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The Development of a Portable Fish Measuring Station for Electronic Data Acquisition in the Field

by

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Management of fish stocks requires the collection of large amounts of data through commercial port sampling, observers on fishing vessels and by means of research vessel surveys (Doubleday, 1981). This entails collecting data concerning fish lengths, weights, maturity stages and material for aging the fish of interest to DFO scientists. Data are usually recorded on field sheets, which must then be transposed, checked and finally keypunched for computer use. Such procedures are laborious, time-consuming and subject to error (Rivard, 1981). It is difficult for the sampler to know what constitutes an adequate sample (Doubleday and Rivard, 1983). On research vessels, one person measures fish, while another records data. Port samplers and observers often work alone, which can create problems for recording data. Field sheets can be damaged or lost because of wet field conditions. It often takes 3-4 months to have data coded and keypunched from a research vessel survey. The Gulf Region Department of Fisheries and Oceans seeks to carry out these duties with limited technical and computer support staff.

The objectives of the present research project have been the following:

1) Collect data in a computer compatible format. This would eliminate the need for data sheets and the need to transpose and keypunch data.

2) Assess the adequacy of sampling during the sampling period. Computerization in the field would allow data to be printed out, plotted as histograms and the number of samples taken to be displayed. This could allow the sampler to decide how many and what further samples might be necessary.

3) Develop a device that could be used by a single sampler under a variety of field conditions. This would necessitate a device which would be lightweight, portable, rugged, waterproof and battery operated. The device should be adaptable to the traditional data aquisition procedures, easy to use and allow rapid data acquisition. Preferably, this would allow the technician to collect more data with less effort.

4) The programming should be user friendly for technical staff with little or no knowledge of computers.

5) The primary information needed is information on fish lengths. However, the device should allow the input of additional information concerning sampling localities, depths, species measured and keep track of the numbers of fish subsampled for otoliths, stomachs, maturities etc.

6) We sought to develop a device which could be expanded to communicate with other data acquisition devices. For shipboard data acquisition, one also needs to collect data concerning the weight of each species caught, the weight of subsamples or individual fish weights and numbers (Doubleday, 1981).

7) The device(s) should efficiently and rapidly communicate among themselves, as well as with other computing devices. This would facilitate efficient data collection and data transfer to other computers.

Armstrong (1976, 1981, 1982) has described the development of a semi-automatic fish measuring board in Aberdeen, Scotland. His system initially consisted of a grooved measuring board with magnetically activited reed switches. The system transfers data to a tape recorder. In 1981 the switches were changed to 'Hall effect' sensors in a fiberglass board. Armstrong (1982) integrated the system to a portable computer (weight 12 kg). The board has been used to measure fish lengths in the Aberdeen market. Limitations to the system are its weight and the ability to digitize only fish lengths. Other data such as species, basket weights, date, gear, category, weight sampled and weight landed must be keyed into the microcomputer after lengths have been digitized by the electronic fish measuring board.

Initial Design of a Portable Fish Measuring Station

In view of our objectives and the previous work by Armstrong (1976, 1981, 1982) a prototype portable fish measuring station was built by the second author under contract with DFO. The prototype consists of a 1 meter fiberglass fish measuring board, linked to an electronic display box. This in turn can communicate with a host computer and printer. (Fig 1) Data can then be transferred to a digital tape drive unit which is housed with the computer and printer in a waterproof Pelican carrying case. An RS232C communications module allows the transfer of data from the digital tape drive to other computers. The case also contains 6 rechargable lead acid batteries which can allow the system to collect data from the board for over 10 hours in the absence of a power source.

The fiberglass fish measuring board with Hall effect transistor sensors represents a substantial improvement over the Scottish measuring board. A keypad on the end of the board allows data concerning locality, species, sex, maturity stages, subsamples such as fin ray counts, otolith and/or scale samples etc., to be digitized into the solid state memory in the board. This is done with a magnetic probe used by the technician measuring fish. Fish are placed on the board in the conventional manner with the snout against a vertical headboard. Placing the magnet vertically on the fish's tail allows the measurer to record the fish's length to the nearest centimeter. This may be either total or fork length, as desired. The memory chips in the board can record up to 2000 measurements when operated without being connected to the Sharp PC 1500 computer. The board can be flipped over to be used either from the left or the right. By putting the probe to a key on the keypad it is possible to tell the board to record data from a left handed recorder. This changes the position of some of the keys on the keypad. Most keys are dual function keys in this respect.

The display unit communicates with the electronic fish measuring board. The technician measuring fish can read the length of the fish as a numerical LED display while hearing an audible beep to know that the value has been recorded in memory by the board. Red LED buttons are activated on the display as the technician touches the magnetic probe to magnetic keys on the keypad. A different beep for each key is emitted to help the measurer keep track of what is being recorded. Audio feedback can be generated by the display or through an external speaker or earphone coupled to the display by an external jack. The display unit has external pin connections for other peripheral devices. A set of electronic digital calipers can be coupled to the display for measuring small fish or invertebrates to the nearest millimeter (McAllister and Planck). Balances can be connected to the display to integrate weights with fish length data. The display unit has RS232-C communications ports to receive and transfer data. Information fed to the display unit is passed to a host computer. The Sharp PC-1500[1] was chosen as the host computer for this prototype. The computer and printer each cost less than $300. The PC-1500 weighs 375 g and the CE-150 printer weighs 900 g. The PC-1500 comes with about 4K of RAM memory. We have added a CE 159 memory module with 8 kilobytes (KB) of C-MOS RAM memory, to run the programming developed so that the Sharp can coordinate and communicate with the processors in the board and display unit. The PC-1500 can be used to alter the programming in the board. Keys on the board's keypad can be redesignated by the Sharp. A digital clock in the Sharp keeps track of the time data is collected and can be recorded. A 2 second interval delay was programmed into the board to adjust the sensitivity of the sensors to the magnetic probe. The Sharp is coupled to the printer and gives a numerical listing of the data (Fig 2) as it is collected. After a series of measurements, the pocket computer can printout histograms (Fig 3) for each set or locality. It is thus possible to evaluate the adequacy of the sampling as it is being collected. Subsamples such as otoliths are indicated on the paper printout. The computer provides a means of programming alphanumeric and numeric data into the display and the board. The host computer can communicate with them as data is collected or it can be used to strip data from the board after it is collected. On research vessels it seems best to transfer data to the computer in real time. Port samplers or observers can collect data with the board and display unit in the absence of the computer. The data can be dumped to the computer after sampling is completed for the day in a more protected environment. Observers can do this in the ship's cabin and port samplers can return to their hotel from the fish plant. This reduces the need to take the computer and digital tape drive in the field.

Data stored in memory in the host computer is transferred to a digital tape drive. The tape drive has cassettes similar to those used in portable dictaphone tape recorders. The cassettes can be removed as they are filled and replaced by blank tape. These cassettes could be mailed back to a central facility by port samplers. Alternatively, the data could be sent to other localities using a modem connected to telephone lines. The RS-232C asynchronous communications port is a widely used means to transfer data to a wide variety of other computers. Data transfer is done electronically with no possability of transposition errors, little time delay and no need for data entry following the survey.

[1] Brand names mentioned does not imply endorsement of any particular product by the Department of Fisheries and Oceans.

Evaluation of Original Prototype

The prototype was tested on the Wilfred Templeman during June 1983. Several technicians tried using the system to measure marine fish such as redfish and cod. The meter long board was noted to be adequate except for larger cod. Lengths of fish exceeding the length of the board can be entered through the numeric keypad on the board.

Initially, the technicians used a magnetic probe to enter length data from the board. This necessitated putting down the probe and picking up a knife to cut open the fish for sex determination. It was then necessary to pick up the probe again to code the sex of the fish on the board's keypad. The idea of putting the magnetic probe in the head of the knife was suggested as a means of saving time. This was tried subsequently and found to facilitate data collection. However, even with a separate probe the technicians found they could measure fish electronically at about the same rate as with the traditional method. With the traditional method the measurer often has to repeat data to the recorder. The electronic board allows the measurer to proceed at his own pace.

Several faulty sensors inhibited the collection of data using the prototype on the Templeman. The Hall effect transitor sensors used were found to be inferior. Different Hall effect sensors were later substituted for the initial ones tested. During October 1983, the prototype was used to measure about 20,000 redfish with no problems from faulty sensors.

A balance which was designed to measure the weight of individual fish up to 5 kg was tested on the Templeman in conjunction with the display unit and board. The balance has been designed to take into account the linear acceleration due to the motion of the ship. A known weight inside the balance is used to correct fish weights in relation to the up and down motion of the ship. The processor in the balance takes 5-7 samples per second and averages between 2 to 5 of those samples to obtain a reading. The results indicated that a higher rate of sampling was necessary.

The prototype was used to collect redfish data on the Lady Hammond during September-October 1983 with one techinican taking measurements. The vessel technicians complained that the 2 second time delay was too slow. The computer reprogrammed the processor in the board to accept data after a 0.25 second time delay. The technicians found that the system appeared to be more sensitive to the magnetic probe. They could input data faster than the printer could take data from the computer. One technician after measuring 300 redfish in 20 minutes had the printer coughing up data for another 5 minutes. Measuring fish at this rate created a communications problem between the board and the host computer. Messages from the board were coming to the computer faster than the Sharp PC-1500 could reply. This caused the computer to stop accepting data 2-3 times each day. The problem was overcome on the cruise by turning off the computer, then restarting the computer and its program.

Initially, the system was used on the ship with the computer connected to the board in the wet laboratory. The Pelican case was kept open because of the slowness of the printer. During the second half of the cruise, the printer stopped working. Later it was found that a small fish scale had become lodged in the printer. Problems with dirt were overcome by placing the Pelican case in the dry laboratory connected to the display and board in the wet laboratory by a long cable.

Modification of Prototype

The fish measuring board initially tested has certain deficiencies. The technicians felt that there were too many cables needed to connect the various parts of the system. To rectify this, a new fiberglass board has been built. The board is 1.4 meters long and 25 cm wide. The original board was 1 meter long and 15 cm wide. This should better accomodate longer cod and wider species such as flatfish. The display unit is now housed at the head of the board inside the fiberglass housing. The LED's are directed upward for rapid consultation. Sex keys which were part of the keypad have been shifted to the lower mid part of the board to reduce reaching to the end of the measuring board.

The Pelican case containing the Sharp PC-1500, printer, digital tape drive and batteries weighs 6.8 kg. Most of the weight and bulk is due to the tape drive which was specially designed and fabricated. The weight of the system and the communications problems cited earlier have induced us to purchase a new host computer.

Late in 1983, the Epson HX-20 became available in Canada. This computer has certain advantages. The unit comes with 16KB of RAM and is expandable to 32KB. A 24 column dot matrix printer can print 42 lines per minute. The unit is powered by Nickel-Cadmium batteries with a 40 hour capacity. A microcasette can be added to the computer to record data coming from the board. External pin connections allow easy RS232-C communication with peripherals and other computers. Communications rates can range from 110 to 4800 characters per second. This should eliminate the communications problem encountered between the display and the Sharp PC-1500. Programming which has been developed on the Sharp system will run in BASIC on the Epson HX-20. The HX-20 system weighs 1.7 kg, in comparison to the Sharp in the Pelican case which weighed 6.8 kg. The modified system will be evaluated in July 1984. The Epson HX-20 linked to the new measuring board promises to be a flexible low-cost portable fish measuring station (Fig 4).

Within the last six months a 50 kg balance for weighing fish baskets at sea has been built. This balance uses similar software as the 5 kg balance previously tested. Like the other balance, the unit can compensate for the ship's motion. An alphanumeric keypad associated with the balance will input information concerning species, set numbers and subsample numbers to the system. The balance will connect to the display unit of the new board. The display unit can communicate with the Epson HX-20 in a manner similar to that described for the Sharp PC-1500.

Plans for Shipboard Data Acquisition

The portable fish measuring station previously described will not be adequate to cope with data acquisition at sea. An expanded system (Fig 5) will incorporate several boards each with a display consul passing data to a Corona PC-2 in an MS-DOS operating system which is compatible with IBM-PC software. It comes with 128 KB RAM memory and is expandible to 512 KB. The display of board A will link to the display of board B which in turn will pass data to the dry lab containing the Corona PC-2 computer on a single cable. The 50 kg balance for weighing fish baskets and the 5 kg balance can also be linked to the displays. The Epson HX-20 will be used to collect data on the bridge to record the information normally placed on a set sheet. This information can then be linked to the host computer to integrate information in localities (Loran C, Latitude and Longitude), depths, distance towed, etc., with the measurements coming from the fish measuring boards. Other computers such as the HP-85 used to collect water temperature profiles can also communicate with the main host computer. A data management system on the Corona PC-2 will incorporate all data onto floppy disks in a manner similar to computerized formats presently operating at the fisheries headquarters on shore. Using such a system it will become possible to place all data collected on a cruise on the host computer before the ship has returned to port.

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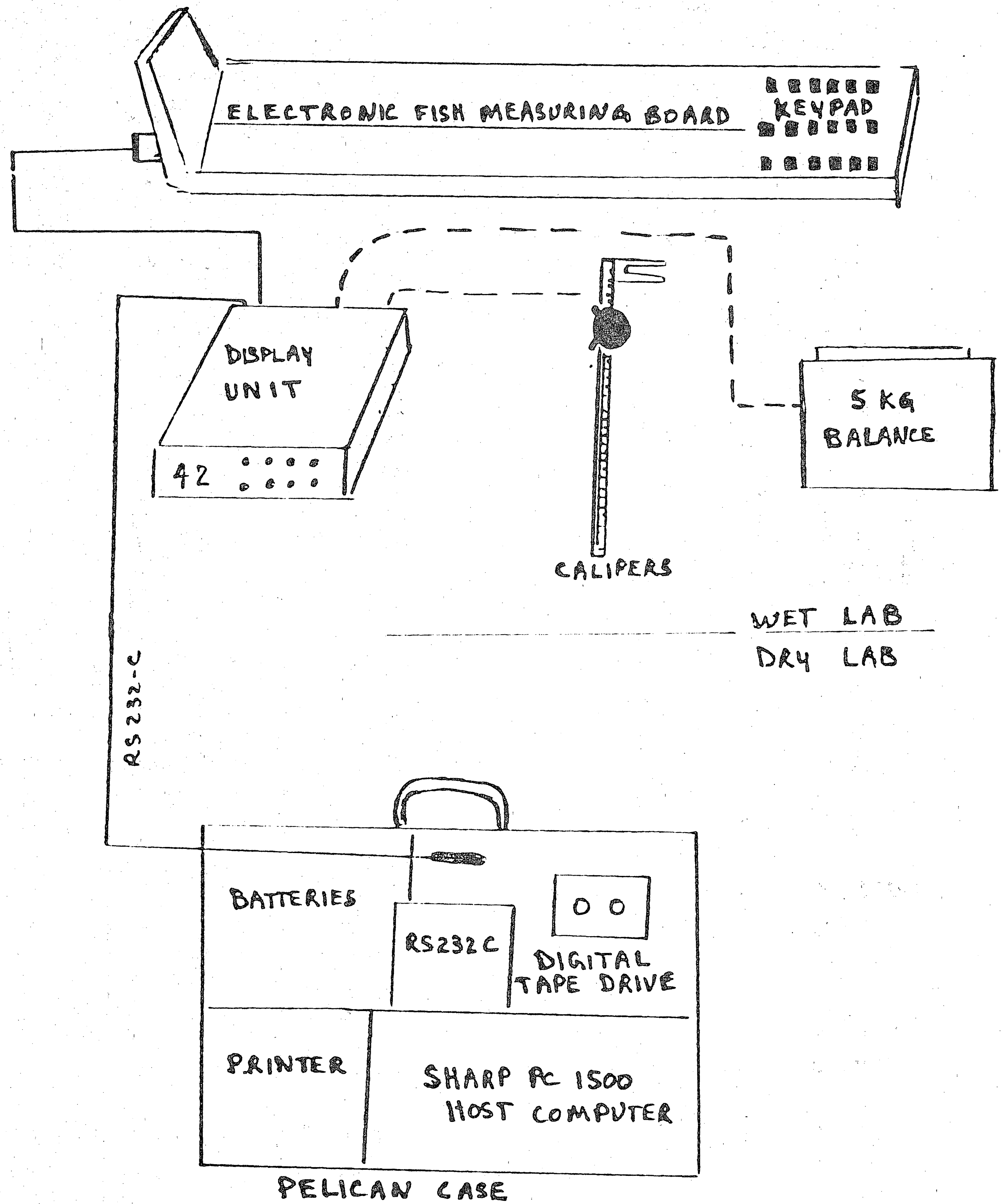

Fig. 1. Portable prototype fish measuring station tested June 1983.

LIMNOTERRA
FISH MEASURING
SYSTEM

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REDFISH SET 119

N	Length	Sex Ma	Sex Fe	Sex Ind	Mat	Ot
13	30		5		8	
14	31		6		7	
15	22		7		7	
16	25		8		7	
17	32	8			7	
18	32	9			7	
19	8			2		
20	10			3		
21	38		9		7	
22	30	10			8	
23	22		10		8	
24	29		11		8	
25	40		12		8	
26	8			4		
27	39		13		7	
28	39		14		8	
29	34		15		8	
30	27	11			7	
31	30		16		8	
32	36		17		8	
33	32	12			7	
34	31	13			7	
35	30		18		7	
36	37		19		7	
37	26	14			7	
38	31	15			8	
39	35		20		7	
40	33	16			7	
41	36		21		8	
42	36		22		8	
43	32	17			7	
44	32	18			8	
45	31	19			7	
46	35	20			7	
47	32	21			8	
48	30		23		7	
49	20		24		8	
50	22	22			7	
51	9			5		
52	31	23			8	
53	36		25		7	
54	35	24			7	
55	35		26		7	
56	28		27		7	
57	37		28		7	
58	30	25			7	
59	30		29		8	
60	31	26			8	
61	33	27			8	
62	32	28			7	
63	28	29			8	
64	38		30		7	
65	35	30			7	
66	34	31			7	
67	29	32			7	
68	33	33			8	
69	37		31		8	
70	21		32		7	
71	32	34			8	
72	40		33		8	
73	30	35			8	
74	32		34		7	
75	27	36			7	
76	37		35		7	
77	35		36		8	
78	37		37		8	
79	35		38		8	
80	27	37			7	
81	30		39		7	
82	33	38			8	
83	37		40		7	
84	32	39			7	
85	40		41		7	
86	31	40			7	
87	30		42		8	
88	28	41			7	
89	36		43		7	
90	31	42			8	
91	30		44		8	
92	37		45		7	
93	31	43			7	
94	32	44			7	
95	30	45			7	

LIMNOTERRA
FISH MEASURING
SYSTEM

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Dr. Jon Planck

Note: This mistake not corrected

REDFISH SET 86

(−1)

N	Length	Sex Ma	Sex Fe	Sex Ind	Mat	Ot
1	49		1		9	*
2	42		2		8	*
3	32		3		8	*
4	39	1			9	*
~~5~~	~~40~~				~~8~~	~~*~~
6	40		4		8	*
7	36	2			8	*
8	30	3			8	*
9	32	4			8	*
10	35		5		8	*
11	33		6		9	*
12	30	5			8	*
13	33		7		8	*
14	31	6			9	*
15	29	7			8	*
16	31		8		9	*
17	38	8			8	*
18	31	9			8	*
19	34		9		8	*
20	33	10			8	*
21	32		10		8	*
22	31		11		8	*
23	31	11			8	*
24	42		12		9	*
25	32		13		8	*
26	29	12			9	*
27	30	13			9	*
28	40		14		8	*
29	29	14			8	*
30	33		15		8	*
31	32	15			8	*
32	31	16			8	*
33	31		16		8	*
34	31		17		8	*
35	32		18		8	*
36	28	17			9	*
37	33		19		9	*
38	33	18			8	*
39	44		20		8	*
40	33	19			8	*
41	34	20			8	*
42	29		21		8	*
43	40		22		8	*
44	31		23		8	*
45	29	21			8	*
46	29		24		7	*
47	31	22			9	*
48	35	23			7	*
49	40		25		8	*
50	31		26		8	*
51	31		27		9	*
52	33		28			
53	30	24				
54	32	25				
55	36	26				
56	42		29			
57	30	27				
58	32	28				
59	31	29				
60	31	30				
61	32		30			
62	33	31				
63	35	32				
64	40		31			
65	30		32			
66	30		33			
67	30		34			
68	29	33				
69	29	34				
70	32		35			
71	35		36			
72	35	35				
73	35	36				
74	33		37			
75	28	37				
76	30	38				
77	42		38			
78	35		39			
79	32	39				
80	31	40				
81	31		40			
82	32		41			
83	33	41				

Fig. 2. Data collected with portable fish measuring station October 1983. Headings are males (Ma), females (Fe), indeterminate sex of juveniles (Ind), maturity stage (Mat). Otoliths (Ot) are indicated by an asterisk.

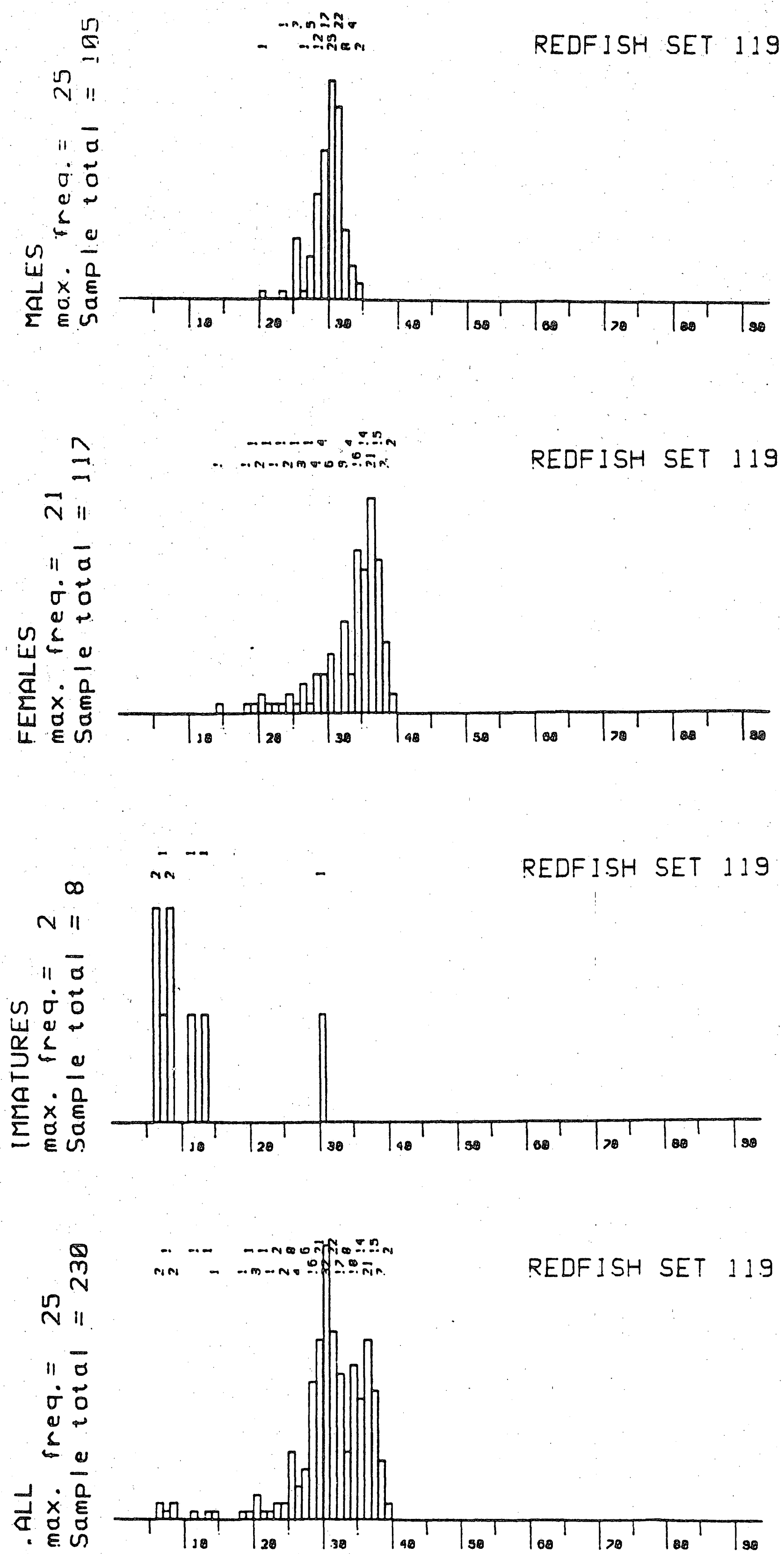

Fig. 3. Length frequency histograms of redfish measured at set 119 in the Gulf of St. Lawrence. Males, females, immature juveniles and the entire sample are indicated in separate graphs.

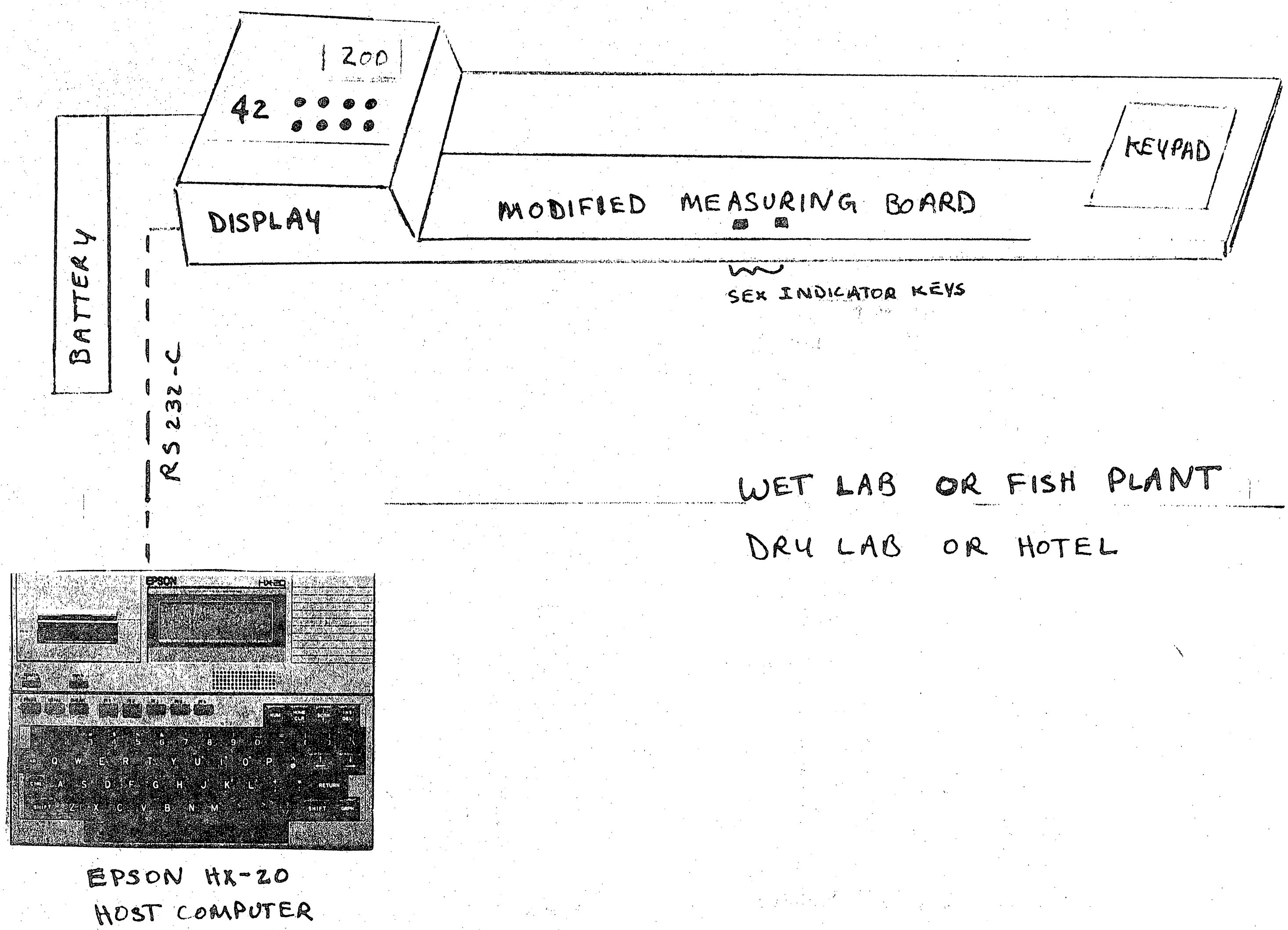

Fig. 4. Modified portable fish measuring station developed in 1984.

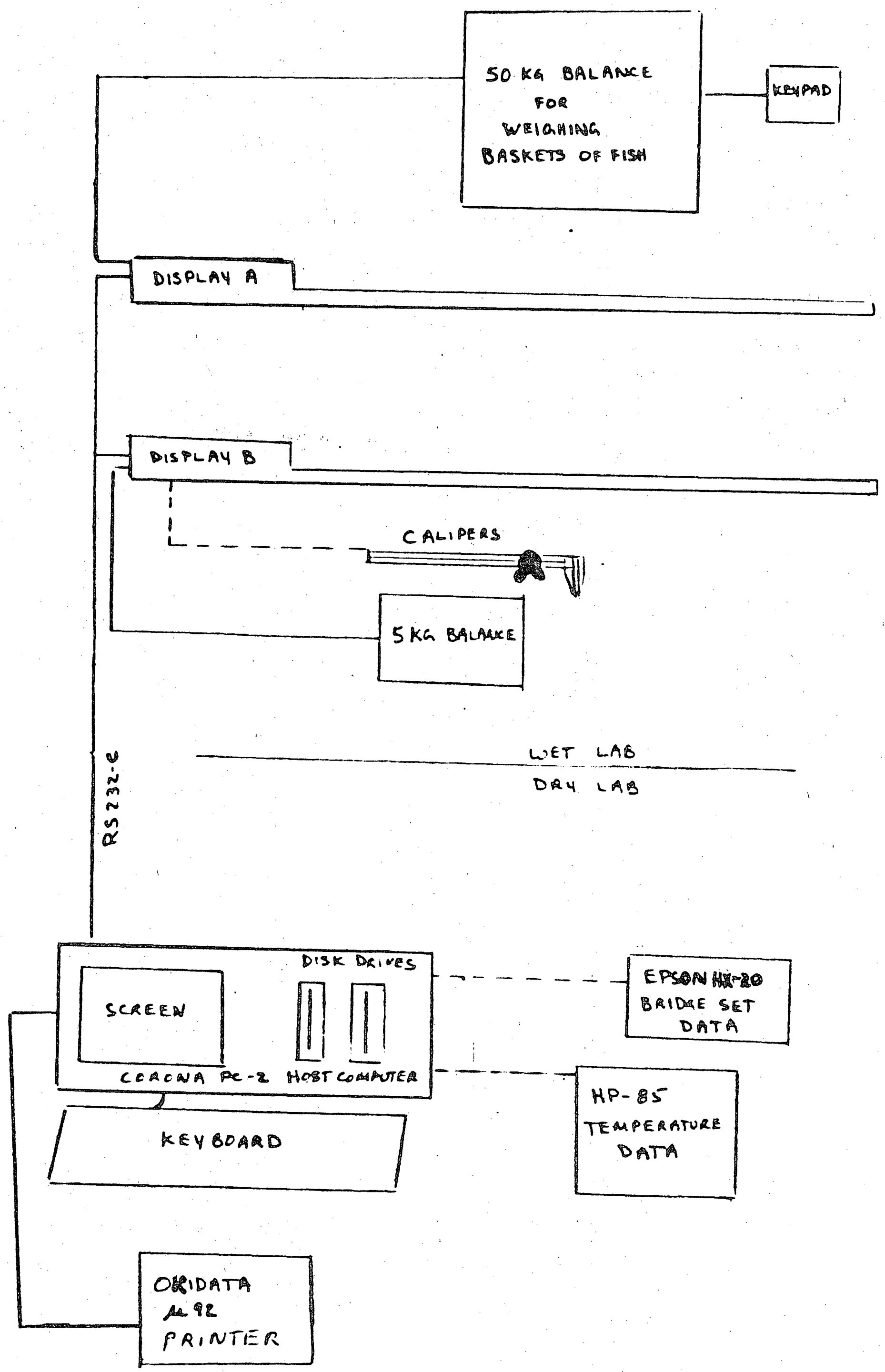

Fig. 5. Shipboard fish measuring station system to be tested in 1984.