Sum of Lengths | | | | X | | | | | | | | |
| Viability | | | X | | | | | | | | | |
| Remarks | X | | | | | | X | | X | | | |

[a]CH&S C ab Halibut a d Salmon

be attributed to the difference between trawler- and longline- based fishing or in mother ship operations Table 11 shows a comparison of the biological sampling forms, the data are generally similar to the data in Tables 9 and 10, but specialized for specific species, basket samples, or length/size frequency distributions A final comparison is made of marine mammal data forms in Table 12 The items in this table are also quite similar to the other comparisons, except for much more detail on individual mammal catch circumstances and disposition

In addition to this fisheries-peculiar data, the weather service would also benefit from similar (plus additional) environmental data The data types of interest to the weather service are shown in Table 13--temperature, pressure, and wind data are considered of critical importance The remaining data points are helpful but not as important to initializing the weather forecast programs This type of data is of a somewhat different class than the fisheries biological data Although accurate observer counting and weight or length measurements are important, interpretation of the biological measuring instrument is not as open to question as is that related to environmental measurements

Where and how temperatures are measured is important The fisheries often measure temperatures by throwing a bucket overboard, pulling it up full of water, and dropping a mercury thermometer in it The weather service places a calibrated device into the vessel engine water inlet (e g , the sea chest) It is questionable whether either method represents the sea surface temperature needed relative to radiative balance calculations between the sea and the air The surface air temperature, similarly, is specified for a specific height above sea level, this height varies considerably when some of the smaller vessels are riding large waves (swells) and cannot always be obtained. Pressure measurements are affected by wind, wind measurements are affected by the ship's motion The specific measurement accuracies needed and the constraints on making measurements are not important to this effort, except that the instruments and techniques presently acceptable to the weather service are not, for the most part, easy for the observer to carry from ship to ship In addition, they are not

# TABLE 11

## COMPARISON OF BIOLOGICAL SAMPLING FORMS

| Observer Area | NW (Research) | NE | SW | SE |
|---|---|---|---|---|
| Vessel Name | | X | X | X |
| Code/ID | X | X | | X |
| Fishery | | X | Long line | Long line |
| Target Specie | | | | X |
| Country | | X | | |
| Permit Number | | X | X | X |
| Captain Name | | | | X |
| Captain ID | | | | X |
| Report Period | | | X | X |
| Observer Name | | | | X |
| Observer ID | | X | | X |
| Trip Number | X | X | | |
| Set/Haul Number | X | X | X | X |
| Begin Date | X | X | X | |
| Time | X | X | X | X |
| Latitude | X | X | X | X |
| Longitude | X | X | X | X |
| Depth | X | X | | |
| End Date | X | X | X | |
| Time | X | X | X | X |
| Latitude | X | X | X | X |
| Longitude | X | X | X | X |
| Depth | X | X | | |
| Time Zone | | | X | |
| Permit Area/Octant/Zone | | X | X | X |
| Maximum Depth | | X | | |
| Minimum Depth | X | X | | |
| Bottom Type | X | | | |
| Average Speed of Tow | | X | | X |
| Direction of Tow | | | X | X |
| Duration/Distance of Tow | X | | | |
| Tow Photograph/Drawings | | X | | X |
| Gear Utilized | X | X | | |
| Length Float to Float | | | | X |
| Ganglion Length | | | | X |
| Floatline Length | X | | | X |
| Number of Baskets (Floats) | | | X | X |
| Number of Hooks/Basket (Float) | | | X | X |
| Number of Hooks | | | | X |
| Bait | | | X | X |
| Mesh Size | | X | | |

| Observer Area | NW (Research) | NE | SW | SE |
|---|---|---|---|---|
| Surface Water Temperature | X | X | | X |
| Bottom Water Temperature | X | X | | |
| Air Temperature | | | | X |
| Wind Direction | | | | X |
| Wind Speed | | | | X |
| Barametric Pressure | | | | X |
| Barametric Change | | | | X |
| Cloud Cover | | X | | |
| Sea State | | X | | |
| Wave Direction | | | | X |
| Wave Height | | | | X |
| Vessel Log Data | | | | |
| Per Specie Name | | X(23) | | |
| Code | | X | | |
| Total Weight | | X | | |
| Product Code | | X | | |
| Total Catch Weight | | X | | |
| Observer Estimates | | | | |
| Per Specie Name | X | X(34) | X(30) | |
| Code | | X | | |
| Total Number | X | | | |
| Total Weight | X | X | | |
| Product Code | | X | | |
| Per Fish Specie Code | | | | X |
| Weight | | | | X |
| Weight Code | | | | X |
| Length | | | X | X |
| Length Code | | | | X |
| Girth | | | | X |
| Hook Number Past Float | | | | X |
| Condition | | | X | X |
| Sex | | | X | X |
| Disposition | | | X | X |
| Biological Samples | | | X | X |
| Tag Number | | | | X |
| Water Temperature | | | | X |
| Time | | | | X |
| Comments | X | | X | X |
| Total Catch Number | | | | X |
| Total Catch Weight | | X | | |

# TABLE 12

# COMPARISON OF MARINE MAMMAL DATA FORMS

| | | NE | | | | SE | SW | | IATTC | | D Regs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mammal T k g R po t | Wh l S ghti g Netwo k | T tl I f F rm | C n D t Rec rd | | Mammal I c d t C t h | Mammal Ob L g | Da ly Effo t R rd | Watch S ght g Rec rd | Mammal I c d t C t h |
| Obs rv | Name | X | X | X | X | | | | | | |
| | Cod | X | | | | | X | X | | | X |
| Vess l | Name/Cod | X | | | | | | | | | |
| | Agent | X | | | | | | | | | X |
| | Age t Address | X | | | | | | | | | |
| | Age t Phone No | X | | | | | | | | | |
| | Call No | X | | | | | | | | | |
| | P rmit No | X | | | | | | | | | X |
| | MM Permit No | X | | | | | | | | | |
| | C pt i Name | X | | | | | | | | | |
| | Home Port | X | | | | | | | | | |
| | N ti lity | X | | | | | | | | | |
| Ye | | | X | X | | | X | X | X | X | X |
| Cruis No | | | | | | | | X | X | X | |
| Ha ls/Cruis | | | | | | | X | | | | |
| Sight No | | | | | | | | | | X | |
| S ies/Set No | | | | | | | X | | X(32) | X | |
| L g No | | | | | | | | | X | X | |
| Card No | | X | | | | | X(27) | | | X | |
| Date | | | X | X | X | | X | X | X | X | X |
| C e Cod | | | | | | | | | | X | |
| Sight C d | | | | | | | | | X | X | |
| Time | Start | X | X | X | X | | | X | X | X | |
| | End | | | | | | | | X | | |
| S rface Temp | | | | X | | | | | X | X | |
| Sea State | | | X | | | | | | X | X | |
| Fog/R i | | | X | X | | | | | X | X | |
| Latitude/Longitud | | X | X | X | X | | X | X | X | X | X |
| Compass Co rse | | | | | | | | | X | | |
| Vess l Speed | | | | | | | | | X | | |
| Gea Code | | X | | | | | X | | | | |
| School | Bea ing from Ship | | | | | | | | | X | |
| | Di-ectio of S i | | X | | | | | | | | |
| | Distance from Ship | | X | | | | | | | X(2) | |
| | Speed of S im | | X | | | | | | | | |
| | Time at Dista ce | | | | | | | | | X | |
| Numbe f Sighti gs | | | | | | | | | X | | |
| Source Cod | | | | | | | | | | X | |
| Total Mammal | Best | | | | | | | | | X(2) | |
| | Highest | | | | | | | | | X | |
| | Lowest | | | | | | | | | X | |
| Pe Speci s | Name | X | X | X | X | | X | X | | X(4) | |
| | Code | | | | | | X | | | X | X |
| | % f Total | | | | | | | | | X | |
| N Observer | | X | X | | | | X | X | | | X |
| No Alive nd R l sed | | — | | | | | X | | | | |
| N Killed by Crew | | | | | | | X | | | | |
| No De d i C t h | | X | | | | | X | | | | X |
| No Decomposed | | | | | | | X | | | | |
| Pe Fi h | Se | X | | | X | | | | | | |
| | Weight | X | | | X | | X | | | | |
| | L gth | X | X | X | X | | | | | | |
| | Age | X | | | | | | | | | |
| Bi ds Pre e t (N & Speci ) | | | X | | | | | X | | X | |
| Photos T k | | X | | X | | | | X | | | |
| Rema ks (Ide tifi atio Beha o tc ) | | X | X | X | | | X | X | | X | |

TABLE 13

WEATHER SERVICE SHIPBOARD ENVIRONMENTAL MEASUREMENTS NEEDS

| Must Category | Nice Category |
| --- | --- |
| • Air surface temperature (often 6 M/19 ft level) | • Dew Point (highest priority of nice category) |
| • Sea surface temperature (often cooling water intake temperature) | • Visibility |
| • Sea level pressure (stagnant pressure desired) | • Ceiling |
| • Surface wind speed and direction (altitude unspecified) | • Cloud cover |
| | • Waves (H 1/3 or distribution of heights, lengths, and directions or just sea state designator) |
| | • Swell (height, length, and direction) |
| | • 3-hour sea level pressure tendency (once per hour trend) |

presently easy for him to install on each ship without disruption to the ship On the other hand, we have surveyed a wide variety of the sensors available to measure these parameters (as part of some ocean clutter and other measurement programs SPC is carrying out for other sponsors) and feel that suitcase packaging of a set of sensors is feasible. SPC has adapted some of these sensors for its own test purposes, and the weather service is presently developing small, accurate, low-cost devices for several of the measurement types Winds, waves, and water temperature in depth are particularly demanding. For this effort, we will assume that either acceptable devices will be available through the host vessel (often the case), or that a separate portable package could be made available with an adequate array of sensors It will be further assumed that the environmental data collected on the host vessel will be made available to the observer (if it exists), the host vessel may even allow a black box to be installed that retrieves these data from onboard sensors in digital format for automatic incorporation into the fisheries and weather service data base

Some minor observations from these comparisons are

- The Northwest region appears uninterested in where, specifically, fishing efforts are carried out--perhaps because individual fishing areas are so specifically defined that it is not necessary to have further differentiation
- The Southeast region collects the largest quantity and broadest array of environmental data These data are similar to weather service interests, but will be needed if integrated biological models for individual species are to be developed
- None of the regions collects nutrient and chlorophyll data relative to catch history or searches for or locates sea surface temperature anomalies, these data should be critical to biological assessment and technology transfer, but they are relegated only to research vessels at present It is our opinion that there are sensible things observers could do along this line with minor instruction
- Regional interests in gear and technique utilization imply trawl technology transfer only in the Northeast and longline technology transfer only in the Southeast and Southwest

All of these data requirements are regional and are summarized in Table 14, which includes almost all of the kinds of data in other domestic fisheries data collection programs as well, including the state and local data bases The data have been ordered in five-column groups under each data type for convenience of display because four columns lost some of the data interrelationships and six columns began breaking up some related subgroups of data that should be kept together One or two five-column rows typically cover the repeating line items in any of the actual data forms Only the items underlined in Table 14 were common to all of the observer program regions or at least to all the trawl or longline fisheries (only trawl fisheries in the Northeast--only longline fisheries in the Southeast) These data appear to represent the critical high-use subset for quota management, biological assessment, and technology transfer These differences in general interests will be used to develop requirements priorities later, and those inputs requiring alphanumerics or that are of interest to the weather service are also marked.

## B OPERATIONAL CONSTRAINTS AND REQUIREMENTS

Operational constraints and requirements involve (1) data perishability, (2) the importance of spatial and temporal locations of catch and environmental data, (3) the formats required by the analysis tools into which the data will be inserted, (4) the existence and need to make maximum utilization of present data transfer, processing, storage and accessing systems, and (5) the environmental conditions under which any equipment for collecting and transferring data needs to operate

### 1 Temporal Perishability

Only a small portion of the data of interest is perishable in near real time Certainly, if an observer is in trouble or is witnessing a confrontation between a foreign vessel and a domestic vessel over gear destruction or fishing area rights, he needs to relay that information to proper authorities as quickly as possible Even with immediate transfer, though,

# TABLE 14

## DATA COLLECTED IN OBSERVER PROGRAMS

## (EXCEPT ESSAY AND DIAGRAMMATIC DATA)

| | | | | | |
|---|---|---|---|---|---|
| | VESSEL DATA | | | | |
| 1 | Vessel Name[a] | V ssel Code | Fish g P rmit N mb | Mammal Permit N mbe | T n g [a] |
| 2 | Cr ise Numbe [a] | Fishery[a] | Ta get Species[a] | Ta get Species[a] | Vess l Typ Se iced[a] |
| 3 | C pt i Name[a] | Captain ID | Home p t[a] | Co t y | C ll Sig [a] |
| 4 | Ag nt N me | Agent City[a] | Age t Phone[a] | | |
| | OBSERVER DATA | | | | |
| 5 | Obse e Name[a] | Obser er Code | Trip N mher | Report Pe iod | P rmit A /Oct t |
| | EFFORT DATA | | | | |
| 6 | D y F hed | Hou s Fish d | Total Numbe S t /Ha ls | Total Obser r S ts/Ha ls | |
| | GEAR DATA | | | | |
| 7 | Ge Util z d | Me h S z | Basket Weight | | |
| 8 | G Utilized | Number of Baskets | Numbe Ho ks/Bask t | Numbe f H oks | Ba t |
| 9 | Numb f Flo ts | Le gth Float to Fl t | Floatline Le gth | G glio L ngth | |
| | TOW DATA | | | | |
| 10 | D t | Begi T me | L tit d | L git de | Depth |
| 11 | Time Z ne | End Time | Lat t de | Longit de | Depth |
| 12 | Ha l/S t/Tow Numb | Du tion/Dista e of Tow | Di ti of Tow | A age Speed f Tow | Tow Photos/D a gs |
| 13 | M mum Depth | Mi um D pth | A age Fishi g Depth | A erage Bottom Depth | B ttom Typ |
| | ENVIRONMENTAL DATA | | | | |
| 14 | S f c W te Temperat re[b] | Fish ng Depth Tempe at re | Bottom Wate Tempe at re | | |
| 15 | Se St t | W /Swell He ght[b] | Wa e/S ll D t o[b] | W /Swell Le gths[b] | |
| 16 | Weather Code | Air Tempe at e[b] | Wi d Spe d[b] | Wi d Dire ti [b] | B omet c P ss r[b] |
| 17 | Dew Po t[b] | Vi ibil ty[b] | C l g[b] | Cl d C e[b] | Ba omet ic Cha ge[b] |
| | CATCH DATA | | | | |
| 18 | Obs e /V l | Total Numbe | Total Weight | Prod ct Code | |
| 19 | Numbe B sk ts pe S mpl | G ss S mpl W ght | N t S mpl W ght | Numbe Me s ed | Numbe f Hach |
| | CATCH DATA PER SPECIES | | | | |
| 20 | Sp c s Name | Spec s C d | Total W ight | Prod ct Code | A erage Weight |
| 21 | Species Code | Numbe Ca ght | P c t F T t l | Numbe R l d | Numbe Ali |
| 22 | Numb Meas d | Sum of Lengths | Average Length | Size Gro ps | Group Freq ency |
| | CATCH DATA PER FISH | | | | |
| 23 | Sp ci s C d | L gth | Le gth C d | Girth | C nditio /V bil ty |
| 24 | W ght | W ight Code | Sex | Ag | Dispositio |
| 25 | Hook Numbe Past Float | Biol gic l Sampl s | Tag N mb | Wat T mp t | T me t C t h |
| | MAMMAL PECULIAR DATA | | | | |
| 26 | B g f om Ship | Dista ce from Ship | Dir ctio of S m | Sp d of S m | Time at Distance |
| 27 | Numbe Obse ed | Numbe Alive and R le s d | Number Killed by C ew | Numb D ad i Cat h | Number Decompos d |
| 8 | S ght ng Numb | Sight C de | N mber Birds P ese t | Bi d Speci s | Photos Take |
| 29 | Total Numbe of Sighti gs | | | | |

R q Alph ume ic

[b]D d by We th Ser ce

there is a considerable delay before a Coast Guard vessel could get to the incident, unless it was fortuitously near However, a call ahead by the Coast Guard, relaying their plans to rendezvous for boarding, would probably ease the situation Presently, with observers only reporting every 3 to 7 days, and with the delays built into the system, it can easily be 3 to 8 days before an observer would be missed in some regions. If observer safety is to be accommodated, then some real-time signaling capability or locational beacon is needed This is only partially effective if it is carried out through satellite passes 4, 6, or 12 hours apart

Other near-real-time data needs include (1) the monitoring of location and fishing efforts to assure that vessels are fishing only in assigned areas and to allow rapid rendezvous to catch the vessels with their nets down or lines out in restricted areas, (2) collecting information on non-allowed gear or fishing techniques or on retention of prohibited species in order that law enforcement personnel can board vessels to witness the evidence extant or to give a lecture on the implications of flagrant non-compliance, (3) catch data on near-quota fisheries in order to aid management efforts in rapid closure to protect the species and to ensure future yields

These are only a small fraction of the data delineated earlier and should be easily handled on the small-data-rate transfer systems like CW radio (Morse Code) or the ARGOS data transfer system on the TIROS/NOAA series of satellites (limited to 256 bits per message) The locational monitoring is the only portion of these three data types that is not trivial to implement Although once a day is probably adequate to report all three data types, the locational data need to be taken more often. Location through use of the TIROS/NOAA data link provides locations up to 8 times a day, depending on latitude, at a per-platform-day cost The density of passes in which the satellite is visible are larger, but logistics limits service This can be borderline for some fisheries where allowed fishing regions are small or where boundaries between allowed and restricted regions are critical Somewhere between 1- and 4-hour intervals for

location measurements appear appropriate depending on the fishery All other location mechanisms, other than the TIROS/NOAA ARGOS system, imply a considerable increase in the cost of the information.

This regular knowledge of location is also of interest to the users of biological and environmental data Locations especially of interest are anomalies in the data, in items of high catch areas, thermoclime, current and upwelling boundaries, etc Locating this information at specific sites promotes improved biological understanding It can also indicate the environmental conditions that promote high fish populations and can aid understanding of weather and ocean front movements Studies encompassing this kind of research in the fisheries do not presently appear to consider any data sources other than those obtained from regional research-vessel cruises The observer program could increase this data base by an order of magnitude if biological or environmental events were accurately tied to specific locations This location information does not have to be transferred in real time, but it does need to be measured in real time Locational information of this type is also needed for technology transfer to aid understanding of where to fish for those fisheries presently underutilized by domestic fishermen Quota assessments could also use more understanding of the locational aspects of stock dynamics.

In general, law enforcement personnel felt they could operate with four to eight location fixes a day for any real-time compliance monitoring Assessment, technology transfer, and biological research personnel indicated that hourly or at least event-oriented indication of location would be highly desirable

Environmental data are needed by the operational portion of the weather service four times a day over 20-minute data transfer periods at 0, 6, 12, and 18 Greenwich Mean Time. These data are merged with worldwide data taken at the same instantaneous times each day and then inserted in weather forecast models as initial conditions Low-earth-orbit satellites cannot

be used to transfer these data because they are not available everywhere at these unique times Geostationary satellites or radio relays would have to be utilized This use implies higher cost

For the most part, the developmental status of biological models does not put any special demands on the data collection in terms of timeliness or format Most projection models are purely related to catch statistics modified by size, sex and age data Chemical/biological data on nutrients, salinity, chlorophyll, phytoplankton, zooplankton, etc , and environmental data on temperatures and water motions do not appear to be utilized in any operational determination of yearly sustainable yields, and consideration of their use in modeling does not appear to be popular in many portions of the fisheries (perhaps due to poor performance from past attempts).

Most of the data in Table 14, then, has no driving need to be transferred in real time unless it can be demonstrated that there is no cost penalty Such a balance could only be established if it can be shown that hand carrying masses of data results either in the loss or destruction of substantial portions of the data This loss can be quantified into dollars equivalent to the cost of digital satellite or radio transfer with substantially less probability of loss We could not establish any rationale for loss in the hand-carry transfer process or in the storage or handling of the data before insertion into an accessible data storage system, providing the data were digitized on board the ship Data stored on paper at the accessing facility prior to being converted into digital format may sometimes be neglected or lost due to funding vagrancies, which place differing priorities on the value of converting the data If the data accumulates until the projected cost of conversion is too large to be easily implemented under limited research funding, the data may be lost to the wide variety of users Although such a situation could be cured by specific management policy, it does exist now and is expected to persist Those who need the data for analysis but have very low budgets would appreciate any mechanization that provides insertion of the data into an available digital data base as part of the operational data collection service

## 2 Shipboard Operational Conditions

The operational conditions under which the data is collected and under which any electronic or mechanical data handling implementations have to be utilized include temperature extremes, saltspray, dampness, and gurry (fish oils, scales, blood, etc) Temperature extremes in the five regional programs studied appear to vary practically between 110°F in summer and -10°F in winter Some of the foreign fisheries efforts in the Bering Sea are carried out right along the edge of the icepack This means that care must be taken that electrical joints can handle the extremes in differential expansions implied by this large thermal excursion Display concepts employing liquid crystals might freeze at the low end or degrade in performance at the high end Battery performance varies widely over these temperatures The presence of dampness, saltspray, and gurry implies potential corrosion of unprotected metallic parts and gradual deteriorations in the performance of mechanical implementations (dials, keyboards or male/female plugs as these materials clog gaps, fill holes, and build up under moving parts). Antennas and equipment outside may experience constant exposure to dampness and saltspray, especially if mounted high to give the antenna look angles free of shadows for data transmission or receipt Equipment carried on a person or used near fish sampling and hauling activities will certainly be subject to gurry. Equipment in portable carrying cases or other packaging must be waterproof to survive "accidental" immersion during boat-to-boat transfer Depending on the cost of the unit, it might be worthwhile to provide an automatic beacon to guide recovery should a unit accidentally be lost overboard

## 3 Present Data System

It is necessary to understand the existing data transfer and handling capability in order to make use of those portions that are of value and to ensure that any new capabilities are not outside the frame of reference utilized in the present system A diagram combining the systems in all five regional programs evaluated here is shown in Figure 8 The major data transfer processes presently in use on foreign and domestic fishing vessels

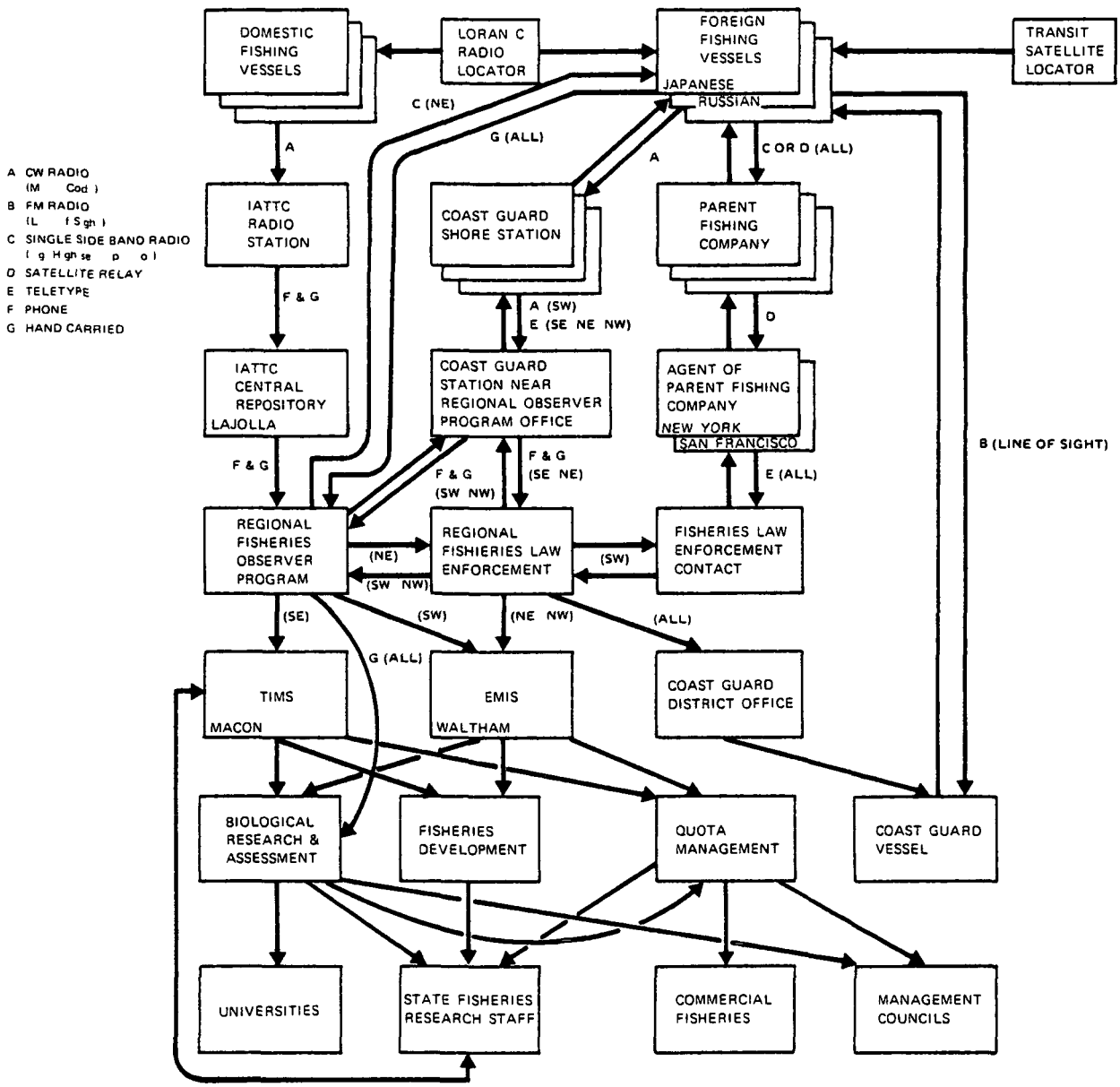


**FIGURE 8**
**PRESENT FISHERIES BIOLOGICAL DATA TRANSFER SYSTEM**

are CW radio for short messages and hand carrying of data forms when massive data accumulation takes place Many vessels also have single sideband radio for longer range transmissions, FM radio (essentially CB units) for line-of-sight communication with approaching Coast Guard units or other vessels, and sometimes satellite relay LORAN C and/or TRANSIT satellite location capability is also often available

All of these capabilities are conceptually available to the observer In practice, the observer uses the CW (Morse Code) radio for all regular short message reporting and hand carries all other data. Official messages from the vessel are routed through the parent company in the originating country to the U S agent (most often in New York City) and then through the official fisheries contact specified in the regulation The CW messages are relayed by the Coast Guard to the Coast Guard station nearest the responsible Observer Program Office, where they are typically hand carried by either observer program personnel or law enforcement officers to the responsible fisheries activity If urgency is indicated by the message, then the Coast Guard, as far up the line as they have been trained to recognize the urgency, usually telephones ahead to inform the program office and/or law enforcement personnel of the problem. In the IATTC mammal program, a single station operated by the observer program services the observers and works through a central repository in La Jolla Return messages to the vessel and/or observer can be transferred through the CW radio or through the high seas operator The Southeast quota management and compliance data and most of the biological data are put into the regional TIMS[1] facility at Macon, Georgia, where many users can draw on it Several Southeast states also store domestic catch data in the Macon facility and they are working on signing up the remaining coastal states in that region. The other three foreign observer regions put their quota management and enforcement data in EMIS[2], which came into being after the Southwest already was using TIMS This Coast Guard/Fisheries computer capability supports enforcement and

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[1]Technical Information Management System

[2]Enforcement Management Information System

quota management activities The major biological data base lies in the Northwest and Alaska Fisheries Center computer for that region in boxes at the Woods Hole Laboratory for the Northeast region and in EMIS (since the data base is so small and they do not have their own facility) at the Honolulu Laboratory for the Southwest region General distribution is then as shown when these data are available Delay in data availability can range from days to years depending on funding priorities in the different regions and whether abbreviated quota data or the more detailed biological and environmental accumulation is desired The IATTC mammal protection observer program puts its accumulated data into the computer at the Southwest Fisheries Center at La Jolla

In addition, the Western states are presently planning and implementing a Fisheries Information Network to consolidate and standardize domestic catch data The Northwest and Alaska Fisheries Center computer is one of the prime possibilities under consideration for implementing this network, but their manpower limitations and stated interest in "independence" from the NMFS make that choice less probable It would be appropriate to make any new capability compatible with this system as well

## C REQUIREMENTS SUMMARY

In order to put all these specific needs and requirements in perspective, it is necessary to assess the organizational responsibilities for each information function Table 15 shows the responsibilities of the Coast Guard, the five major user areas in the National Marine Fisheries Service, and the National Weather Service for the five benefit areas discussed earlier For the purpose of future capability, we will combine observer safety with real-time location and effort determination, since the problem and the responsibilities are interrelated We will also similarly combine biological and environmental data collection This places the location, effort determination, and safety efforts under Coast Guard jurisdiction, compliance and quota management effort under the Fisheries Law Enforcement, and Quota Management efforts and Biological and Environmental

TABLE 15

LEGAL OR NEED-DERIVED RESPONSIBILITY FOR CAPABILITY DEVELOPMENT

| | Coast Guard | National Marine Fisheries Service | | | | | Weather Service |
|---|---|---|---|---|---|---|---|
| | Surveillance and Logistics | Law Enforcement | Quota Management | Technology Development | Fisheries Stock Assessment | Biological Research | Environmental Monitoring |
| Observer Safety | X | X | | | | | |
| Real-Time Location/ Activity Determination and Boarding Logistics | X | (X) | | | | | |
| Real-Time Quota and Compliance Management | (X) | X | X | | | | |
| Biological Data Collection | | | (X) | X | X | X | X |
| Environmental Data Collection | | | | X | X | X | X |

( ) Secondary responsibility

data collection under a shared responsibility between the weather service and the fisheries

For planning purposes we also made some assumptions about what data was needed for what capability development stage in each of the three areas Table 16 shows minimal, nominal, and fully developed capability assumptions for each data area In the location and effort determination area, we assumed unattended capabilities on all vessels For minimal capability, the vessel code, date, and location information are needed. For the nominal capability, speed, pitch or roll indicators of fishing activity are additionally assumed and up to four measurements are assumed between each transmission. For the fully developed capability, the cumulated location and effort indications between transmissions are assumed to be six

For minimal compliance and quota data capability, five additional identification items are assumed, plus one infraction code and two repeats of a three-item specie input For the nominal case, three infraction codes, two specie inputs, and five environmental inputs are allowed These environmental inputs are the five "must" category measurements for the weather service, or the inputs indicated in Table 14 as having high importance to the fisheries. For the fully developed case, most of the underlined items in Table 14 are included Those underlined values not included were of a strictly biological research and stock assessment application nature Allowance was made for the peculiarities of both the foreign fisheries and IATTC Observer Programs For the biological and environmental data collection, the full matrix of Table 14, with almost any expansion, is assumed for all capabilities

These assumptions and the basic constraints and requirements discussed earlier translate into the specific requirements shown in Table 17 In Part a of Table 17, the location and effort capability is listed The minimal capability implies a low-earth-orbit satellite relay location capability alone, with the facility only supplying an identification signal and time reference For the nominal capability, a continuous location and effort monitoring is assumed with data transfer still performed by low earth orbiting satellites In the fully developed case, a more sophisticated instantaneous locator with more reporting options is assumed

# TABLE 16

## DATA GROWTH ASSUMPTIONS FOR PLANNING

| | | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 | COLUMN 5 |
|---|---|---|---|---|---|---|
| **Location Effort and Safety Data** | | | | | | |
| Minimal | • Identification and Location | • Vessel Code | • Date | • Time | • Latitude | • Longitude |
| Nominal | • Identification<br>• Location and Activity (4X) | • Vessel Code<br>Time | • Date<br>• Latitude | • Longitude | • Speed Indicator | • Pitch/Roll Indicator |
| Fully Developed | • Identification<br>• Location and Activity (6X) | • Vessel Code<br>Time | • Date<br>• Latitude | • Longitude | • Speed Indicator | • Pitch/Roll Indicator |
| **Compliance and Quota Data** | | | | | | |
| Minimal | • Identification<br>• Compliance<br>• Quota Data (2X) | • Permit No<br>• Infraction Code<br>• Species Code | • Permit Area<br>• Wt/No Caught | • Observer Code<br>• Viability Code | • Start Report Period | • End Report Period |
| Nominal | • Identification<br>• Compliance (3X)<br>• Quota Data (2X)<br>• Environmental Data | • Permit No<br>• Infraction Code<br>• Species Code<br>• Air Temperature | • Permit Area<br>• Wt/No Caught<br>• Water Temperature | • Observer Code<br>• Viability Code<br>• Barometric Pressure | • Start Report Period<br>• Obs /Ves Source<br>• Wind Velocity | • End Report Period<br>• Wind Direction |
| Fully Developed | • Identification<br>• Compliance (6X)<br>• Quota Data (6X)<br>• Environmental Data | • Vessel Name<br>• Observer Name<br>• Infraction Code<br>• Species Code<br>• Mammal Code<br>• Air Temperature<br>• Dew Point<br>• Wave Height | • Vessel Code<br>• Observer Code<br>• Total Wt/No Caught<br>• No Observed<br>• Water Temperature<br>• Visibility<br>• Wave Length | • Permit No<br>• Start Report Period<br>• Viability Code<br>• Birds Present<br>• Barometric Pressure<br>• Ceiling<br>• Wave Direction | • Permit Area<br>• End Report Period<br>• Obs /Ves Source<br>• No Captured<br>• Wind Velocity<br>• Cloud Cover<br>• Wave Period | • Total Sets/Hauls<br>• Days Fished<br>• Disposition<br>• Disposition<br>• Wind Direction<br>• Barometric Changes<br>• Fishing Temperature |
| **Biological and Environmental Data** | | | | | | |
| | | All of Matrix in Table 14 | | | | |

# TABLE 17

## SYSTEM REQUIREMENTS

a Requirements for Location and Effort Capability

| | Minimal | Nominal | Fully Developed |
|---|---|---|---|
| Locational Accuracy | ± 2 0 km | ± 1 0 km | ± 0 5 km |
| Repeat of Locational Measurement | 4 times daily | 4 to 8 times daily | Hourly or event oriented |
| Speed Accuracy | -- | ± 1 m/sec | ± 1 m/sec |
| Pitch/Roll Accuracy | -- | TBD | TBD |
| Inertial Integration Time | -- | 10 min | 15 to 30 min |
| Identification and Location Inputs | 5 to 14 items[a] | 22 items[a] | 32 items[a] |
| Data Transfer Repeat | 1 time | 2 times | 4 times daily |

b Requirements for Quota and Activity Compliance Capability

| | Minimal | Nominal | Fully Developed |
|---|---|---|---|
| Additional Identification --Number of Inputs | 5 items[a] | 5 items[a] | 8 items[a] |
| Species Quota Inputs --Number of Inputs | 1 to 6 items[a] | 8 items[a] | ~ 24 items[a] |
| Activity Compliance --Number of Inputs | 1 item[a] | 3 items[a] | 6 items[a] |
| Quota/Compliance Data Transfer Repeat | At least 1 time daily | At least 2 times daily | 4 times daily |
| Environmental Data Inputs --Number of Inputs | None | 5 items[a] | 15 items[a] |
| Environmental Data Taking/Transfer Repeat | 12 a m p m daily | 12 a m p m daily | 12 a m p m daily |

[a]3- to 8-digit numbers per item

TABLE 17 (Continued)

SYSTEM REQUIREMENTS

c Requirements for Biological and Environmental Data Logging Capability

| | Minimal | Nominal | Fully Developed |
|---|---|---|---|
| Hand Portable Input | | | |
| --Keyboard | None | Numeric | Alphanumeric |
| --Display Lines | None | Special Functions | Special Functions |
| --Display Columns | None | 1 to 3 | 3 to 72 |
| --Recall Capability | None | Yes | Yes |
| --300 Hours per Battery Charge | None | Yes | Yes |
| Portable Suitcase Terminal | | | |
| --Keyboard | Numeric and Special Functions Only | Alphanumeric and Special Functions | Alphanumeric and Special Functions |
| --Display | 1 Line, 2 Columns | CRT | CRT |
| --Microprocessor | Z-80 or Better | Dual Z-80 or Better | TBD |
| --Automatic Inputs | No | No | Environmental and Biological |
| --Recording | Dual Cassettes | Dual Cassettes | Dual Disks |
| --Recall Capability | Yes | Yes | Yes |
| --Edit Capability | Yes | Yes | Yes |
| --Special Indicator Lights | Yes | Yes | Yes |
| --Printer (hardcopy) | No | No | Yes |
| --CB Radio and Microphone | No | No | Yes |
| --Battery or Ship Power Options | Yes | Yes | Yes |

In Part b of Table 17, the additional capability for an observer-attended activity is shown Additional identifiers, quota, compliance, and environmental imputs are assumed with increases in complexity as shown in Table 16 Transfer for the fisheries inputs are on the same frequency as the earlier location and effort data, but the environmental data are tied to the four daily data input times to support weather forecasting A search and rescue beacon for observer safety might also be provided

For the biological and environmental data capability, the requirements are biased to relate to what is proposed as an acceptable progression in capability flexibility. The minimum capability represents existing capability repackaged for portable suitcase operation, with and without self-contained power For use of vessel power, special adaptive converters will be needed to allow for the wide variety of vessel voltages and to protect against a variety of potential overloads For the normal capability, we have assumed a simple hand-held portable data input unit. A more powerful suitcase unit, which addresses the CRT packaging problem will be discussed later The fully developed capability does everything for everyone For each of these capabilities there are many additional options possible, but we are focusing on these samples to generate cost building blocks and possible development schedules to support planning

# V FUNCTIONAL CAPABILITY OPTIONS

In this chapter, the capabilities available for each of the major performance functions of interest for shipboard terminals are reviewed In addition, some of the options available for data transfer, processing, storage, and accessing are discussed.

## A SHIPBOARD TERMINALS

In this section, we will not discuss the system options suggested in the requirements chapter in a coordinated fashion This is essentially an opportunities discussion, coalescence of the opportunities into specific systems concepts will come later

### 1 Location Determination Alternatives

Each of the major location determination techniques are summarized briefly in Table 18. The TIROS N/NOAA satellites are primarily used as data relay links. Platform signals, with the doppler shift characteristics, are picked up from several places along the satellite orbit so that the source can essentially be located by triangulation From these overlapping conuses, location, speed, and direction can be derived. Coverage is worldwide, but gaps between opportunities range between 1-1/2 and 7-1/2 hours. With two satellites, there are typically as many as 6 sightings per day at the equator with adequate tracking time for good location determination and as many as 21 sightings at latitudes of the order of 65 degrees The satellite can handle up to four signals simultaneously, but experience has shown that it becomes confused when more than 130 platforms are in its field of view The disadvantage in this system is in (1) the variable wait times if observer safety is a problem and (2) providing accurate locations

to match events on the ocean (e g , thermoclines, nutrient upwelling, school locations, time of entry into a restricted zone)

The TRANSIT Satellite location capability (see Table 18) is widely used by marine vessels since it provides worldwide coverage, is not widely subject to the vagaries of the weather, and is available somewhat more often and at evener intervals than the ARGOS system Also the determination of location is made on board the ship for most users The two frequencies are used to make ionosphere refraction corrections The improved TRANSIT now being phased into service includes a ranging capability that allows similar accuracies just using the 400-MHz frequency. Receiver prices are dropping and the addition of a one-frequency option could aid this trend Many of the foreign fishing vessels already have this capability The Global Positioning Satellite (GPS) or Navstar system is meant to replace TRANSIT The original concept had 24 satellites in three orbit planes, distributed so that 4 satellites would be in view at all times. The planned constellation has been reduced to 18, but the early-phase nine-satellite combination with three in each of three orbit planes has adequate accuracy for the purpose of this effort The technique and configuration delineated are for the eventual full capability, but the accuracies quoted belong with the simpler system. Manpack developments are in progress to develop simple portable units, and low-cost versions are expected to evolve in parallel due to the high commercial potential

LORAN C has the advantage of being inexpensive and is adequately accurate for this use It is not, however, available in any of the Pacific Island regions of interest (except Hawaii) and not in the IATTC jurisdiction area OMEGA is similarly inexpensive and available worldwide but has poor accuracy and is not always dependable A nearby and well located fixed station is necessary for calibration of OMEGA when large propagation errors appear due to atmosphere/conosphere anomalies The RF Beacon concept is listed only for completeness in that some development is necessary to make it available and its accuracies would not necessarily be good It is the radio equivalent to the TIROS concept where the vessel supplies the signal and multiple locations on the shore triangulate on the

# TABLE 18

## COMPARISON OF VESSEL LOCATION CAPABILITIES

| | | | |
|---|---|---|---|
| | TIROS-N/NOAA Satellites (NOAA Operated) | | |
| Technique | Doppler shift in data signal collected at several positions used to locate source | Location Accuracy (absolute) | < 0 5 nm |
| Configuration | Two satellites in 400 nm sun synchronous orbits | Wait Time | 2 to 8 hours |
| Areal Coverage | Worldwide at local times of 3 00 and 7 30 AM/PM | Unit Cost | ∿ $2000 |
| Frequency | 401 650 MHz ±1 3 kHz | | |
| | TRANSIT SATELLITES (Navy Operated) | | |
| Technique | Uses doppler shift of signal from accurately located satellite | Location Accuracy (absolute) | < 300 ft |
| Configuration | Five satellites in 600 nm polar orbit | Wait Time | 30 to 120 minutes |
| Areal Coverage | Worldwide | Integration Time | 10 to 16 minutes |
| Frequency | 150 and 400 MHz (or 400 MHz only) | Unit Cost | $6000 to $30 000 |
| | GPS/NAVSTAR - SATELLITE (Air Force Operated) | | |
| Technique | Triangulate on 3 satellites with known locations | Location Accuracy (absolute) | < 300 ft |
| Configuration | Eighteen satellites in 3 orbit planes at ∿ 10 800 nm | Wait Time | 80 to 180 sec |
| Areal Coverage | Worldwide | | |
| Frequency | 1200 and 1600 MHz | Unit Cost | < $10,000 |
| | LORAN C (Coast Guard/Navy Operated) | | |
| Technique | Master and two slaves provide navigating signal | Location Accuracy (absolute) | < 1500 ft |
| Configuration | Not worldwide | Wait Time | 15 sec |
| Areal Coverage: | Essentially coastal U S waters only | Unit Cost | $1200 to $6000 |
| Frequency | 90 to 110 kHz | | |
| | OMEGA (Navy Operated) | | |
| Technique | Three stations provide area fix from phase differences | Location Accuracy (absolute) | < 2 nm |
| Configuration | Eight stations 5000 nm apart | Wait Time | 10 sec |
| Areal Coverage: | Worldwide | Unit Cost | $1800 to $11 000 |
| Frequency | 10 2 11 3 and 13 6 kHz | | |
| | RF BEACON (Presently FCC Operated) | | |
| Technique | Beacon located by 2 shore stations with accurate angle determination | Location Accuracy | > 10 km |
| Configuration | Thirteen stations in U S (incl Hawaii Alaska and Puerto Rico) | | |

signal Under an improved version from the present FAA concept, the shipboard unit would potentially cost considerably under $1,000 Message capacity appears to be extremely low in the present FAA concept A single side-band radio transmitter with an 11-foot telescoping whip aerial can transmit long distances Even the CW signal for the Morse Code system could essentially be utilized The expense then goes into the shore facilities that provide accurate angular location of the signal source

The various satellite location techniques look most desirable in the long run for providing full capabilities The TIROS-N location is adequate for most early demonstrations, especially at high latitudes The location is included in the cost of the relay function A charge is made for government users of approximately $8 a platform per day for up to 6 or 8 passes For non-government users, this fee is $20 a platform day For longer range needs, TIROS-N is inadequate It can only handle four platforms simultaneously and begins getting confused when more than 130 sources are in its field of view at one time It is limited to message sizes of 256 bits and may not give enough location density to adequately position all of the biological and environmental anomalies that might be of interest Addition of an ARGOS data collection system similar to NOSS (National Oceanic Satellite System) would alleviate this somewhat, eventually, especially if the higher data rate options presently proposed by GSFC are adopted

For a short run demonstration of the value of continuous monitoring of location, LORAN C is probably the most economic option with sufficient accuracy and constancy The low cost value quoted is a recent sale price advertised in a magazine, the problem is that LORAN C is not available in the IATTC region or in the Pacific Island FCZ jurisdictions remote from Hawaii For the longer run, a demonstration of a TRANSIT and then GPS would be appropriate in order to tie locations to important fish management events (e g catch location, environmental anomalies, control area, entry and exit) NASA might provide a civilian community service by seeing to it that the so-called "low-cost" military GPS system is converted into an even lower cost commercial system In particular, the accuracy needs for this

activity are much less than the military specification LORAN C, and possibly OMEGA, are to be phased out as GPS capabilities become equivalent A receiver of similarly low cost as the LORAN C version will have to be developed, though, before the commercial and private users will drop their LORAN C and OMEGA equipment

## 2 Activity Indicator Alternatives

It is important to know if a vessel is pulling a net or setting out or hauling back a longline at each location Only in this way is location surveillance useful in terms of monitoring whether the vessel is obeying the fishing area restrictions The problem is one of choosing an adequate indicator of the presence of a net or longline in the water This surrogate would then be used to suggest deployment of a Coast Guard vessel to catch flagrant offenders in the act This is especially valuable for untended implementations

Motion is probably the best surrogate Cruising speeds for getting in position for another tow or for heading into port or returning home are considerably higher than those used for towing a net or setting out, drifting with, and then hauling back a longline In addition, the net acts as a giant sea anchor, stabilizing a ship's pitch and roll dynamics Coast Guard ships have seen fishing vessels in gale conditions with nets out and everyone on board in good shape, while the Coast Guard vessel was down to less than half complement due to sea sickness

A simple strap-on gyro system or a one-to-three axis accelerometer package could monitor translational and rotational motions We expect that operation on a fisheries research vessel for a few months would provide enough interpretive base to allow gross indication of activity Strap down gyros are now available for about $300 Appropriate low-frequency accelerometers are available for similar prices in single-axis configurations and for more in three-axis configurations Simple signal processing, power supplies, packaging, etc , would add several hundred dollars to a unit cost Operational unit costs should run about $500 to $800 apiece, although a good prototype model to answer all questions on performance

might require equipment of two or three times that cost to ensure understanding

3 Timing Options

Time references are particularly important for the satellite location capabilities Although simple devices are adequate for keying events, small drifts in the clocks between the vessel and the satellite translate into large errors in location The Fishing Vessel Transmitting Terminal presently developed by the Coast Guard has this problem, in that its timing mechanism drifts in such a way that adequate positions have not been consistantly obtained in the early tests last winter A wide range of timing capabilities are available commercially. Crystal oscillators with stabilities matching the ARGOS platform specifications are reasonably inexpensive (< $20)

4 Data Input and Display Options

Data input and display is key to the efficiency of the man-machine interface. The major requirements for these functions include simplicity, good visibility, resistance to clogging from salt spray and gurry, and editing capability Some sample display concepts are shown in Figure 9 to provide some scoping

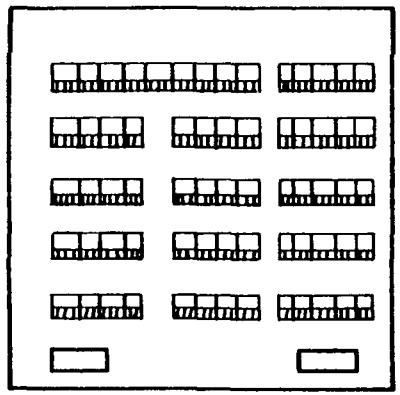
Digital dial switches are relatively inexpensive in three- to five-number configurations (e g , $8 to $13 apiece) They could be assembled in arrays like 1 or 1a so that all of the data types discussed earlier for quota management and compliance reporting could be utilized The Coast Guard unit, discussed earlier, has enough switches so that, when all are used, the 256-bit limit on TIROS-N data transfers is just accommodated The second option utilizing dial switches groups the data formats into categories via Table 16, so that repetitive inputs reuse one row over and over, inserting the earlier data into memory This way more than one message worth of data can be accumulated, even though it may take several relay opportunities to get the total data base back to the regional center with observer management responsibility The advantages of these digital

dial switches is that they act as their own display for verification before committing to the message and are relatively simple to use The disadvantage is that they are mechanical devices that are highly susceptible to salt spray and gurry if used in the open, on the decks of ocean vessels or in the fish processing areas

Button-type keyboards are now available with tactile sensing so that the faces are sealed from water and sticky substances (developed for fast food restaurant and grocery store use) Simple, thrifty 4 x 4, numerical-only inputs are available for as low as $7 or $8 Full typewriter keyboards are available for under a $100 or for several hundred dollars. Tactile one- to six-button strips and 3 x 4 or 4 x 4 pads are available for designing one's own system at comparable prices Since eight-digit LED displays are available for under $10 apiece, it appears possible to design a simple combination (like '2' in Fig 9) that provides the same performance as the Coast Guard dial version at the same cost but is not susceptible to clogging from salt spray or gurry The drawback in this concept is that the Light Emitting Diode (LED) displays cannot be read well in sunlight, which limits their usefulness under unshaded shipboard conditions

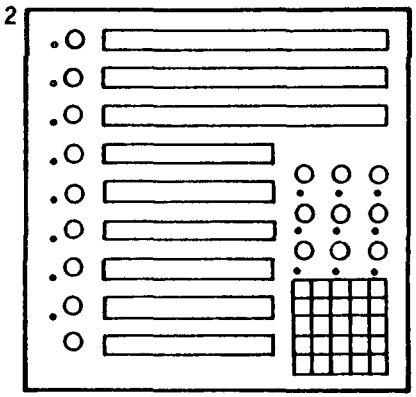
Some alternative display capabilities are compared in Table 19 Each has its own problems and advantages LEDs wash out in sunlight LCDs freeze below -10 °C (14°F). Gas discharge and vacuum fluorescence implementations tend to be similarly susceptible to low-temperature degradation In addition, they are prone to shock damage and require high voltages to implement (which are not always easily available from battery implementations) The incandescent option has the best sunlight performance, but its tungsten filaments are shock prone and tend to have relatively short lives (especially per cost) in any case Some experimenting with LEDs and LCDs is probably warranted Perhaps two display versions, one for high latitudes (LEDs) and the other for low latitudes (LCDs), might be worth considering In addition, these displays are available in lines up to 80 characters and in implementations with up to 24 lines with as many as 40 characters These LCD implementations do not require the depth inherent in most present CRT designs This is particularly good for suitcase

1



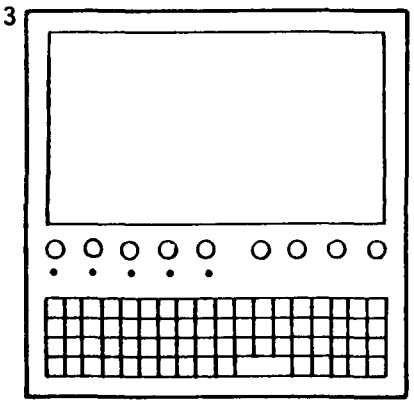
COAST GUARD SIMILAR UNIT
DIAL ARRAY
SEARCH & RESCUE

2



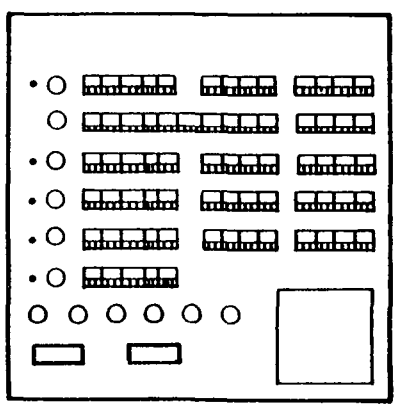
ADAPTED FOR BUTTON INPUTS
NUMERIC KEYBOARD ONLY
MEMORY INSERTION BY LINE
RECALL/REVIEW CAPABILITY

3



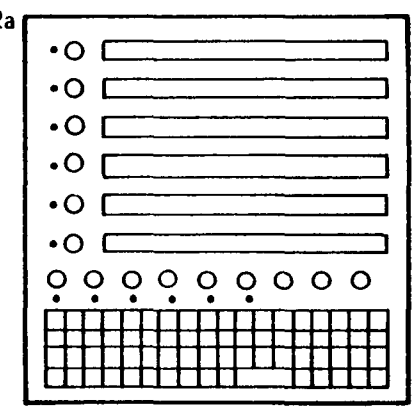
ADAPTED FOR CRT DISPLAY
ALPHANUMERIC KEYBOARD
MEMORY INSERTION BY DATA GROUP
REPETETIVE GROUPS HELD TO
DISPLAY (10) LINES AT TIME
RECALL/REVIEW/EDIT CAPABILITY
SUMMARIES/AVERAGES

1a



ADAPTED GENERALIZED UNIT
COORDINATED DIAL ARRAYS
MEMORY INSERTION BY LINE
REMINDER LIGHTS

2a



ADAPTED FOR BUTTON INPUTS
ALPHANUMERIC KEYBOARD
MEMORY INSERTION BY LINE
RECALL/REVIEW/EDIT CAPABILITY
MEMORY SUMMARIES

**FIGURE 9**
**EXAMPLE TERMINAL DISPLAYS**

TABLE 19

COMPARISON OF DISPLAY ALTERNATIVES

| | Light Emitting Diodes LED | Liquid Crystal Displays LED | Gas Discharge Displays | Incandescent Displays | Vacuum Fluorescent Displays |
|---|---|---|---|---|---|
| Sunlight Sensitivity | washes out | OK | OK | best visibility | OK |
| Operating Temperature | $-40^{o}$ to $85^{o}C$ | $-10^{o}$ to $65^{o}C$ | $0^{o}$ to $70^{o}C$ | $-55^{o}$ to $100^{o}C$ | $10^{o}$ to $55^{o}C$ |
| Voltage Requirement | nominal | nominal | high | nominal | high |
| Shock Proneness | OK | OK | high | high | high |
| Life Expectation | ∿10 times LCD | good | good | short | good |
| Cost | | | | highest | |

packaging CRTs with 4- by 3-inch screens and 24-line formats are comparatively available at $250 and larger sizes for corresponding increases in price Building blocks are thus available for all kinds of implementations at competitive prices

5. Data Handling Options

Data handling is treated here as a catchall in terms of storing, accessing, and manipulating data at the collection site Manipulation might include only the recall and editing functions or various mechanisms for combining different data sets, putting time and location reference into the data sets, carrying out some of the sensor calibrations, or doing specific calculations or analyses on the data It also might include formatting and coding data for the data transfer process Again, a variety of inexpensive options exist

Memory is available in tape cassettes, disks, solid state, and bubble formats Some sample comparisons of the dollar-per-kilobyte investments typical for these four memory types are provided in Table 20 The tape cassettes are the least expensive for mass storage, but quite a bit of time is spent reading in and reading out in order to find specific data of interest Large computers are needed simply to read all of the data in, if data from widely dispersed storage locations is needed at one time Disks provide a better performance, in that they can be read from individual sectors as needed Disks are limited by the slow scan rates across the disk while accessing data Disks may have some potential for damage to records if storage cases are not provided for the observer The cassettes can more easily be placed in zip-lock storage bags to prevent damage Solid state memory provides even more rapid access and is necessary for active processor memory It is fairly costly though for mass storage and requires a tiny backup battery to prevent loss of data from power failure Bubble memory is believed to be potentially the lowest cost immediate-access memory, but it is not capable of providing these economics at this stage of its development The wide variety of memory capabilities

TABLE 20

COMPARATIVE INVESTMENTS IN TERMINAL MEMORY

| | CAPACITY (kbytes per unit) | COST | COMPARATIVE COST per kbyte |
|---|---|---|---|
| Tape Cassettes | | | |
| Low-Speed | 340 | $100 | $0 30 |
| High-Speed | 280 to 1,000 | $1,200 to $2,250 | $2 45 to $4 30 |
| Disks | | | |
| 5-inch | 315 | $980 | $3 10 |
| 8-inch | 500 to 1,000 | $1,200 to $2,250 | $2 45 |
| Solid State Memory | | | |
| CMOS | 32 to 64 | $700 to $900 | $12 to $15 |
| Bubble Memory | | | |
| 8 holders on 1 driver | 64 | $2000 | $31.00 |

available in cost categories consistent with this terminal requirement is shown in Table 20

Another data storage device of interest to some users is a simple printer that could print out data from information on command, thereby providing information copies for the vessel captain or for the observer to mark up for other purposes Thermal and impact printers with 15 to 40 columns and 54 to 96 print characters are available for from $165 to $880 depending on complexity There are combinations of full alphanumeric input keyboards, processor, 20-column, 1-line LED display, and 20-column printer available for under $500 (e g , Rockwell).

## 6 Data Relay and Communication Options

There are a number of data relay capabilities available for data collection (see Table 21) Their capabilities have been demonstrated by the NIMBUS-6 for low-earth-orbit satellites and the ATS (Applications Technology Satellite) for geostationary satellites The ATS capability is now defunct The NIMBUS-6 and Landsat capabilities have too low a message rate and have not been further considered TIROS-N has an adequate message rate for much of the near-real-time fisheries needs It will, however, have difficulties in the Alaska region where more platforms are often in view than it can handle This is especially true if such a system were put on all of the foreign vessels presently fishing in that region The message size is also limiting in terms of the typical CW radio messages presently sent by observers weekly (or every 3 days) It would not handle even near-real-time data loads in some regions, if several species are near quota and if additional locational or gear/technique compliance data had to be included in the message There is an improved system proposed by NASA GSFC for NOSS which would more than double this capacity and allow for any of the contingencies presently identified in this assessment of Fisheries Observer Program needs It is not known whether this NOSS system will be approved by the NASA/NOAA/NAVY team involved in this decison, but the NMFS, NWS, and USCG should strongly support the addition of this unit to NOSS In addition, the legal restraints on the use of the TIROS-N/NOAA data

## TABLE 21

## SAMPLE DATA TRANSFER OPTIONS

| | TIROS N ARGOS DCS | NIMBUS-6 RAMS | LANDSAT DCS | GOES DCS | MARISAT | Single Sideband Radio |
|---|---|---|---|---|---|---|
| Number of Passes Daily | 6 min ∿21 at ± 65° | 3 to 5/day | 3 to 4/day | In sight up to 70° latitude | In sight up to 70° latitude | Variable interference |
| Number of Platforms Simultaneously | 4 | 8 | | 10,000 | 10 000 | 1 |
| Number of Platforms in Field of View at Same Time | ≤ 200 (130 in practice) | ≤ 200 | 1 000 | 10 000 | 10 000 | Scheduled |
| Frequency of Channel | 401 65 MHz | 401 20 MHz | 401 55 MHz | 401 7-402 1 MHz | | 4-22 MHz |
| Data per Message | ≤ 256 data bits | 32 data bits | 64 data bits | 100 b/sec | 100 b/sec | As needed |
| Power Required | 12W | | 10W | 5W | | 100W |
| Message Cost | $8 20/platform/day | -- | -- | -- | $6/1-minute message | -- |
| Unit Cost (Transmitter and Antenna) | $1 800 | -- | -- | ∿$4 000 | ∿$4 000 | $750 to $5 000 |

collection system presently do not provide for fisheries compliance data within its charter, and present permission comes from the research nature of the activity and the presence of environmental data in the input data package (one air temperature measurement) If such a capability moves toward operational use, it could be disallowed on the TIROS-N/NOAA satellites The NOSS system is intentionally proposed to handle these situations, which include most of the potentially higher data rate users.

GOES and MARISAT are geostationary satellites The GOES system is operated by NOAA, whereas MARISAT is commercially operated Both systems utilize large antennas (approximately 4 ft) that must be pointed generally south to keep the satellites within the antenna's beamwidth This large antenna is necessary to keep the power requirements down when the data collection terminals are remotely located On land, the antennas can be fixed, but at sea some mechanism for pointing is needed although omniantennas with higher power might be implemented if vessel power was made available Exposed mechanical joints for the pointing action can additionally be a problem in the sea environment Many of the larger foreign fishing vessels already have MARISAT capability Such capability will eventually be needed to support real-time observer safety and to allow tracking of important ocean events related to fisheries activities. Cost and antenna/power characteristics limit the utility of these systems at the present time

The single sideband radio is included for completeness It appears to be an excellent alternative at first glance It has real-time exchange capability at any data rate contemplated and can be purchased cheaply An 11-ft whip areal could be deployed from the deck on the direct line side of the ship and could transmit to a single shore station at the observer program management location in each region or at existing Coast Guard facilities Although ionospheric reflection processes do not allow transmissions at all times, it is normally a case of waiting out the interference for several minutes or at most waiting until evening hours to pass signals across The biggest factor against the single sideband radio though, is the need to license all operators For many of the observer programs that do not employ, this would be impractical

## 7 Power Options

Power can be a problem Batteries with good power storage capability tend to be heavy, bulky, and expensive The three types of terminals suggested earlier may alleviate this problem The implementation of an unattended location and data relay capability will permit the use of the bulky types of batteries since logistics and portability are less of a problem The hand-held units can operate off small batteries and/or charge packs chargeable from vessel power The suitcase terminal could be operated off vessel power Vessel power is somewhat of a problem, however, because of the wide range of power available The observer would either have to carry a large number of adapters or would have to know the power capability of the ships he planned to serve on so that he could carry a smaller number of adapters In general, power capability is available, but must be specifically designed for the terminal in question.

## 8 Packaging and Portability Options

Options for packaging and portability are important for establishing practicality in the use of any of the proposed terminals Getting terminals to and from pickup points from their refurbishment/checkout center and moving them from ship to ship at sea requires some reasonable portability In addition, observers often have their own sea trunks, and, in some regions, they carry environmental sensors, biological sampling gear, reams of data collection paper, etc If a terminal is to be used near the fish processing area, it must be resistant to salt spray, perspiration, and fish gurry Data relay equipment mounted high on the ship or on deck must be protected to prevent salt buildup from degrading their performance Observer equipment often gets dumped into the ocean when being passed from vessel to vessel Terminals which are used to report compliance infractions can be accidently washed overboard If not carefully protected, suitcase terminals with displays and electronics are susceptible to failures due to accidental shocks Design of terminals for sea use is much more difficult than design of comparable land data collection

terminals The estimated system costs presented later in this report reflect these design considerations

## B. DATA TRANSFER NETWORK

The data transfer network envisioned for this effort is shown in Figure 10 At present, there are some differences in the dissemination portion of the network (shown on the right side) compared to the existing system shown earlier in Figure 8 These variations are minor in terms of regional differences--whether the law enforcement or observer program office sees the near-real-time data first and which of those two offices actually inserts that data into the Enforcement Management Information System (EMIS) If a specific relay network were set up to get the data to the regional operations center, then it would be natural to either put all data through the observer office or to set up specific criteria for when some subset of data bypasses the observer office and goes directly to Fisheries Law Enforcement or to the Coast Guard offices for action There are advantages both ways. If there truly is a fast reaction situation, then bypassing might be appropriate The observer offices know, however, that knowledge of the personality of the observer must be taken in account when interpreting messages which imply or demand rapid response

The data collection relay options shown on the left in Figure 10 are the same discussed earlier and compared in terms of transmitter performance and costs in Table 21 We will not discuss further these comparisons here but will instead address the networks between the satellite and the regional receivers. TIROS-N/NOAA, NOSS, and GOES are all NOAA environmental satellites, NOSS, in particular obtains environmental measurements of interest to the fisheries All operate through NOAA ground stations at Wallops Island, Virginia, and Gilmore Creek, Alaska, with further relay, as necessary, to the Environmental Data Information System (EDIS) facility in Suitland, Maryland Data collection platform data are usually available through this system within an hour and 2 hours from the time when it is received by the satellite. EDIS then redistributes the data to each of the interested users Comsat similarly has its own ground receiver facilities

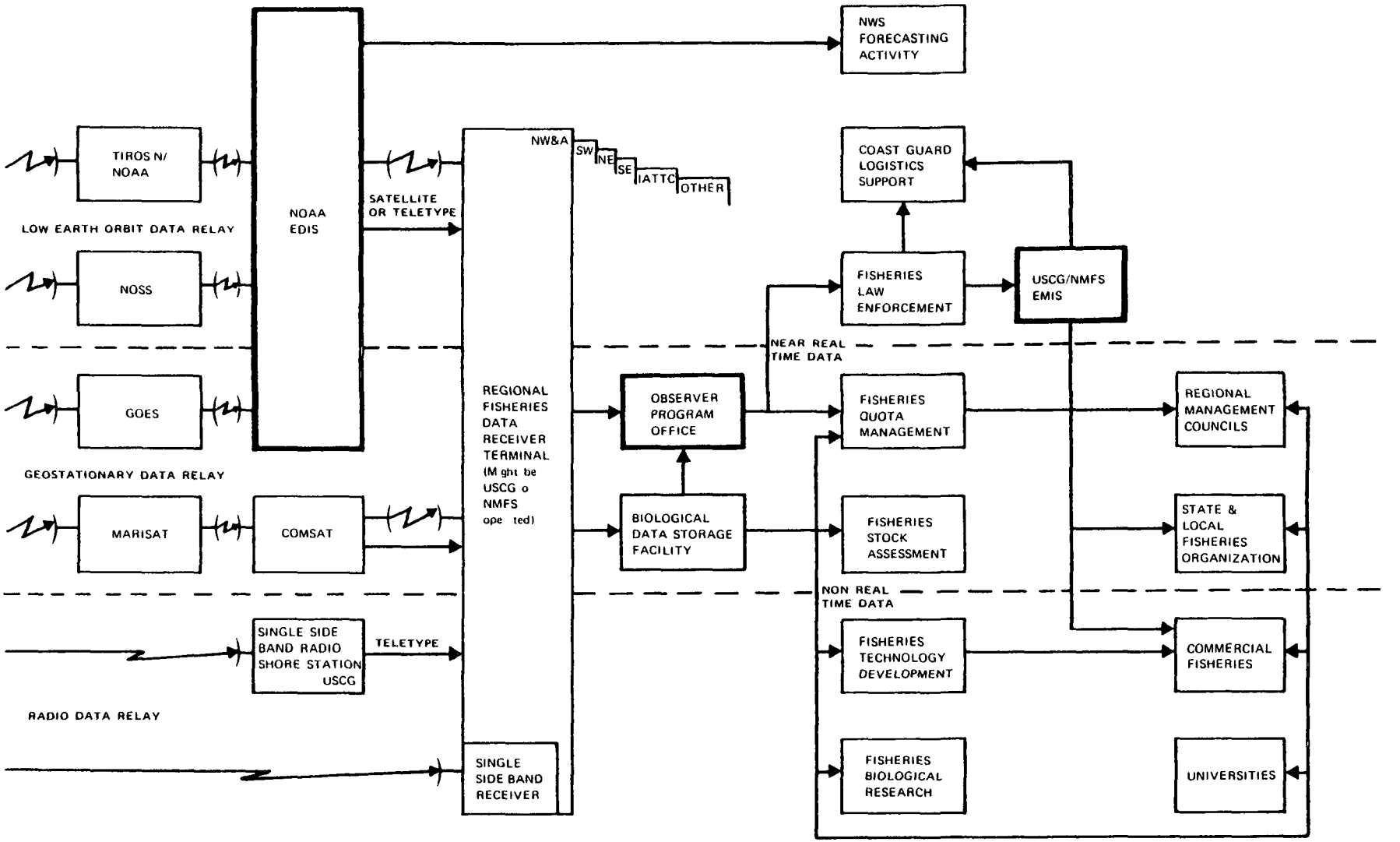



**FIGURE 10**
**FISHERIES DATA TRANSFER NETWORKS**

and can re-relay data immediately to any pickup location desired Future Comsat satellites may be able to separate out each data collection message on board the satellite and then beam it down directly to the appropriate regional location with almost no delay The single sideband radio option could use existing Coast Guard stations or new stations located at each regional fisheries management center Again, this option appears competitive with satellites in performance and cost but the need to license each operator makes it infeasible to use.

## C DATA PROCESSING, STORAGE, AND ACCESS

The data storage and access facilities are shown in boxes with somewhat heavier outlines in Figure 10 EDIS is set up by law to act as a repository for environmental data and could be expanded to accommodate biological data as well If the EDIS data accessing system were upgraded somewhat, then it could act as a central biological data repository and each region could be tapped into it as needed The regional data storage facility might not then be needed Such a centralization does not appear warranted, since then biological data would have to compete with environmental data for limited data processing funds and could very well lose out The differences in regional needs for data types and data display types also make it somewhat impractical to try to satisfy all of these needs out of a central facility

Regional data storage facilities thus appear more appropriate The Southwest region observer program and several states in that region use the Technical Information Management System (TIMS) facility in Macon, Georgia The west coast states and the NW and SW fisheries centers are presently involved in choosing a facility for a state fisheries-data repository, and this facility might also be valuable for observer-program and NMFS-research-vessel data. We believe some regional data storage and access facility is appropriate as long as the interfaces between regions are also implemented to allow some cross-region stock assessment and research Although most present efforts investigating such regional facilities are emphasizing ties to larger computers, we believe that data

storage and accessing of this type is directly adaptable to simpler implementations All of the data formatting, editing, and processing capabilities we have discovered in this effort appear to be within the capabilities of relatively inexpensive smart terminals (well under $10,000) It remains to set up a disk (or bubble) memory system which allows data to be redistributed for storage into interrelated sets These interrelated sets could then be reaccessed for all the variety of users with considerably less investment than that necessary to implement a major computer facility and without significant loss of service

The EMIS facility is meant to handle only enforcement data of mutual interest to the Coast Guard and the NMFS Law Enforcement actitvity Its specialized use and relatively low cost of implementation may warrant its retention as a separate data entity If the regional biological data network were implemented, then this activity could easily be absorbed by it at some savings At present, it is an important link between enforcement jurisdictions

# VI SAMPLE SYSTEM ALTERNATIVES

The performance requirements developed in Chapter IV and the agency responsibilities developed in Chapter III imply a developmental matrix like that shown in Table 22 Three kinds of terminals appear appropriate The Location and Activity Terminal is a legal Coast Guard responsibility It is used to transmit information on fishing vessel location and activity The Compliance and Quota Management Terminal is an NMFS responsibility. It might be implementable on the Coast Guard terminal but it is more useful if it can be carried easily from shore-to-ship and ship-to-ship, if it can be used out in the work area where it is exposed to gurry and salt spray, and if it can interact with both the Coast Guard unit and the Biological and Environmental Data Terminal The Biological and Environmental Data Terminal essentially already exists in table mounted versions with all of the capabilities desired These terminals cannot be transported easily and are not generally designed to withstand even the indoor ship environment or vessel power electrical transients Packaging is thus the key problem area.

Three levels of capability are shown in Table 22 The minimal capability represents the essentially no risk options that are extremely easy to implement and that follow naturally out of the demonstrated capability already extant The nominal capability options are also considered low risk In this case, all of the pieces have been separately demonstrated, they only need to be assembled and exercised together Such an assembly is not expected to generate operational problems but primarily needs only to be done The full capability is only a high risk in a relative sense Some of the components of interest are still in the development stage, and initial cost estimates are most likely high, in that they are based on following military specifications A number of the other elements are

## TABLE 22

## REQUIREMENTS FOR A MATRIX OF SHIPBOARD FISHERIES MANAGEMENT TERMINAL OPTIONS

| Capability Option | Location and Activity Terminal | Compliance and Quota Management Terminal | Biological and Environmental Data Terminal |
|---|---|---|---|
| Minimal | • Intermittent locations ± 1-2 km<br>• Accuracy information data relay 2 to 8 times daily<br>• Simple dial-on-cover inputs<br>• Remote terminal interface<br>• Unattended operation in exposed shipboard location | • Remote data input adjunct to Location and Activity Terminal<br>• Simple keyboard input and display<br>• Cassette recording compatible<br>• Hand held | |
| Nominal | • Near continous radio based location<br>• Near continuous indication of fishing activity<br>• Intermittent data relay 1 to 4 times daily<br>• Simple dial input retained as backup<br>• Remote terminal interface<br>• Unattended operation | • Remote data input adjunct to Location and Activity Terminal<br>• Remote data input adjunct to biological and environmental data terminal<br>• Tactile alphanumeric keyboard input<br>• Multiline, multicharacter display<br>• Programmable prompters<br>• Wrist mountable | • Suitcase packaged smart terminal<br>• Dual cassette recording<br>• Remote I/O interface |
| Full Capability | • Near continuous satellite-based location 0 5 km<br>• Near continuous indication of fishing activity<br>• Intermittent and interrogatable data relay<br>• Tactile button input and simple display kept as backup<br>• Remote terminal interface<br>• Unattended operation | | • Suitcase packaged smart terminal<br>• Dual cassette recording<br>• Remote I/O interface<br>• Continuous location 0 5 km<br>• Interrogatable data relay<br>• Hard copy printout |

bulky in their present configurations, and so packaging again becomes the key design challenge The remainder of this chapter will address the options for the three terminal types separately and then will bring them back together integratively to suggest modular development programs and schedules

## A LOCATION AND ACTIVITY TERMINALS

The options for each of the major components of the Location and Activity Terminal are shown in Table 23 For location, it is a matter of deciding whether you are going to use a vessel-generated signal to locate vessels from several shore stations or from several satellite positions or use shore-based or satellite-generated signals from several well known locations to generate a location for the ship at the ship All have been demonstrated The ship-generated signal options tend to be the lower accuracy capabilities but are also the easiest (and least expensive) options to implement The exact FAA location system accuracy was not established for this effort, since it is known to be poorer than needed The TIROS or NOAA satellite relay location accuracies and repeat times are adequate for many needs, although operational considerations limit the repeat time generally to less then eight times daily This is considered the best option for immediate application and indeed is that used in the present Coast Guard Fisheries Vessel Transmitting Terminal (FVTT)

For continued location monitoring to support more event-oriented assessments, one of the concepts uses the ship as the repeater or as the receiver processor of shore-based or satellite-generated location signals LORAN C is the least expensive system to use in a demonstration and should be considered for that use LORAN C does not cover all areas of interest though LORAN C, OMEGA, and TRANSIT are all to be phased out when GPS becomes extant All developmental cycles should consider evolution towards this capability

The differences in performance characteristics of strap-down gyros and accelerometers as indicators of fishing or non-fishing activity will have

TABLE 23

MAJOR COMPONENT OPTIONS FOR THE LOCATION AND ACTIVITY TERMINAL

| Terminal Capabilities | System | Repeat Time | Accuracy |
|---|---|---|---|
| Location Options | | | |
| Ship-Signal/Satellite-Repeater | TIROS-N/NOAA<br>NOSS | 2 to 20 times daily<br>2 to 20 times daily | 0 5 to 2 km<br>0 5 to 2 km |
| Ship-Signal/Shore-Repeater (or receiver/processor) | FAA like | As needed | TBD |
| Satellite-Signal/Ship-Repeater (or receiver/processor) | TRANSIT<br>GPS (9 satellite configuration) | 6 to 20 times daily<br>As needed | < 100 m<br>< 100 m |
| Shore-Generated-Signal/Ship-Repeater (receiver/processor) | LORAN C<br>OMEGA | As needed<br>As needed | < 50 m<br>< 500 m |
| Inertial Reference Options | | | |
| Strap-Down Gyros | | Continuous | TBD |
| Accelerometers | | Continuous | TBD |
| Data Transfer Options | | | |
| Low-Earth-Orbit Satellites | TIROS-N/NOAA[a]<br>NOSS[b] | 2 to 20 times daily<br>2 to 20 times daily | |
| Geostationary Orbit Satellites | GOES[c]<br>MARISAT[c] | Periodically or as interrogated<br>Periodically or as interrogated | |
| Radio | Single Sideband[d]<br>CW (Morse Code)[d] | Periodically or as needed<br>Periodically | |

[a]Data content = 256 bits

[b]Data content = TBD (>256 bits)

[c]Data content = 100 b/s

[d]Data content = As needed, TBD

to be determined by experiment No data presently exist to our knowledge Part of the development activity will be to assess alternative capabilities in somewhat more depth before committing to either option.

The data transfer options are also as shown on Table 22 and discussed earlier The TIROS-N/ARGOS concept is the best immediate solution, but it will not be able to handle the volume expected in the future (i e , the data per message and the number of platforms which can be handled at one time within the antenna beam of the satellite). The proposed NOSS data collection system would alleviate this somewhat, but it has not yet been approved Radio implementations are good in terms of data rate and availability, but they require very high powers (100 to 200 W) for on board operation and may only be operated by licensed operators GOES and MARISAT have somewhat equivalent performance for the fully developed capability. In their case, the ship may be interrogated to check on location, to support rendezvous operations, or to check a trend in the intermittent but periodic location data transferred through the system

Antennas are also a concern for the data relay function Radio antennas are typically 25-ft whip antennas, although we feel an 11-ft version might be sufficient for this application The GOES and MARISAT antennas are sizable dishes, which must be pointable for shipboard use

It is our opinion that these location capabilities and satellite transfer capabilities are of as much interest to the home office of the fishing vessels as they are to the U S. Many ships already have this capability in terms of TRANSIENT location terminals and MARISAT data relay It should be possible to include in the permit agreement a mechanism for giving fisheries law enforcement functions direct access to these capabilities automatically when the ships enter U S waters The observers should also be able to tap into this system directly when on board A radio operator middleman is not needed for such a system, since there is no present licensing mechanism.

Estimated costs for these systems alternatives are shown in Table 24 These engineering costs represent design, component procurement, assembly, and lab test of a prototype model Field test demonstrations

TABLE 24

ESTIMATED COMPARATIVE COSTS FOR RECOMMENDED LOCATION AND ACTIVITY TERMINAL OPTIONS

| Alternative | Minimal | Nominal | | Full Capability |
|---|---|---|---|---|
| | a | b | c | d |
| Terminal Cost | | | | |
| Engineering | $10,000 to $25,000 mods to FVTT | $50,000 | $50,000 | $100,000 |
| Unit | $2,500 to $3,500 | $5,000 to $6,000 | $5,000 to $6,000 | $7,000 to $12,000 |
| Message Cost | | | | |
| Daily | ∿ $8 per platform day | ∿ $8 per platform day | - | $6 per message |
| Shore Receiver Cost | | | | |
| Engineering | - | - | - | - |
| Unit | -[a] | -[a] | $1,000 to $5,000 | - |
| Operations | -[a] | -[a] | Present staff? | - |
| Assessment Cost | | | | |
| Software | $25,000 | $50,000 | $50,000 | $50,000 |
| Computer | $1,000 to $25,000 per year | $1,000 to $25,000 per year | $1,000 to $25,000 per year | $1,000 to $25,000 per year |
| Operations | Present staff? | Present staff? | Present staff? | Present staff? |
| Total | | | | |
| 150 Units, 300 30-day cruises | $500,000 to $700,000 per year | $900,000 to $1,100,000 per year | $800,000 to $1,000,000 per year | $1,300,000 to $2,100,000 per year |

were not included, although a few man-weeks of effort plus travel and per diem in each region in which a demonstration is to be made would cover that effort It should be remembered that there is a software cost if anything reasonable is to be done with the data once it is put into EMIS This cost might be undertaken by existing fisheries personnel, but allowances should be made for its funding in advance As an example, 150 units on 300 thirty-day cruises were used to show how costs accumulate. If care has not been taken in the initial design, refurbishment costs may be as much or more than the initial capital cost Battery costs were also not included

The cost logic noted above resulted in the recommended Location and Effort Terminal options shown in Figure 11 The minimal option is ARGOS oriented for location and data transfer and has no inertial reference data It differs functionally from the existing Coast Guard terminal only in that it is intended to be used unattended as well as attended and has an additional interface to allow remote loading of data into the unit from hand-held observer input units The nominal options make use of existing components but add the LORAN C receiver to demonstrate continuous location monitoring. ARGOS and radio data relay options need to be alternatively assessed as means of returning data The ARGOS is considered prime For Pacific Island observer cruises where the observer is out for long periods, it may be additionally necessary to use professional personnel who have a radio license[1] Inertial reference capability is also to be included in nominal level capability. Full capability emphasizes GPS and GOES/MARISAT implementations This is a development option due to the problems of packaging this capability. The relay antenna is particularly difficult to package in a portable configuration

---

[1]SPC has an experiment under way to test radio reception of 21- to 22-MHz single sideband radio signals from ships by a 25-ft omnidirectional whip aerial fixed to the ground at a fixed location in Maryland Radio traffic on the ship ham radio band will be recorded at the synoptic networking times, and each ship identifying itself will be located for reference This work will not be completed by the time this report is distributed

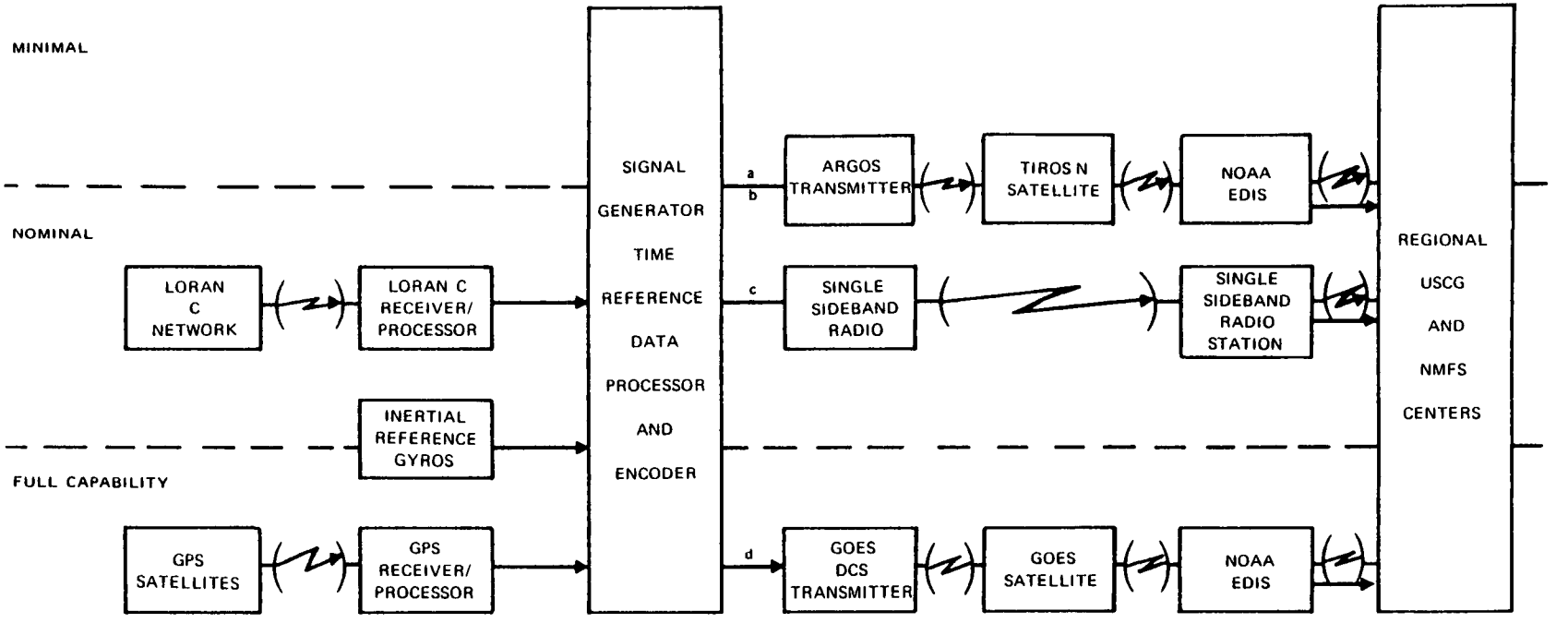



**FIGURE 11**
**RECOMMENDED LOCATION AND EFFORT TERMINAL OPTIONS**

## B COMPLIANCE AND QUOTA MANAGEMENT TERMINALS

The Compliance and Quota Management Terminal idea is essentially one of using the expanding capability of hand-held calculators, language translators, and inventory units to efficiently provide the data input functions of interest to the fisheries and the Weather Service. Initially, small hand-held units could be used to input and format the compliance and quota management information for transfer through the Coast Guard FVTT or its derivative terminals Hand-held data units already exist with capability very near that needed for this use. Pictorial representations of the units identified in a cursory survey of commercial data input units are shown in Figure 12 Comparative data are provided in Table 25 Units exist (with tactile numeric or alphanumeric keyboards) that will not be bothered by gurry and salt spray. The Tau Mark unit has four lines of display There are units with up to 120 K of memory and units with programmable memory attachments that would allow data collection forms to be stepped through, item by item Some units are cassette recorder compatible, others radio transfer the data to a master data processor SPC owns a Radio Shack unit that it is evaluating for this use We believe that the most cost effective approach would be to buy several different units (after a more thorough survey) and to evaluate them relative to this specific job Several of the companies are willing to modify the units at their own expense if the changes are not extensive, believing they will make it up on potential volume We believe that simple adaptations will probably be sufficient to accommodate the requirement for compliance and quota management data inputting and formatting

The second level of capability of interest is to use the portable terminal for logging in all of the detail catch data and environmental data This would be a wrist-mounted unit based on the units shown in Figure 12 but having larger memory capacity and enough display capability to provide three lines of approximately 30 characters each One concept of such a unit is shown in Figure 13. The 30 characters allow for five columns of 6-digit data The first single-line display provides reminders like date, time, haul or set number, sample member, etc , to keep track of

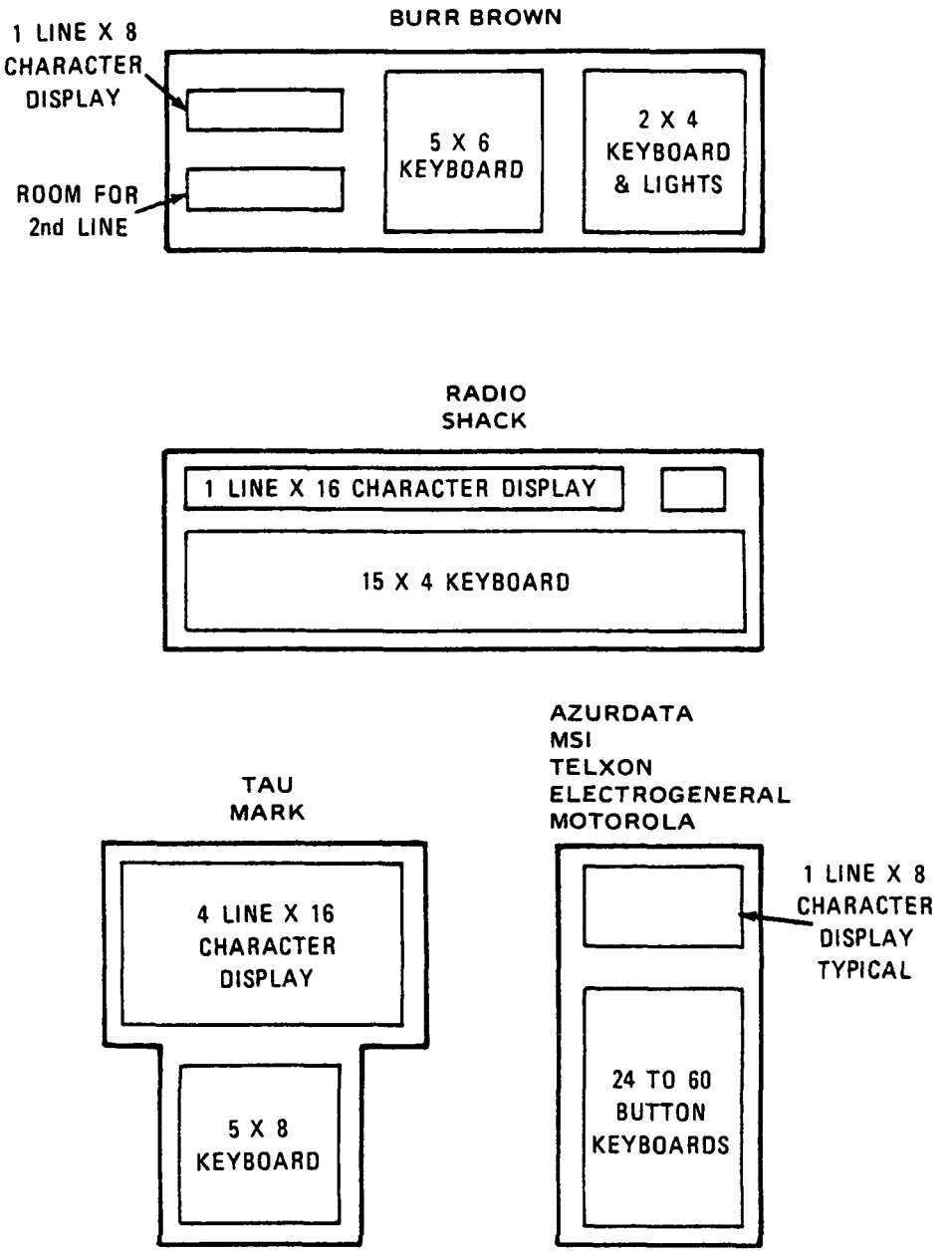



FIGURE 12
PICTORIAL REPRESENTATIONS OF EXISTING COMMERCIAL DATA INPUT UNITS

TABLE 25

COMPARATIVE CHARACTERISTICS OF HAND-HELD COMMERCIAL DATA TERMINALS

| Company | Keyboard | Display | Memory | Power Source | Approximate Cost | Special Features |
|---|---|---|---|---|---|---|
| Azurdata | 20 characters<br>tactile<br>audible confirmation | 14 character line<br>LED | To 64 K NMOS | Rechargeable NiCd<br>backup watch battery | | Optical wand scanner<br>RS 232 interface<br>edit capability<br>acoustic coupler |
| Burr Brown | 18 characters<br>7 function keys<br>tactile | 8 characters | | | $274 | Acoustic coupler |
| Electrogeneral | 41 character<br>alphanumeric | 2 8-character lines<br>LCD | 48 K | Rechargeable NiCd | $2 000 to $3 800 | Operator programmable<br>RS 232 interface<br>edit and prompting capa bility scratch pad |
| Motorola | 53 character<br>alphanumeric<br>tactile | 16 character line<br>LED | 480 characters | Rechargeable NiCd<br>backup watch battery | | FM radio to master<br>edit capability<br>optical wand scanner<br>acoustic coupler |
| MSI | 28 character<br>alphanumeric | 16 character line<br>LED or LCD | To 64 K<br>14 memory pages | 4 AA penlight batteries<br>backup watch battery | $1 450 to $2 700 | Optical wand scanner<br>RS 232 interface<br>attachable PROMS |
| Radio Shack | 57 character<br>alphanumeric | 24 character line<br>LCD | 1 5 K RAM | 4 camera batteries | $400 | Cassette interface<br>edit capability |
| Tau Mark | 64 character<br>alphanumeric | 4 lines of 16 characters<br>LED | 16 single line<br>messages | | $3 600 | 2-way radio to master<br>optical wand scanner |
| Telxon | 32 character<br>alphanumeric<br>(can be tactile) | 16 character line<br>LED or vacuum<br>flourescence | To 64 K CMOS<br>To 128 K NMOS | 4 AA penlight batteries<br>or rechargeable NiCd<br>backup watch battery | $1 200 to $2 800 | Optical wand scanner<br>RS 232 interface<br>20 column thermal printer<br>40 column impact printer |

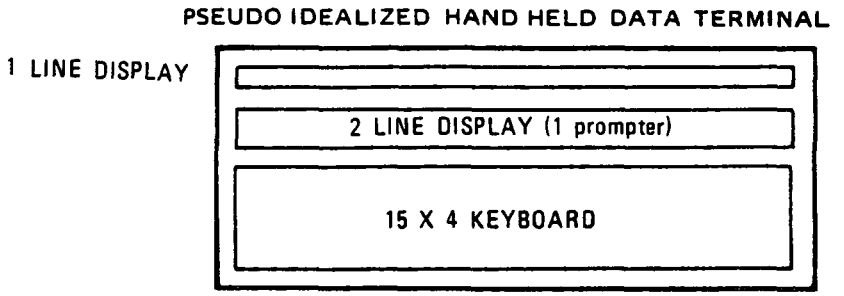



**FIGURE 13**
**SAMPLE IDEALIZED VERSION OF A WRIST MOUNTED DATA INPUT UNIT**

where in the data collection process the observer is. The first line of the two-line display is a selectable five column prompter with the prompting categories aligned as shown earlier in Tables 14 and 16. The second line shows the data inputted. If the observer verifies that line of data is punched correctly, then an input button places it in memory as a recallable item number The keyboard would be tactile and thus not affected by exposure to salt spray and fish gurry The major design problem will be in the connection mechanism between this unit and either the Coast Guard terminal or the suitcase-packaged smart terminal to be addressed in the next section

The major characteristics of these two units are summarized in Table 26 along with first-level estimates of the costs to develop the units The high-data-capacity unit, in particular, should have an extremely large market beyond the fisheries and environmental data usage

## C BIOLOGICAL AND ENVIRONMENTAL DATA TERMINALS

Although the wrist-mounted terminal described in the last section is potentially a very powerful data input tool, there are a number of things it cannot do It cannnot save up catch data from several different memory loads in order to put together daily or weekly summaries It cannot merge

TABLE 26

COMPLIANCE AND QUOTA MANAGEMENT OPTIONS AND COMPARATIVE COSTS

| Minimal Version | Nominal and Full Capability Version |
|---|---|
| • Adapting software/firmware of existing hand-held terminals<br>• Buy several versions for study<br>• Input one or more ARGOS loads at a time and transfer data to Location and Effort Unit<br>• Easy to transport | • New assembly of available components for hand-held or wrist-mounted use<br>• Design capability to input at least several hours of biological data collection before needing data dump<br>-- At least 3-30 character display lines<br>-- Tactile numeric or alphanumeric input<br>-- Additional interfaces to Location and Effort Terminal, cassette or disk recorder, printer, or data handling and transfer unit<br>-- Recall and edit capability |
| • Approximately $400 to $1,000 per unit<br>• $30,000 for investigation and demonstration of capability | • $35,000 to $50,000 for design study to demonstrate unit<br>• $500 to $2,000 per unit on quantities, $5,000 to $10,000 per demonstration |

location, environmental data, or other peripheral data (taken at other work locations) into the biological data stream at the places where they are interactive It cannot recall entire data sheets for review to check missing data systematically or allow verification while the day's activity is still fresh in the mind It cannot interface with a printer in such a way as to provide ordered copies. It might be possible to work around these problems somewhat by doing running summaries of species data that are retained during normal dumps into the cassettes, or by taking the penalties in lack of freshness and potential conflicts in time-availability by waiting until the data are returned to the regional assessment center, but we believe that relatively inexpensive portable smart terminals can be developed to allow these functions to be economically accomplished on board the foreign fishing NWS vessels

The SEAS unit, the TI SILENT 700 used in the NW fisheries region, and some selected systems put out by other companies are compared in Table 27 These systems are all table-mounted units They illustrate that almost any capability can be put together at a variety of reasonable costs The SEAS unit includes the GOES/MARISAT data relay capability, batteries, etc , not included in the other units The TRANSIT position locator is a planned add-on to a later model The SILENT 700 is a single package--with keyboard, computer, CRT, dual cassettes, and additional interface connections The printer is optional. Rockwell has the keyboard, computer, one line of display, printer, and an interface unit for about $500 CRT, cassette recorders and additional working memory can be added to this unit for any capacity desired. Cromenco is also a modular growth system A separate keyboard and CRT system was added to the cost of the basic unit, which contains dual-disk drives, computer, 4 K of memory, and suitable interfaces The cost variation shown is purely from memory additions Exidy is one of many home computer manufactures and has a little more capability then most of the more popular versions It, too, could do the basic job well

In addition, the Army has developed a Special Forces Burst Communications System that has much of the data logging, manipulation, and relay capabilities of interest This system includes a hand-held Digital Message

TABLE 27

COMPARATIVE CHARACTERISTICS OF SOME SELECTED SMART TERMINALS

| Company or Organization | Keyboard | Display | Memory | Approximate Cost | Special Features |
|---|---|---|---|---|---|
| National Weather Service (SEAS) | Standard alphanumeric not tactile | CRT | To 64 K RAM, 8 K ROM, or | $14,000 | To Parallel I/O lines, RS 232 compatible GOES data relay, TRANSIT position locator, 8080 microprocessor |
| Texas Instruments (Silent 700 Series) | Not tactile | CRT | Twin Cassettes | $3,000 to $6,000 | |
| Rockwell | Standard alphanumeric, not tactile | 2-character display CRT compatible | Dual-cassette compatible, PROM expandable | $500 plus CRT and dual cassettes | |
| Cromenco | Standard alphanumeric | CRT | 4 K to 512 K RAM, 1 K PROM dual disk | $3,000 to $27,000 | |
| Exidy | Standard alphanumeric | CRT | 32 K RAM, PROM languages | $1 800 | |

Device that enters and formats alphanumeric messages for burst transmission through standard radio or satellite channels (Ref 6) This and the transmitting equipment are powered on NICAD batteries, rechargeable from a hand-cranked generator

What is needed for the collection of biological and environmental data is the equivalent of these units, suitcased packaged, and with as many high-volume, low-cost components strapped together as is practical Two typical front configurations are shown in Figure 14, one for an LCD display the other for a CRT The first can be flat packaged (e g , 4 to 6 inches deep with all the capacity needed by using the 24 x 64 LCD display suggested earlier The observer will not be able to play computer games on that configuration, but otherwise all data taking functions will be feasible If a deeper suitcase is allowed, then a small CRT could be added. In both configurations, batteries are assumed to be a separately packaged module--carried separately, and attached to the bottom or part of the lid

This terminal would functionally look like Figure 15. TRANSIT or GPS location inputs, automated environmental and biological sensors, and the hand-portable data input unit would all have interfaces in a prototype unit All desired processing and storage capabilities could be included, and all three of the future data relay options[1] could also be included

Table 28 was developed to compare both the Biological and Environmental Data Terminals and the earlier discussed Location and Activity Terminals The capability progress is obvious. The nominal data terminal option is just the suitcase-packaged smart terminal with a TRANSIT locator and a TIROS-N data relay for emergency messages The full-capability option (f) is similar to the Model IV version of SEAS at a considerably more optimistic estimation of cost (see Ref 2) We must point out that the design philosophy we propose is different than that used in the SEAS effort If we responded to their RFP, we would probably bid higher than their estimate since we do not have manufacturers economies of scale and

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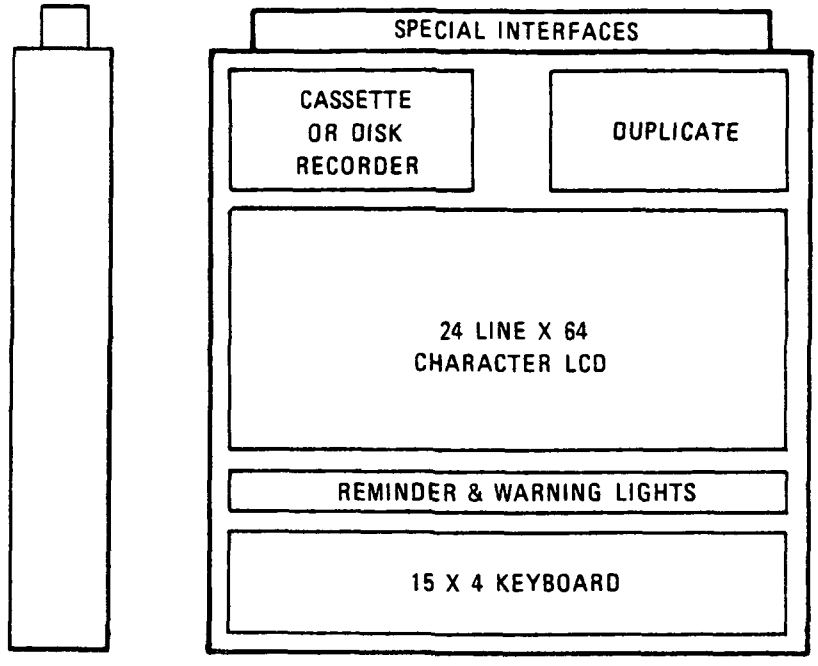
[1]The NOSS system would replace ARGOS if the present system proposed by SGFC is approved



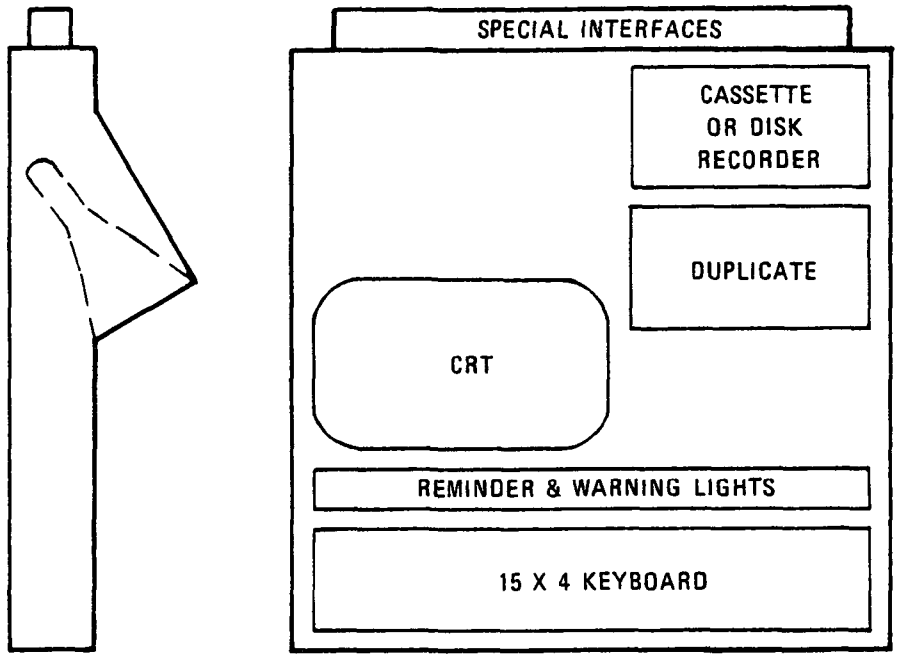




FIGURE 14
PSEUDO IDEALIZED SUITCASE PACKAGED DATA TERMINAL

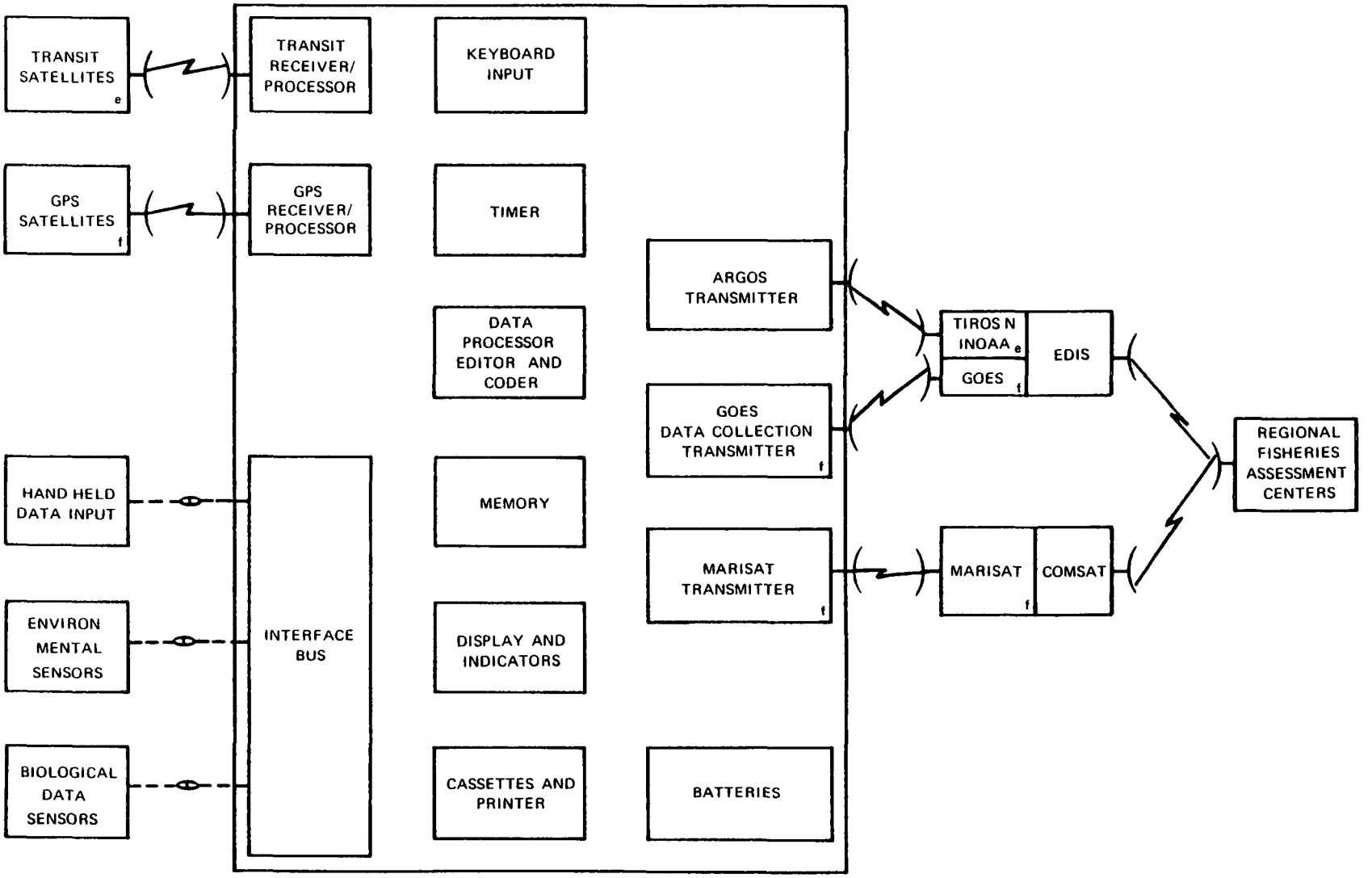



**FIGURE 15**
**BIOLOGICAL AND ENVIRONMENTAL DATA TERMINALS**

# TABLE 28

## COMPARATIVE CAPABILITIES OF BIOLOGICAL AND ENVIRONMENTAL DATA TERMINALS

| | Location and Activity Terminals | | | | Data Terminals | |
|---|---|---|---|---|---|---|
| | Modified FVTT | Nominal Satellite Based | Nominal Radio Based | Full Capability | Nominal | Full Capability |
| | a | b | c | d | e | f |
| Location Mechanism | TIROS N/ NOAA | LORAN C | LORAN C | GPS | TRANSIT | GPS |
| Position fixes per day | 2 to 20 | As needed | As needed | As needed | 6 20 | As needed |
| Nominal accuracy | 0 5 2 km | < 50 m | < 50 m | < 100 m | < 100 m | < 100 m |
| Inertial Mechanism | No | Gyro | Gyro | Gyro | No | No |
| Data Input Mechanism | Dials | Tactile | Tactile | Tactile | Tactile | Tactile |
| Contained or remote keyboard | Both | Both | Both | Both | Both | Both |
| Automatic inputs | No | No | No | Yes | Yes | Yes |
| Data Handling | | | | | | |
| Recall and edit | On Dials | Yes | Yes | Yes | Yes | Yes |
| Calculations | No | No | No | No | Yes | Yes |
| Printer | No | No | No | No | No | Yes |
| Cassettes or disks | No | No | No | Yes | Yes | Yes |
| Data Transfer | TIROS N/ NOAA | TIROS N/ NOAA | SSB Radio | GOES or MARISAT | TIROS N/ NOAA | GOES or MARISAT |
| Transfers per day | 2 20 | 2 20 | As needed | As needed | 2 20 | As needed |
| Saturation level | 130 in view | 130 in view | TBD | 10 000 | 130 in view | 10 000 |
| Interrogatable | No | No | Yes | Yes | No | Yes |
| Two way capability | No | No | Yes | Yes | No | Yes |
| Relay Risk | Some | Some | Can be high | Low | Some | Low |
| Approximate Unit Cost | $3 000 | $5 000 | $5 000 | $8 000 | $9 000 | $12 000 |
| Plus Hand Held Unit Cost | $500 | $1 000 | $1 000 | $2 000 | $1 000 | $2 000 |
| Total Data Input & Relay Unit Cost | $3 500 | $6 000 | $6 000 | $10 000 | $10 000 | $14 000 |
| Message Cost per Platform Day | ∿ $8 | ∿ $8 | TBD | ∿ $6 | ∿ $6 | ∿ $6 |

would be meeting those specific specifications To get the costs we estimated, it was assumed that it would be acceptable to assemble high-volume components from several manufacturers into an integrated capability without the design activity implied by their specification. We believe the industry is mature enough to allow this modular approach

## C COMBINED PERSPECTIVES

A combined developmental flow plan for capability improvements in these three terminal types is shown in Figure 16 Feasibility has been demonstrated by existing units The first of the three capabilities shown represents a minimal effort that just gives a first-level practicality demonstration for each terminal type and its specific benefit functions The nominal capability versions represent options in which all benefit capabilities are present, but in the versions least expensive to implement rather than those giving the best long-range service The full capability options represent inclusion of all of the capabilities of interest in their long-range configurations (e g , GPS location and GOES/MARISAT data relay)

The flow concept shown in Figure 16 is developmentally correct, but not what we would recommend directly in terms of a time progression The appropriate time progression agreeing with Table 22 was shown in Figure 4 The differences from Figure 16 are only in the bottom three boxes and result in shifting essentially one position to the right The Step 1 options then are zero risk developments, with minor modifications to the existing Coast Guard terminal and commercial data input units, essentially within their present packaging Step 1 provides near-immediate operational capability, although limited in the quantity of benefits achievable Step 2 is also low risk in that all of the capabilities exist in economic (high volume) versions at the component level and only need to be integrated into portable packages Step 2 provides access to most of the potential benefits identified Step 3 allows incorporation of new subsystems not presently available economically, but intended to eventually replace capabilities incorporated as stop gaps in the Step 2 systems

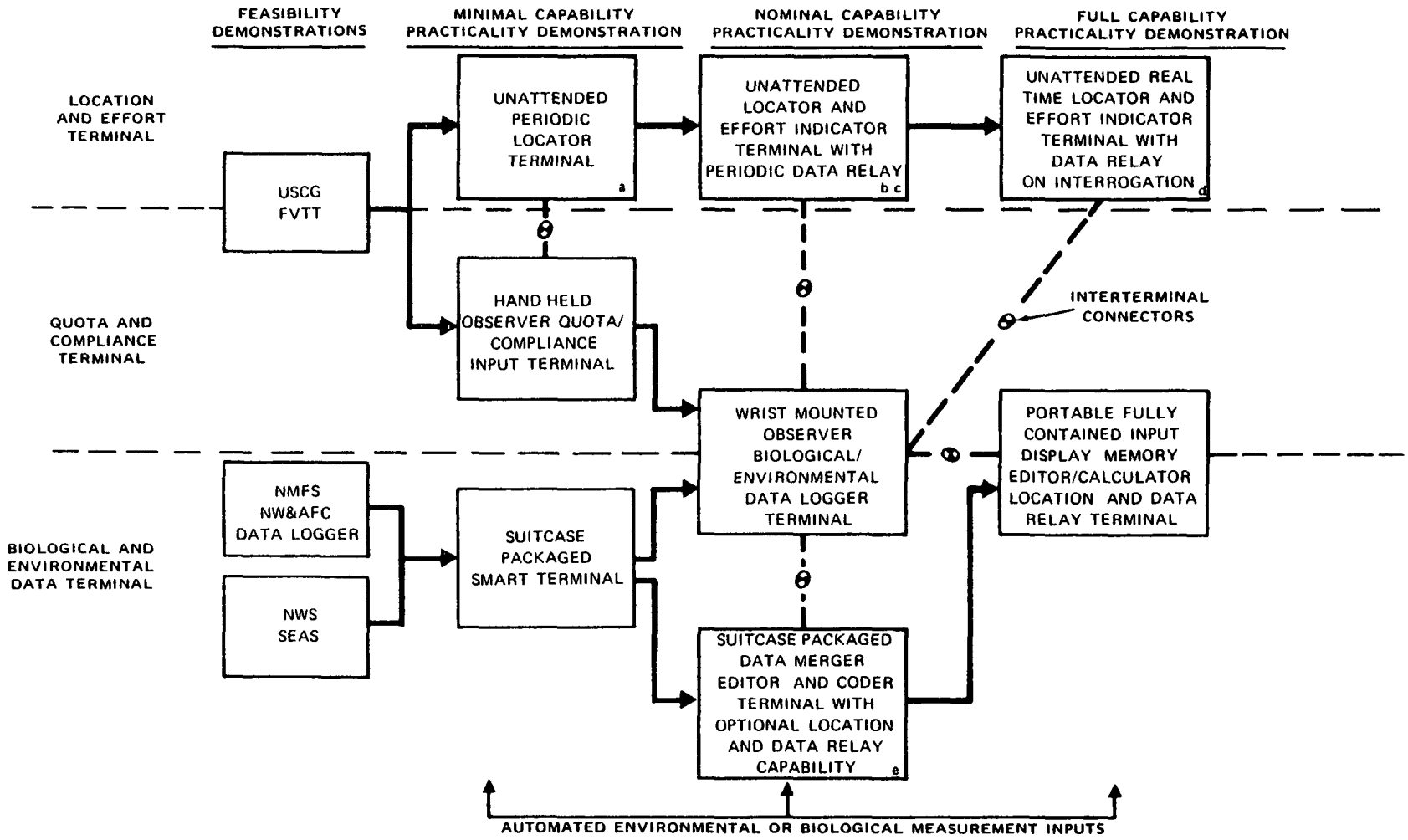



**FIGURE 16**
**DEVELOPMENTAL FLOW FOR CAPABILITY EVOLUTION IN SHIPBOARD FISHERIES MANAGEMENT TERMINALS**

It is important to stress that all of these units are interdependent and do different things for different Fisheries, Weather Service, and Coast Guard functions, but they share certain capabilities in order to prevent unnecessary and costly duplications For this reason, they should be developed modularly and the interfaces carefully thought out and controlled An example of this modular approach, fitting the flow concept shown in Figure 4, is shown in Figure 17 Interdependence is the key notion

The recommended development plan for these three terminal types is shown in Table 29 The schedules are not staggered since all items represent pieces that can be stretched to meet funding prognoses, and earlier steps can be bypassed if the need is great enough to go directly to full capability The costs shown do not include software costs for data manipulation and interpretation at the storage and access facility nor do they conclude terminal maintenance costs Texas Instruments SILENT 700 maintenance contracts run about 10 percent of the purchase price, and the SEAS program has allowed 25 percent of the equipment costs in its estimates This bounds the problem Sufficient cost building blocks are furnished to allow costs to be developed once specific options, in terms of system capability and the number of desirable buys, are developed

The development plan assumes that the Coast Guard will implement the Operational Location and Activity Terminals but that NASA might join them in the prototype developments for the higher performance versions It was assumed that the hand-held and wrist-mounted terminals were direct applications of existing commercial technology and thus the NMFS would take major responsibility for these units We would like to point out, though, that these terminals have broader application throughout NOAA, in particular, and in other portions of the government with data collection interests from observers in the field A more multiuser development might be warranted. This could take place within NOAA, by itself, or perhaps by NASA interfacing with many government organizations

The suitcase units are also of broad application both with NOAA, NASA, and other agencies Again some form of joint implementation is recommended, with the present participants forming a good initial subset

| | PRESENT | STEP 1 | STEP 2 | STEP 3 |
|---|---|---|---|---|
| DATA TRANSFER | ARGOS | ARGOS | ARGOS | GOES/MARISAT |
| LOCATION | ARGOS | ARGOS | LORAN C | GPS |
| ACTIVITY | NONE | NONE | GYRO | GYRO |
| DATA INPUT & DISPLAY | DIALS ON A SUITCASE | ADAPTED LOW CAPACITY COMMERCIAL DATA TERMINAL | NEW HIGH DATA CAPACITY WRIST MOUNTED DATA TERMINAL | |
| PORTABLE INPUT | NONE | | | |
| SMART TERMINAL | TI SILENT 700 ET AL | | NEW LCD DISPLAY SMART TERMINAL | NEW LCD DISPLAY SMART TERMINAL |
| DATA STORAGE FOR MANUAL RETURN | DUAL CASSETTES | | DUAL CASSETTES | DUAL CASSETTES |
| | TABLE MOUNTED | | SUITCASE | SUITCASE |
| LOCATION | NONE | | NONE | GPS |
| DATA TRANSFER | NONE | | NONE | GOES/MARISAT |

FIGURE 17
EXAMPLE MODULAR GROWTH

TABLE 29

RECOMMENDED SHIPBOARD FISHERIES MANAGEMENT TERMINALS DEVELOPMENT PLAN

| Terminal | | Cost Estimate | Schedule - Months from Start of Effort (0 1 2 3 4 5 6 7 8 9 10 11 12 13 14) | |
|---|---|---|---|---|
| Location and Activity Terminal | | | | |
| Step 1 | Modify design of FVTT | $10,000 to $25,000 | Design | USCG |
| | Purchase multiple LATs | $3,500 per terminal | Procure Production | USCG |
| | Software development | $25 000 | Procure Production | USCG |
| Step 2 | Design, develop and test LAT with near-continuous location/effort | $50 000 to $100,000, $6,000 per terminal | Design Develop Test | NOAA/ NASA |
| Step 3 | Design, develop and test LAT with near-continuous location/effort and inter-rogatable data transfer | $100,000 to $150,000, $10 000 per terminal | Design Develop Test | NOAA/ NASA |
| Compliance and Quota Management Terminal | | | | |
| Step 1 | Develop plug-in data input from available designs (includes purchase of three off-the-shelf units) | $30,000 | Assess Demonstrate | NMFS |
| Step 2 | Develop a full capability wrist-mounted data terminal from available subsystems | $35,000 to $50,000 | Design Assemble Demonstrate | NMFS |
| Biological and Environmental Data Terminals | | | | |
| Step 2 | Suitcase version of smart terminals without location and satellite transfer capabilities | $25,000 to $50,000, $2,500 to $5,000 per unit[a] | Design Assemble Test or Design Procure Test | NOAA & NASA |
| Step 3 | Suitcase version of smart terminals with satellite location and data transfer | $100,000, $10,000 to $15 000 per unit[a] | Design Assembel Test | NOAA & NASA |

[a]Less than estimated SEAS unit costs

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