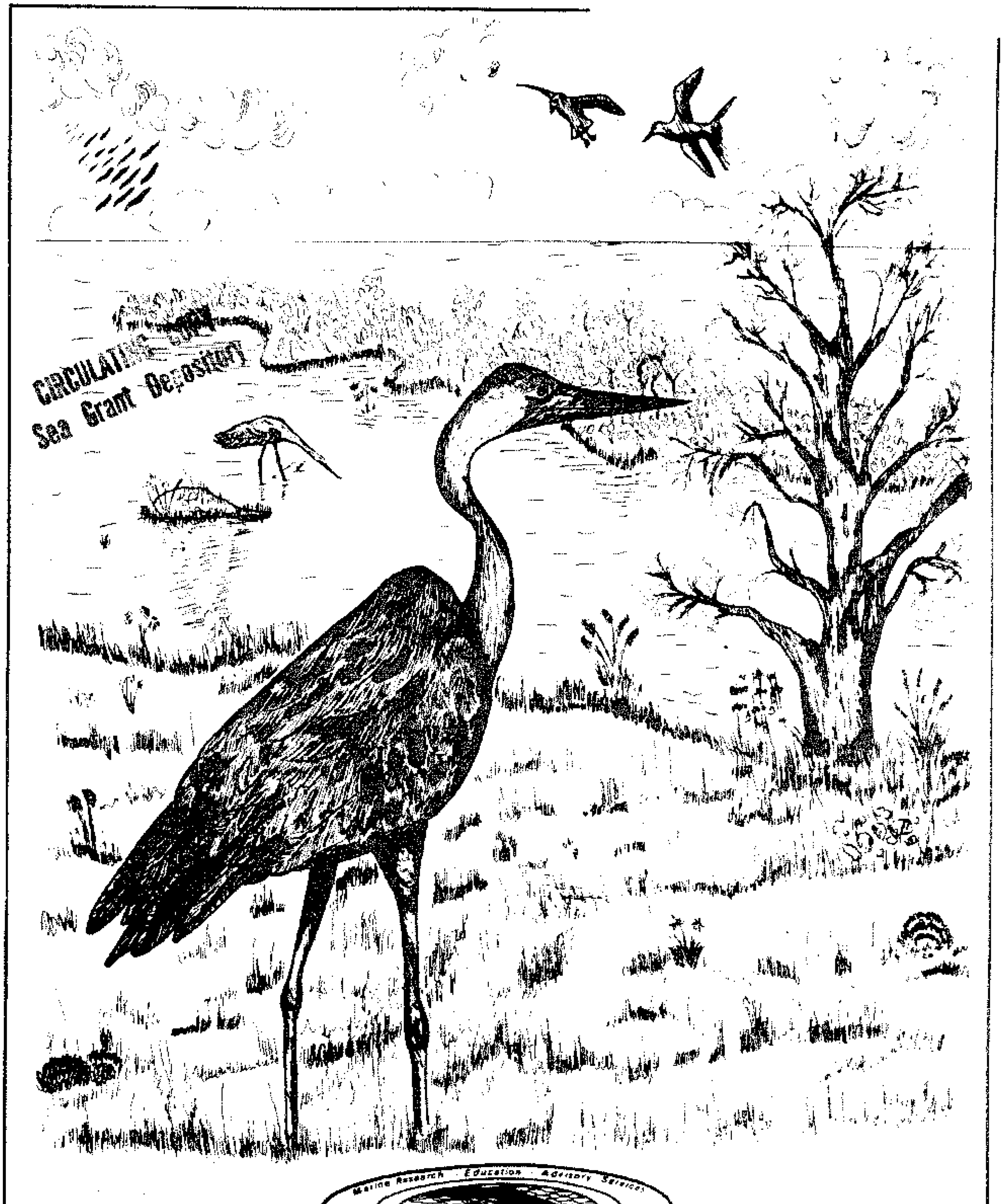
4-H 338

FIELD STUDY OF THE MARINE ENVIRONMENT
4-H LEADERS' GUIDE



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John T. Woeste, Dean for Extension

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FIELD STUDY OF THE MARINE ENVIRONMENT

by
Neil Crenshaw*

For Whom Is This Publication Intended?

It is not necessary for a person to have a college degree in marine science, biology or some other closely related subject in order to be able to use this publication. An interest in marine science and some experience with the ocean, which could be almost anything from self-study to formal education, is sufficient. However, the more knowledge you have, either through education or experience, the more useful this publication will be.

Purpose of This Publication

The purpose of this publication is to provide the reader with information which will aid him or her in helping 4-H members learn about the marine world through field work, classroom work and active participation.

The marine world is a vital part of our everyday lives. Many different kinds of plants and animals live in the ocean which we, as humans, depend upon, either directly or indirectly. There is a flow of energy from one kind of ecosystem to another. An ecosystem such as a coral reef depends on the energy it might get from a nearby tidal flat, sand dune area, river or estuary.

It is through this field study of the marine environment that a leader can take a 4-H group and help them understand the importance of one marine ecosystem to another and in turn the ecosystems' importance to humans and vice versa. This knowledge will be advantageous to the 4-H'ers when they begin working on their marine-related projects.

How Is the Study Used?

Many methods and techniques can be used to teach the 4-H member about the marine environment, but probably the best method is through experience and involvement.

Naturally those who live close to the beach have a better opportunity for studying the marine environment. The type of field work and techniques you, as a leader can use will depend upon the type of environment that surrounds your area and how easily accessible the marine environment is. The intention here, however, is to demonstrate how one teaching technique can be used for all.

Because Florida is surrounded by the Atlantic Ocean, the Caribbean and the Gulf of Mexico, many different kinds of ecosystems exist in Florida. For instance, at Jacksonville Beach there exists one of the few remaining natural sand dune areas in the state. Along the coast on the southern half of Florida there are mangrove swamps perfect for studying this specialized type of ecosystem. All along the coast of Florida one can find many kinds of estuaries, marshes, and maritime forests. There are numerous worm reefs near shore between West Palm Beach and Miami. Coral reefs as well as mud flats can be found all along the Keys from Key Largo to Key West. Environments such as mud flats, sandy beaches, and jetties are located along both the west coast and the east coast of the state.

The Study

For illustrative purposes, the field work has been divided into six different studies according to ecosystem: *intertidal zone, upper beach, sand dunes, maritime forest, estuary* and *marsh*. The objective is twofold:

(1) To teach the student how to use simple field gear and
(2) to have the 4-H Member understand the important relationships between the factors (abiotic and biotic) of each ecosystem.*

Each ecosystem is studied separately and after all ecosystems have been studied they are grouped together on a Data Retrieval Chart for study of all the ecosystems' interrelationships.

The 4-H Members are divided into groups according to what they will be studying, and the groups are rotated for each study so that every member will have the opportunity to use all sampling gear and equipment.

*Florida 4-H Marine Education Specialist

*Abiotic factors are those that are not living such as sand, water, tides, etc. while biotic factors are living organisms.

How the Members May Be Grouped

On the next page is a chart explaining how the members may be divided into the groups, and each group into subgroups. The example is for the intertidal zone. Remember that this is only one way that it may be done. Different groups may be formed according to area, number of members, equipment and gear available.

After all the members have been assigned to a group and understand what equipment they will be using, it may be necessary to explain how to use some of the equipment such as **plankton net, seine, seive,** etc. Also, more than one day or outing may be necessary in order to complete the study of a particular ecosystem. If so, that's quite all right.

It is important to remember that after one ecosystem has been studied by the group, the members are rotated to a different group for studying the next ecosystem. For instance if Linda used the plankton net for the intertidal zone study she would have a different job while studying the upper beach. This way everyone will have an opportunity to use all of the equipment available

The Use of Some Equipment

Plankton Net

Plankton are free floating plants and animals. They are usually microscopic but are very important in the food web of the ocean. Plankton are caught with a very fine-mesh net called a plankton net. When the plankton net is used, it is best to keep the plankton in jars which can be labeled and stored in a refrigerator for later study by the entire group. This way the plankton can be observed alive and moving as they would be in nature rather than dead, preserved in formalin.

If a factory-made plankton net is not available, one can easily be constructed from a lady's nylon stocking or muslin, a wire clothes-hanger, and a small collecting bottle. If muslin is used, sew it into a funnel shape, like a nylon stocking. Make a hoop from the wire of the clothes-hanger and sew the open end of the nylon hose or muslin to the hoop. Nylon fishing line and a large needle works well. Cut the small end of the nylon stocking or muslin (net) and attach a small collecting bottle to this opening. A baby food jar or medicine bottle of equal volume

INTERTIDAL ZONE STUDY

Groups	Members	Equipment
1. Invertebrates		
Zooplankton	Sam, Linda and Bill	Plankton net
Higher Invertebrates	Ralph and John	Seine, Nets, Sieve
Recorder	Bob	Tablet and Pencil
2. Vertebrates		
Birds and Mammals	Salley and Kevin	Binoculars
Fish	Will, Tina, Fred and Muff	Seine and Cast Nets
Recorders	Sue and Jane	Tablets and Pencils
3. Plants		
Phytoplankton	Don, Alice and Andy	Plankton net
Higher plants	Jake	Dip Net
Recorders	Entire group in lab.	Microscopes (Optional) Tablets and Pencils
4. Chemical Analysis (Abiotic)		
Salinity	Jenny and Cindy	Hydrometer and Graduated cylinder
Temperature	Dean	Thermometer

works nicely as the collecting bottle. Tie the collecting bottle into the cut end of the net so that when the net is towed through the water, plankton becomes concentrated in it. Sew canvas around both of the open ends to prevent fraying. Tie three pieces of nylon cord, of equal length, to the wire hoop to make the bridle. Secure the three pieces of cord at their free ends to a fishing swivel.(See Fig. 1.)Make the tow-line of at least 20 lb. test nylon fishing line. The length of the tow-line depends on where the plankton net will be used. If the net is used by simply wading in the water and pulling it behind you, it wouldn't need to be much longer than 10 feet, but if it is being thrown from a pier, bridge, etc. it would have to be considerably longer.

It is not absolutely necessary to identify the plankton collected by using microscopes. If microscopes are available, though, use them. Sometimes there will be large plankton collected, e.g. pieces of seaweed, copepods, baby shrimp, crab larvae, etc. that can be identified by using inexpensive 10X hand lenses or magnifying glasses.

Sieve

A sieve is a very useful item for collecting small invertebrates that bury themselves in the sand or mud. You can easily make a sieve by hammering out the slats of a wooden soft drink case and then nailing or tacking a rectangular piece of window screen to the bottom of the case. You may want to put some braces under the screen, such as pieces of coat hangers. This helps maintain the "life" of the screen.

For ease of handling, two people are better than one when working a sieve. While in knee deep water, one person shovels up a load of sand or mud from the bottom and places it gently in the sieve which is being held by the second person. The person holding the sieve submerges it so that water fills the sieve about one-half full. The buoyancy of the water lessens the apparent weight of the sieve and sand and eases the load on the holder's back. With the sieve partially submerged the person holding the sieve shakes it back and forth sifting the sand, mud and small particles throught the screen leaving behind larger particles, e.g. shells, shark's teeth, worms, sand fleas, etc. that can easily be identified.

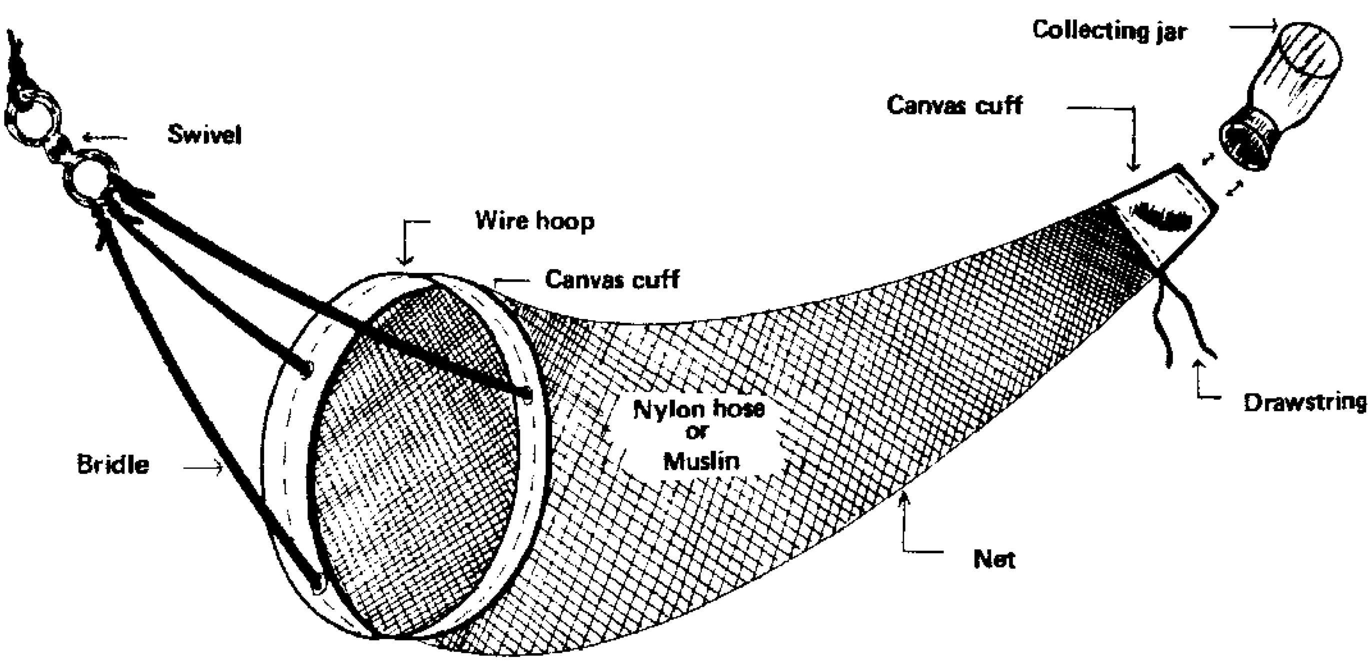

FIGURE 1.

A Plankton net is used in capturing plankton.

Using the sieve and shovel to find invertebrates is usually rewarding.

A small-mesh seine is used to capture small swimming vertebrates.

Salinity

The greater the amount of dissolved salts in water, the greater its salinity will be. Salinity is expressed as parts per thousand (o/oo). If one thosand ml. of water has 20 grams of dissolved salts in it, its salinity is written 20 o/oo. On the average, the open ocean has a salinity of 34 o/oo.

A hydrometer is a compact, convenient, and inexpensive tool for determining salinity in the field. Whenever a hyrdometer is used for determining salinity, the temperature of the water also has to be taken. A hydrometer and a thermometer can be purchased at most drugstores, pet stores and aquarium shops. A hydrometer actually measures the specific gravity of the water. At a temperature of 14°C, pure fresh water (having no salts) has a specific gravity of 0.9991 (almost 1.0000) while average ocean water, with a salinity of 34°/oo, has a specific gravity of 1.0252..

There are two basic types of hydrometers. The one used most extensively is based upon the specific gravity of seawater at 15°C (59°F) using the density of distilled water at 4°C (39°F). Hydrometers of this type carry a designation of 15°/4°. The other type of hydrometer is based upon the specific gravity of seawater at 60°F using the density of distilled water at 60°F. This is a 60°/60°F standard hydrometer. This type of hydrometer carries a designation of 60°/60°.

Get the type of hydrometer that measures specific gravity units. Specific gravity is also expressed in most tables as density. Specific gravity hydrometers usually cover the entire range (from 0.9960 to 1.0310 with 0.0005 gradations).

Pour some water to be tested into a graduated cylinder. If a graduated cylinder is not available, a jar or some other container large enough to hold the hyrdometer but small enough to handle easily can be used. The hydrometer and water jar should be clean before any seawater samples are taken. The jar should be rinsed with the seawater to be tested. The jar containing the sample sould be placed on a flat surface and the hydrometer immersed below the point where it reaches neutral buoyancy which it may then be allowed to attain. The temperature of the water should be taken while in the field (on location). Take the temperature of the actual water, not the sample of water in the jar, because the jar water will change with the air temperature.

Read the number on the scale of the hydrometer where the surface of the water meets the hydrometer. The surface of the water will "sag" in the middle while the water near the glass will "cling" to the surface of the container. This sagging effect of the water forms a crescent shape. The crescent shape is called the meniscus. Read the bottom of the meniscus. To do this, the eye level should be brought from below the water line up to a point where the water line forms an intersect with the stem of the hyrdometer. This is the specific gravity of the water. (See Figure 2)

After the *observed* temperature and specific gravity of the water have been recorded, tables must be used in order to convert these values to *standard* temperature and specific gravity (density). If a Fahrenheit thermometer is used it may, if necessary, first be converted to centigrade. Use Table 1 for converting °F to °C.

If the hydrometer is based upon a 15°/4° standard, use Table 2. Table 2 gives only corrected density values. For salinity, you must refer the corrected density to Table 3 for salinity at 15°C. If the hydrometer is based upon a 60°/60° standard, Table 2 is used after 0.0010 has been subtracted from the observed specific gravity.

It is important to record all of the data whenever salinity is being determined by using a hydrometer. It is also useful to record all correction factors and arithmetic manipulations so that checks for accuracy may be made later. *

Example of Measuring Salinity

Using a Standard 15°/4° Hydrometer. The observed readings for a sample of seawater were: temperature 23°C; density 1.0140. Finding the observed density in the left column of Table 2 and looking at the top of the table, one proceeds to the right until reaching the observed temperature of 23°C. To the right of the observed density and down from the observed temperature is the number 17. This means that 0.0017 must be added to the observed density, giving a corrected density value of 1.0157. Table 3 shows that the salinity at 15°C is 21.6°/oo. *

QUESTIONS AND PROBLEMS

Below are some sample questions that could be used to stimulate thought and short-term projects:

1. Give a description of the ecosystem just studied.
2. What are some of the biotic and abiotic features of the ecosystem and how are they interrelated?

*Adapted from *Colligative Properties of Seawater and Their Importance in Certain Analytical Procedures*, by Dunathan and Ingle.

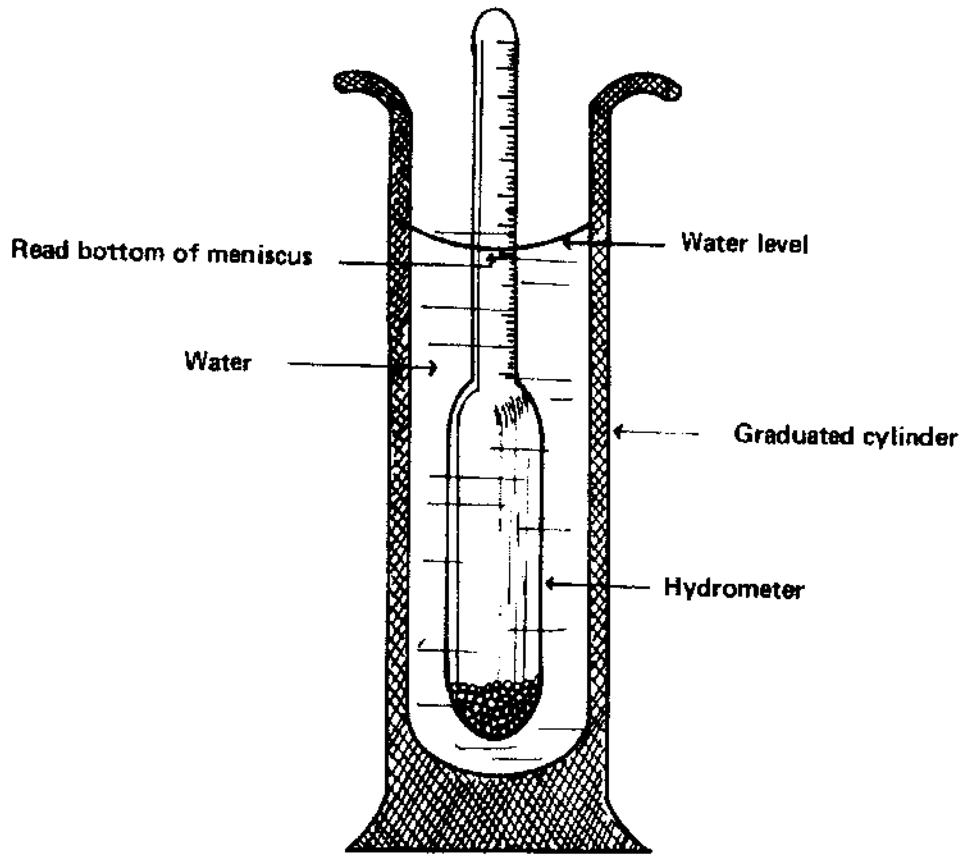

FIGURE 2.

3. What biotic and abiotic features have changed and are undergoing change at the present time?
4. What are some man-made factors causing changes in the ecosystem and how are they brought about?
5. What will be or are the results of the changes?
   (a) beneficial;
   (b) detrimental.
6. Draw a food web of the ecosystem and give a brief explanation of its interrelationships. Figure 3 is an example of a simple Intertidal Food Web. Notice that the arrows go from what is being eaten to what is doing the eating.

After the Intertidal Zone has been studied, the members are rotated to different groups and then move on to the Upper Beach Study and conduct it in a similar manner as they did the Intertidal Zone.

THE DATA RETRIEVAL CHART

Once all the ecosystems have been studied in the field, including: Intertidal, Upper Beach, Sand Dunes, Maritime Forest, Estuary and Marsh, and the results recorded, a data retrieval chart is drawn up by the leader and filled in with help of all the members involved. Figure 4 is an example of a completed data retrieval chart.

Remember, the data retrieval chart is not used until all of the ecosystems have been studied. It is best to wait until the next meeting to start on the chart. This way, everyone will be rested and ready to begin filling in the chart. It has been found that once the study has been completed and everyone has used the gear and equipment, they are quite enthusiastic about completing the data retrieval chart and interpreting it.

TABLE 1 TEMPERATURE CONVERSION – FAHRENHEIT TO CENTIGRADE *

°F	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	°F	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
25	-3.9	-3.8	-3.8	-3.7	-3.7	-3.6	-3.6	-3.5	-3.4	-3.4	65	18.3	18.4	18.4	18.5	18.6	18.6	18.7	18.7	18.8	18.8
26	-3.3	-3.3	-3.2	-3.2	-3.1	-3.1	-3.0	-2.9	-2.9	-2.8	66	18.9	18.9	19.0	19.1	19.1	19.2	19.2	19.3	19.3	19.4
27	-2.8	-2.7	-2.7	-2.6	-2.6	-2.5	-2.4	-2.4	-2.3	-2.3	67	19.4	19.5	19.6	19.6	19.7	19.7	19.8	19.8	19.9	19.9
28	-2.2	-2.2	-2.1	-2.1	-2.0	-1.9	-1.9	-1.8	-1.8	-1.7	68	20.0	20.1	20.1	20.2	20.2	20.3	20.3	20.4	20.4	20.5
29	-1.7	-1.6	-1.6	-1.5	-1.4	-1.4	-1.3	-1.3	-1.2	-1.2	69	20.6	20.6	20.7	20.7	20.8	20.8	20.9	20.9	21.0	21.1
30	-1.1	-1.1	-1.0	-0.9	-0.9	-0.8	-0.8	-0.7	-0.7	-0.6	70	21.1	21.2	21.2	21.3	21.3	21.4	21.4	21.5	21.6	21.6
31	-0.6	-0.5	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.1	-0.1	71	21.7	21.7	21.8	21.8	21.9	21.9	22.0	22.1	22.1	22.2
32	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	72	22.2	22.3	22.3	22.4	22.4	22.5	22.6	22.6	22.7	22.7
33	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.1	73	22.8	22.8	22.9	22.9	23.0	23.1	23.1	23.2	23.2	23.3
34	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.6	74	23.3	23.4	23.4	23.5	23.6	23.6	23.7	23.7	23.8	23.8
35	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.1	2.1	2.2	75	23.9	23.9	24.0	24.1	24.1	24.2	24.2	24.3	24.3	24.4
36	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.7	76	24.4	24.5	24.6	24.6	24.7	24.7	24.8	24.8	24.9	24.9
37	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	77	25.0	25.1	25.1	25.2	25.2	25.3	25.3	25.4	25.4	25.5
38	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.7	3.8	3.8	78	25.6	25.6	25.7	25.7	25.8	25.8	25.9	25.9	26.0	26.1
39	3.9	3.9	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.4	79	26.1	26.2	26.2	26.3	26.3	26.4	26.4	26.5	26.6	26.6
40	4.4	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.9	4.9	80	26.7	26.7	26.8	26.8	26.9	26.9	27.0	27.1	27.1	27.2
41	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.4	5.4	5.5	81	27.2	27.3	27.3	27.4	27.4	27.5	27.6	27.6	27.7	27.7
42	5.6	5.6	5.7	5.7	5.8	5.8	5.9	5.9	6.0	6.1	82	27.8	27.8	27.9	27.9	28.0	28.1	28.1	28.2	28.2	28.3
43	6.1	6.2	6.2	6.3	6.3	6.4	6.4	6.5	6.6	6.6	83	28.3	28.4	28.4	28.5	28.6	28.6	28.7	28.7	28.8	28.8
44	6.7	6.7	6.8	6.8	6.9	6.9	7.0	7.1	7.1	7.2	84	28.9	28.9	29.0	29.1	29.1	29.2	29.2	29.3	29.3	29.4
45	7.2	7.3	7.3	7.4	7.4	7.5	7.6	7.6	7.7	7.7	85	29.4	29.5	29.6	29.6	29.7	29.7	29.8	29.8	29.9	29.9
46	7.8	7.8	7.9	7.9	8.0	8.1	8.1	8.2	8.2	8.3	86	30.0	30.1	30.1	30.2	30.2	30.3	30.3	30.4	30.4	30.5
47	8.3	8.4	8.4	8.5	8.6	8.6	8.7	8.7	8.8	8.8	87	30.6	30.6	30.7	30.7	30.8	30.8	30.9	30.9	31.0	31.1
48	8.9	8.9	9.0	9.1	9.1	9.2	9.2	9.3	9.3	9.4	88	31.1	31.2	31.2	31.3	31.3	31.4	31.4	31.5	31.6	31.6
49	9.4	9.5	9.6	9.6	9.7	9.7	9.8	9.8	9.9	9.9	89	31.7	31.7	31.8	31.8	31.9	31.9	32.0	32.1	32.1	32.2
50	10.0	10.1	10.1	10.2	10.2	10.3	10.3	10.4	10.4	10.5	90	32.2	32.3	32.3	32.4	32.4	32.5	32.6	32.6	32.7	32.7
51	10.6	10.6	10.7	10.7	10.8	10.8	10.9	10.9	11.0	11.1	91	32.8	32.8	32.9	32.9	33.0	33.1	33.1	33.2	33.2	33.3
52	11.1	11.2	11.2	11.3	11.3	11.4	11.4	11.5	11.6	11.6	92	33.3	33.4	33.4	33.5	33.6	33.6	33.7	33.7	33.8	33.8
53	11.7	11.7	11.8	11.8	11.9	11.9	12.0	12.1	12.1	12.2	93	33.9	33.9	34.0	34.1	34.1	34.2	34.2	34.3	34.3	34.4
54	12.2	12.3	12.3	12.4	12.4	12.5	12.6	12.6	12.7	12.7	94	34.4	34.5	34.6	34.6	34.7	34.7	34.8	34.8	34.9	34.9
55	12.8	12.8	12.9	12.9	13.0	13.1	13.1	13.2	13.2	13.3	95	35.0	35.1	35.1	35.2	35.2	35.3	35.3	35.4	35.4	35.5
56	13.3	13.4	13.4	13.5	13.6	13.6	13.7	13.7	13.8	13.8	96	35.6	35.6	35.7	35.7	35.8	35.8	35.9	35.9	36.0	36.1
57	13.9	13.9	14.0	14.1	14.1	14.2	14.2	14.3	14.3	14.4	97	36.1	36.2	36.2	36.3	36.3	36.4	36.4	36.5	36.6	36.6
58	14.4	14.5	14.6	14.6	14.7	14.7	14.8	14.8	14.9	14.9	98	36.7	36.7	36.8	36.8	36.9	36.9	37.0	37.1	37.1	37.2
59	15.0	15.1	15.1	15.2	15.2	15.3	15.3	15.4	15.4	15.5	99	37.2	37.3	37.3	37.4	37.4	37.5	37.6	37.6	37.7	37.7
60	15.6	15.6	15.7	15.7	15.8	15.8	15.9	15.9	16.0	16.1	100	37.8	37.8	37.9	37.9	38.0	38.1	38.1	38.2	38.2	38.3
61	16.1	16.2	16.2	16.3	16.3	16.4	16.4	16.5	16.6	16.6	101	38.3	38.4	38.4	38.5	38.6	38.6	38.7	38.7	38.8	38.8
62	16.7	16.7	16.8	16.8	16.9	16.9	17.0	17.1	17.1	17.2	102	38.9	38.9	39.0	39.1	39.1	39.2	39.2	39.3	39.3	39.4
63	17.2	17.3	17.3	17.4	17.4	17.5	17.6	17.6	17.7	17.7	103	39.4	39.5	39.6	39.6	39.7	39.7	39.8	39.8	39.9	39.9
64	17.8	17.8	17.9	17.9	18.0	18.1	18.1	18.2	18.2	18.3	104	40.0	40.1	40.1	40.2	40.2	40.3	40.3	40.4	40.4	40.5

*Adapted from *Colligative Properties of Seawater and Their Importance in Certain Analytical Procedures*, by Dunathan and Ingle.

TABLE 2 DENSITY CORRECTIONS FOR SEAWATER *
USING A 15°/4° DENSITY SCALE HYDROMETER

Observed Density	Temperature of Water in Jar (°C) −2.0°	−1.0°	0.0°	1.0°	2.0°	3.0°	4.0°	5.0°	6.0°	7.0°	8.0°	9.0°	10.0°
0.9960													
0.9970													
0.9980													
0.9990	−1	−2	−3	−4	−5	−5	−6	−6	−6	−6	−6	−5	−5
1.0000	−2	−3	−4	−5	−5	−6	−6	−6	−6	−6	−6	−5	−5
1.0010	−3	−4	−4	−5	−6	−6	−6	−7	−7	−6	−6	−6	−5
1.0020	−3	−4	−5	−6	−6	−7	−7	−7	−7	−7	−6	−6	−5
1.0030	−4	−5	−6	−6	−7	−7	−7	−7	−7	−7	−6	−6	−5
1.0040	−4	−5	−6	−7	−7	−7	−8	−8	−7	−7	−7	−6	−6
1.0050	−5	−6	−6	−7	−8	−8	−8	−8	−8	−7	−7	−6	−6
1.0060	−6	−6	−7	−8	−8	−8	−8	−8	−8	−8	−7	−6	−6
1.0070	−6	−7	−8	−8	−8	−8	−8	−8	−8	−8	−7	−7	−6
1.0080	−7	−8	−8	−9	−9	−9	−9	−9	−8	−8	−7	−7	−6
1.0090	−7	−8	−9	−9	−9	−9	−9	−9	−9	−8	−8	−7	−6
1.0100	−8	−9	−9	−10	−10	−10	−10	−9	−9	−8	−8	−7	−6
1.0110	−9	−9	−10	−10	−10	−10	−10	−10	−9	−9	−8	−7	−6
1.0120	−9	−10	−10	−10	−10	−10	−10	−10	−10	−9	−8	−7	−7
1.0130	−10	−10	−11	−11	−11	−11	−11	−10	−10	−9	−8	−8	−7
1.0140	−10	−11	−11	−11	−11	−11	−11	−11	−10	−10	−9	−8	−7
1.0150	−11	−11	−12	−12	−12	−12	−11	−11	−10	−10	−9	−8	−7
1.0160	−12	−12	−12	−12	−12	−12	−12	−11	−11	−10	−9	−8	−7
1.0170	−12	−12	−12	−13	−13	−12	−12	−12	−11	−10	−9	−8	−7
1.0180	−13	−13	−13	−13	−13	−13	−12	−12	−11	−10	−9	−8	−7
1.0190	−13	−13	−14	−14	−13	−13	−13	−12	−12	−11	−10	−9	−8
1.0200	−14	−14	−14	−14	−14	−13	−13	−12	−12	−11	−10	−9	−8
1.0210	−14	−14	−14	−14	−14	−14	−13	−13	−12	−11	−10	−9	−8
1.0220	−15	−15	−15	−15	−15	−14	−14	−13	−12	−11	−10	−9	−8
1.0230	−15	−15	−15	−15	−15	−15	−14	−13	−12	−12	−10	−9	−8
1.0240	−16	−16	−16	−16	−15	−15	−14	−14	−13	−12	−11	−10	−8
1.0250	−16	−16	−16	−16	−16	−15	−15	−14	−13	−12	−11	−10	−8
1.0260	−17	−17	−17	−16	−16	−16	−15	−14	−13	−12	−11	−10	−8
1.0270	−18	−17	−17	−17	−17	−16	−15	−14	−14	−12	−11	−10	−9
1.0280	−18	−18	−18	−17	−17	−16	−16	−15	−14	−13	−11	−10	−9
1.0290	−19	−18	−18	−18	−17	−17	−16	−15	−14	−13	−12	−10	−9
1.0300	−19	−19	−19	−18	−18	−17	−16	−15	−14	−13	−12	−10	−9
1.0310	−20	−19	−19	−19	−18	−17	−16	−16	−15	−13	−12	−10	−9

Observed Density	Temperature of Water in Jar (°C) 11.0°	12.0°	13.0°	14.0°	15.0°	16.0°	17.0°	18.0°	18.5°	19.0°	19.5°	20.0°
0.9960												
0.9970												
0.9980							3	4	5	6	7	8
0.9990	−4	−3	−2	−1	0	1	3	4	5	6	7	8
1.0000	−4	−3	−2	−1	0	1	3	4	5	6	7	8
1.0010	−4	−3	−2	−1	0	1	3	4	5	6	7	8
1.0020	−4	−3	−2	−1	0	1	3	4	5	6	7	8
1.0030	−4	−3	−2	−1	0	1	3	4	5	6	7	8
1.0040	−5	−4	−3	−1	0	2	3	5	6	6	7	8
1.0050	−5	−4	−3	−1	0	2	3	5	6	7	8	9
1.0060	−5	−4	−3	−1	0	2	3	5	6	7	8	9
1.0070	−5	−4	−3	−2	0	2	3	5	6	7	8	9
1.0080	−5	−4	−3	−2	0	2	3	5	6	7	8	9
1.0090	−5	−4	−3	−2	0	2	3	5	6	7	8	9
1.0100	−5	−4	−3	−2	0	2	3	5	6	7	8	9
1.0110	−5	−4	−3	−2	0	2	3	5	6	7	8	9
1.0120	−6	−4	−3	−2	0	2	3	5	6	7	8	9
1.0130	−6	−4	−3	−2	0	2	4	5	6	7	8	10
1.0140	−6	−4	−3	−2	0	2	4	5	6	8	9	10
1.0150	−6	−4	−3	−2	0	2	4	5	6	8	9	10
1.0160	−6	−5	−3	−2	0	2	4	6	7	8	9	10
1.0170	−6	−5	−3	−2	0	2	4	6	7	8	9	10
1.0180	−6	−5	−3	−2	0	2	4	6	7	8	9	10
1.0190	−6	−5	−3	−2	0	2	4	6	7	8	9	10
1.0200	−6	−5	−3	−2	0	2	4	6	7	8	9	10
1.0210	−6	−5	−3	−2	0	2	4	6	7	8	9	10
1.0220	−7	−5	−3	−2	0	2	4	6	7	8	9	11
1.0230	−7	−5	−4	−2	0	2	4	6	7	8	9	11
1.0240	−7	−5	−4	−2	0	2	4	6	7	8	10	11
1.0250	−7	−5	−4	−2	0	2	4	6	7	8	10	11
1.0260	−7	−5	−4	−2	0	2	4	6	7	9	10	11
1.0270	−7	−5	−4	−2	0	2	4	6	7	9	10	11
1.0280	−7	−6	−4	−2	0	2	4	6	8	9	10	11
1.0290	−7	−6	−4	−2	0	2	4	6	8	9	10	11
1.0300	−7	−6	−4	−2	0	2	4	6	8	9	10	12
1.0310	−8	−6	−4	−2	0	2	4					

*Adapted from *Colligative Properties of Seawater and Their Importance in Certain Analytical Procedures*, by Dunathan and Ingle.

TABLE 2 (CONTINUED) *

Observed Density	Temperature of Water in Jar (°C) 20.5°	21.0°	21.5°	22.0°	22.5°	23.0°	23.5°	24.0°	24.5°	25.0°	25.5°	26.0°	26.5°
0.9960											19	20	21
0.9970			10	11	12	14	15	16	17	18	19	20	22
0.9980	9	10	11	12	13	14	15	16	17	18	19	21	22
0.9990	9	10	11	12	13	14	15	16	17	18	20	21	22
1.0000	9	10	11	12	13	14	15	16	17	19	20	21	22
1.0010	9	10	11	12	13	14	15	17	18	19	20	21	23
1.0020	9	10	11	12	13	14	16	17	18	19	20	22	23
1.0030	9	10	11	12	13	15	16	17	18	19	21	22	23
1.0040	9	10	11	12	14	15	16	17	18	20	21	22	23
1.0050	10	11	12	13	14	15	16	17	19	20	21	22	24
1.0060	10	11	12	13	14	15	16	18	19	20	21	23	24
1.0070	10	11	12	13	14	15	17	18	19	20	21	23	24
1.0080	10	11	12	13	14	16	17	18	19	20	22	23	24
1.0090	10	11	12	13	15	16	17	18	19	21	22	23	25
1.0100	10	11	12	14	15	16	17	18	20	21	22	24	25
1.0110	10	12	13	14	15	16	17	19	20	21	22	24	25
1.0120	10	12	13	14	15	16	18	19	20	21	23	24	25
1.0130	11	12	13	14	15	16	18	19	20	22	23	24	26
1.0140	11	12	13	14	15	17	18	19	20	22	23	24	26
1.0150	11	12	13	14	16	17	18	20	21	22	23	25	26
1.0160	11	12	13	14	16	17	18	20	21	22	24	25	26
1.0170	11	12	13	15	16	17	18	20	21	22	24	25	27
1.0180	11	12	14	15	16	17	19	20	21	23	24	25	27
1.0190	11	12	14	15	16	18	19	20	21	23	24	26	27
1.0200	11	13	14	15	16	18	19	20	22	23	24	26	27
1.0210	12	13	14	15	17	18	19	21	22	23	25	26	27
1.0220	12	13	14	15	17	18	19	21	22	23	25	26	28
1.0230	12	13	14	16	17	18	20	21	22	24	25	26	28
1.0240	12	13	14	16	17	18	20	21	22	24	25	27	28
1.0250	12	13	15	16	17	18	20	21	23	24	25	27	28
1.0260	12	13	15	16	17	19	20	22	23	24	26	27	29
1.0270	12	14	15	16	17	19	20	22	23	24	26	27	29
1.0280	12	14	15	16	18	19	20	22	23	25	26	28	29
1.0290	13	14	15	16	18	19	21	22	23				
1.0300	13	14	15	16	18								
1.0310													

Observed Density	Temperature of Water in Jar (°C) 27.0°	27.5°	28.0°	28.5°	29.0°	29.5°	30.0°	30.5°	31.0°	31.5°	32.0°	32.5°	33.0°
0.9960	23	24	25	27	28	29	31	32	34	35	37	38	40
0.9970	23	24	26	27	28	30	31	33	34	36	37	39	40
0.9980	23	25	26	27	29	30	31	33	34	36	38	39	41
0.9990	24	25	26	28	29	30	32	33	35	36	38	39	41
1.0000	24	25	26	28	29	31	32	34	35	37	38	40	41
1.0010	24	25	27	28	30	31	32	34	35	37	39	40	42
1.0020	24	26	27	28	30	31	33	34	36	37	39	41	42
1.0030	25	26	27	29	30	32	33	35	36	38	39	41	42
1.0040	25	26	28	29	30	32	33	35	36	38	40	41	43
1.0050	25	26	28	29	31	32	34	35	37	38	40	42	43
1.0060	25	27	28	30	31	32	34	36	37	39	40	42	44
1.0070	26	27	28	30	31	33	34	36	38	39	41	42	44
1.0080	26	27	29	30	32	33	35	36	38	39	41	43	44
1.0090	26	28	29	30	32	33	35	36	38	40	41	43	45
1.0100	26	28	29	31	32	34	35	37	38	40	42	43	45
1.0110	27	28	30	31	32	34	36	37	39	40	42	44	45
1.0120	27	28	30	31	33	34	36	37	39	41	42	44	46
1.0130	27	29	30	32	33	35	36	38	39	41	43	44	46
1.0140	27	29	30	32	33	35	36	38	40	41	43	45	46
1.0150	28	29	31	32	34	35	37	38	40	42	43	45	47
1.0160	28	29	31	32	34	35	37	39	40	42	44	45	47
1.0170	28	30	31	33	34	36	37	39	40	42	44	46	47
1.0180	28	30	31	33	34	36	38	39	41	42	44	46	48
1.0190	29	30	32	33	35	36	38	39	41	43	44	46	48
1.0200	29	30	32	33	35	37	38	40	41	43	45	47	48
1.0210	29	31	32	34	35	37	38	40	42	43	45	47	49
1.0220	29	31	32	34	36	37	39	40	42	44	45	47	49
1.0230	30	31	33	34	36	37	39	41	42	44	46	47	49
1.0240	30	31	33	34	36	37	39	41	42	44	46	48	49
1.0250	30	31	33	35	36	38	39	41	43	44	46	48	50
1.0260	30	32	33	35	37	38	40	41	43	45	46	48	50
1.0270	30	32	34	35	37	38	40						
1.0280	31	32											
1.0290													
1.0300													
1.0310													

*Adapted from *Colligative Properties of Seawater and Their Importance in Certain Analytical Procedures*, by Dunathan and Ingle

TABLE 3 DENSITY TO SALINITY CONVERSION
(Density at 15°C – Salinity in 0/00)

Density	Salinity	Density	Salinity	Density	Salinity	Density	Salinity	Density	Salinity	Density	Salinity
0.9991	0.0	1.0046	7.1	1.0101	14.2	1.0156	21.4	1.0211	28.6	1.0266	35.8
0.9992	0.0	1.0047	7.2	1.0102	14.4	1.0157	21.6	1.0212	28.8	1.0267	35.9
0.9993	0.2	1.0048	7.3	1.0103	14.5	1.0158	21.7	1.0213	28.9	1.0268	36.0
0.9994	0.3	1.0049	7.5	1.0104	14.6	1.0159	21.8	1.0214	29.0	1.0269	36.2
0.9995	0.4	1.0050	7.6	1.0105	14.8	1.0160	22.0	1.0215	29.1	1.0270	36.3
0.9996	0.6	1.0051	7.7	1.0106	14.9	1.0161	22.1	1.0216	29.3	1.0271	36.4
0.9997	0.7	1.0052	7.9	1.0107	15.0	1.0162	22.2	1.0217	29.4	1.0272	36.6
0.9998	0.8	1.0053	8.0	1.0108	15.2	1.0163	22.4	1.0218	29.5	1.0273	36.7
0.9999	0.9	1.0054	8.1	1.0109	15.3	1.0164	22.5	1.0219	29.7	1.0274	36.8
1.0000	1.1	1.0055	8.2	1.0110	15.4	1.0165	22.6	1.0220	29.8	1.0275	37.0
1.0001	1.2	1.0056	8.4	1.0111	15.6	1.0166	22.7	1.0221	29.9	1.0276	37.1
1.0002	1.3	1.0057	8.5	1.0112	15.7	1.0167	22.9	1.0222	30.1	1.0277	37.2
1.0003	1.5	1.0058	8.6	1.0113	15.8	1.0168	23.0	1.0223	30.2	1.0278	37.3
1.0004	1.6	1.0059	8.8	1.0114	16.0	1.0169	23.1	1.0224	30.3	1.0279	37.5
1.0005	1.7	1.0060	8.9	1.0115	16.1	1.0170	23.3	1.0225	30.4	1.0280	37.6
1.0006	1.9	1.0061	9.0	1.0116	16.2	1.0171	23.4	1.0226	30.6	1.0281	37.7
1.0007	2.0	1.0062	9.2	1.0117	16.3	1.0172	23.5	1.0227	30.7	1.0282	37.9
1.0008	2.1	1.0063	9.3	1.0118	16.5	1.0173	23.7	1.0228	30.8	1.0283	38.0
1.0009	2.2	1.0064	9.4	1.0119	16.6	1.0174	23.8	1.0229	31.0	1.0284	38.1
1.0010	2.4	1.0065	9.6	1.0120	16.7	1.0175	23.9	1.0230	31.1	1.0285	38.2
1.0011	2.5	1.0066	9.7	1.0121	16.9	1.0176	24.1	1.0231	31.2	1.0286	38.4
1.0012	2.6	1.0067	9.8	1.0122	17.0	1.0177	24.2	1.0232	31.4	1.0287	38.5
1.0013	2.8	1.0068	9.9	1.0123	17.1	1.0178	24.3	1.0233	31.5	1.0288	38.6
1.0014	2.9	1.0069	10.1	1.0124	17.3	1.0179	24.4	1.0234	31.6	1.0289	38.8
1.0015	3.0	1.0070	10.2	1.0125	17.4	1.0180	24.6	1.0235	31.8	1.0290	38.9
1.0016	3.2	1.0071	10.3	1.0126	17.5	1.0181	24.7	1.0236	31.9	1.0291	39.0
1.0017	3.3	1.0072	10.5	1.0127	17.7	1.0182	24.8	1.0237	32.0	1.0292	39.2
1.0018	3.4	1.0073	10.6	1.0128	17.8	1.0183	25.0	1.0238	32.1	1.0293	39.3
1.0019	3.5	1.0074	10.7	1.0129	17.9	1.0184	25.1	1.0239	32.3	1.0294	39.4
1.0020	3.7	1.0075	10.8	1.0130	18.0	1.0185	25.2	1.0240	32.4	1.0295	39.6
1.0021	3.8	1.0076	11.0	1.0131	18.2	1.0186	25.4	1.0241	32.5	1.0296	39.7
1.0022	3.9	1.0077	11.1	1.0132	18.3	1.0187	25.5	1.0242	32.7	1.0297	39.8
1.0023	4.1	1.0078	11.2	1.0133	18.4	1.0188	25.6	1.0243	32.8	1.0298	39.9
1.0024	4.2	1.0079	11.4	1.0134	18.6	1.0189	25.8	1.0244	32.9	1.0299	40.1
1.0025	4.3	1.0080	11.5	1.0135	18.7	1.0190	25.9	1.0245	33.1	1.0300	40.2
1.0026	4.5	1.0081	11.6	1.0136	18.8	1.0191	26.0	1.0246	33.2	1.0301	40.3
1.0027	4.6	1.0082	11.8	1.0137	19.0	1.0192	26.1	1.0247	33.3	1.0302	40.4
1.0028	4.7	1.0083	11.9	1.0138	19.1	1.0193	26.3	1.0248	33.5	1.0303	40.6
1.0029	4.8	1.0084	12.0	1.0139	19.2	1.0194	26.4	1.0249	33.6	1.0304	40.7
1.0030	5.0	1.0085	12.2	1.0140	19.3	1.0195	26.5	1.0250	33.7	1.0305	40.8
1.0031	5.1	1.0086	12.3	1.0141	19.5	1.0196	26.7	1.0251	33.8	1.0306	41.0
1.0032	5.2	1.0087	12.4	1.0142	19.6	1.0197	26.8	1.0252	34.0	1.0307	41.1
1.0033	5.4	1.0088	12.6	1.0143	19.7	1.0198	26.9	1.0253	34.1	1.0308	41.2
1.0034	5.5	1.0089	12.7	1.0144	19.9	1.0199	27.1	1.0254	34.2	1.0309	41.4
1.0035	5.6	1.0090	12.8	1.0145	20.0	1.0200	27.2	1.0255	34.4	1.0310	41.5
1.0036	5.8	1.0091	12.9	1.0146	20.1	1.0201	27.3	1.0256	34.5	1.0311	41.6
1.0037	5.9	1.0092	13.1	1.0147	20.3	1.0202	27.5	1.0257	34.6	1.0312	41.7
1.0038	6.0	1.0093	13.2	1.0148	20.4	1.0203	27.6	1.0258	34.8	1.0313	41.9
1.0039	6.2	1.0094	13.3	1.0149	20.5	1.0204	27.7	1.0259	34.9	1.0314	42.0
1.0040	6.3	1.0095	13.5	1.0150	20.6	1.0205	27.8	1.0260	35.0	1.0315	42.1
1.0041	6.4	1.0096	13.6	1.0151	20.8	1.0206	28.0	1.0261	35.1	1.0316	42.3
1.0042	6.6	1.0097	13.7	1.0152	20.9	1.0207	28.1	1.0262	35.3	1.0317	42.4
1.0043	6.7	1.0098	13.9	1.0153	21.0	1.0208	28.2	1.0263	35.4	1.0318	42.5
1.0044	6.8	1.0099	14.0	1.0154	21.2	1.0209	28.4	1.0264	35.5	1.0319	42.7
1.0045	6.9	1.0100	14.1	1.0155	21.3	1.0210	28.5	1.0265	35.7	1.0320	42.8

INTERTIDAL ZONE FOOD WEB

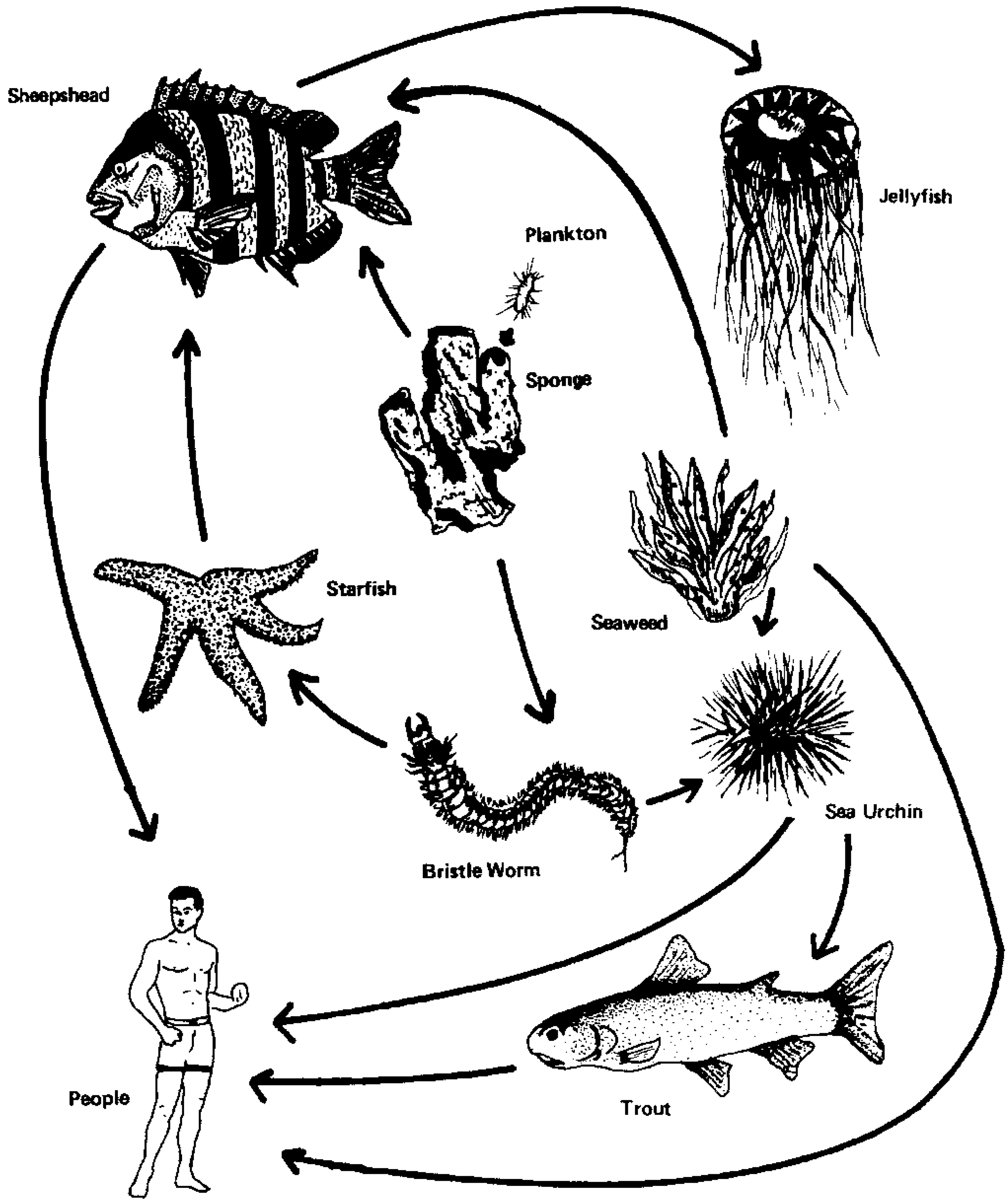

FIGURE 3

DATA RETRIEVAL CHART

Ecosystems ↓ Factors →

	ABIOTIC	INVERTEBRATES	VERTEBRATES	PLANTS
INTERTIDAL ZONE	Temp = 60°F Rocks Sand Salt Water @ 34‰ Waves	Sponge Bristle Worm Jellyfish Sea Urchin Starfish	Puffer Fish Trout People	Seaweed Diatoms
UPPER BEACH	Sand Steel groins	Moon Snail Whelk Eggcase Razor Clam Portuguese Man-of-War	Pelicans Baby Terns Mother Tern Skates egg Turtle People	Beach morning-glory Cordgrass Seaweed
SAND DUNES	Sand Erosion	Caterpillar	People Birds	Cordgrass Sea Oats Palm Trees
MARITIME FOREST	Sand	Spider	Willet	Palm Trees Cactus Palmetto Berries Yucca
ESTURAY	Mud Temp: 65°F Salinity: 15%	Crab larvae Worm larvae Copepods	Flounder Blue Heron	Marsh grass Green Algae
MARSH	Oil in water Temp: 66°F Salinity: 16‰	Fiddler Crab Jellyfish	Common egret Duck	Marsh grass

The data retrieval chart (Fig. 4) shows the various ecosystems that were studied listed down the left side, and the four different groups in which the members worked along the top. The chart may be drawn on a blackboard or on a large rectangular piece of white cardboard. The empty chart is placed in front of the members. Have someone in each of the four groups fill in the chart according to what they found in that particular ecosystem. For instance, if Bob was the recorder for the invertebrate group in the intertidal zone he would fill in the square on the chart under **INVERTEBRATES** and across from **INTERTIDAL ZONE**.

Interpretation of the Chart

After the chart is filled in to the satisfaction of the members, the leader then begins to help the members interpret the chart. An outline with sample questions that may be followed is suggested below:

1. **Identifying points:** Are there any similarities on the chart?
2. **Identification:** Explain the similarities and differences.
3. **Making inferences:** What would you conclude from the chart? What type of relationships do the factors present: The ecosystem?
4. **Predicting:** What would happen if the sand dunes were destroyed?
5. **Explaining and Supporting:** The member should form some type of explanation to support his prediction. This may come from personal interviews, newspapers, etc.
6. **Verifying:** The member develops some type of experiment or study on paper to prove his hypothesis.

Members should feel as though they have the major role in determining what goes on the data retrieval chart and how the results are interpreted. When writing the suggestions on the chart, the leader can very easily sway members' suggestions by implying that their suggestions are good or bad ones. A frown or a smile from the leader can cause the members to offer suggestions that have come indirectly from the leader. The chart's data should come entirely from members' suggestions even though you may think that some are worthless or irrelevant. You may have to force yourself to let the members offer their own suggestions, but you may also discover that some of the suggestions for the data were more valuable than you thought.

LIST OF SUGGESTED RESOURCE BOOKS

Below is a list of some resource books that can be used for studying and identifying the various organisms that may be caught within the intertidal zone in Florida. They can be purchased from the publisher, checked out from practically any university or college library and many coastal high schools will have them in their library. Some of the books are available, on loan, from the Florida 4-H Department Marine Library.

Invertebrates

**Field Book of Seashore Life* $8.00 Roy Waldo Miner, G. P. Putnam's Sons, New York, 1950.
An excellent field and laboratory guide for identifying most of the invertebrates encountered along Florida's coasts. It uses very few common names. May be confusing to beginners. 888 pages.

**Marine Invertebrates* $9.95 U. Erich Friese, TFH Publications, Inc., 1967.
A beautifully illustrated book with color photographs. It is not as thorough as *Field Book of Seashore Life* but it contains the common names as well as the scientific names. 240 pages.

**Tropical Marine Invertebrates of Southern Florida and the Bahama Islands* $1.95 Warren Zeiller, John Wiley & Sons, New York, 1974.
Many excellent color photographs but it does not cover many of the invertebrates that can be found in the area of Southern Florida. 132 pages.

Seashore Life of Florida and the Caribbean $10.00 Gilbert L. Voss, E. A. Seemann Publishing, Inc., Miami, Fl. 1976.
A fine book with many excellent line drawings from protozoa to chordata. 168 pages.

*Available from the Florida 4-H Department Marine Library, 2039 McCarty Hall, University of Florida, Gainesville, FL 32611.

Vertebrates

Sea Birds $3.95. David Saunders, Grosset & Dunlap Publishers, New York, 1973.
Painted drawings with descriptions of most of the sea birds found around the world. 159 pages.

**Seashore and Wading Birds* $1.95. Patricia E. Pope, Great Outdoors Publishing Co., St. Petersburg, Fl. 1974.
Painted drawings with descriptions of many sea birds that you may encounter in Florida. 44 pages.

**Vertebrates of Florida* $35.00. Henry M. Stevenson, University Presses of Florida, Gainesville, Fl., 1976.
A very thorough book for identifying and keying out all vertebrates, except marine fishes, in Florida. 607 pages.

**Guide to the Reptiles, Amphibians, and Fresh-Water Fishes of Florida* $8.00. Archie Carr and Coleman J. Goin, University of Florida Press, Gainesville, Fl., 1969.
An excellent book for identifying marine reptiles. Contains black and white photographs. 341 pages.

The Sharks Around Us $3.95. R. D. Skocik, Star Publishing Co., Inc., Boynton Beach, Fl., 1970.
Most of the sharks found in Florida waters can be identified using this book. The tooth count and shape are used for identification. 208 pages.

**Fishes of the Northern Gulf of Mexico* $9.95. Jerry G. Walls, TFH Publications, Inc., Neptune City, New Jersey, 1975.
Line drawings, descriptions with common and scientific names for most of the fish found in the Gulf of Mexico. Has a large color chart showing many of the fishes. 432 pages.

**Fishes of the Gulf of Mexico* $12.50. Dickson Hoesc and Richard H. Moore, Texas A and M University Press, College Station, Texas 1977.
This book is much like *Fishes of the Northern Gulf of Mexico* by Jerry Walls. 327 pages.

**The Many-Splendored Fishes of the Atlantic Coast Including the Fishes of the Gulf of Mexico, Florida, Bermuda, the Bahamas and the Caribbean* $2.95.
Describes 408 fishes in colored drawings. An excellent book for high-school students. 205 pages.

Fishwatcher Guide to West Atlantic Coral Reefs $5.95. Charles C. G. Chaplin, Livingston Publishing Co., Wynnewood, PA. 1972.
Over 160 species illustrated in painted drawings. Covers most of the fishes found in the tropical coral reefs of Florida. It is waterproof and can be taken underwater. 65 pages.

Caribbean Reef Fishes $15.00. John E. Randall, TFH Publications, Inc., Jersey City, New Jersey, 1968.
An excellent book with black-and-white and color photographs. 318 pages.

Guide to Coastal Fishes of Georgia and Nearby States $8.00. Michael D. Dahlberg, University of Georgia Press, Athens, Georgia, 1975.
A good key to most of the fishes found along the eastern coast of Florida. Black-and-white photographs. 186 pages.

Shells

**Handbook for Shell Collectors* $9.95. Walter Freeman Webb, Lee Publications, Wellesley Hills, Mass., 1935.
Black-and-white photographs and line drawings of over 2,000 shells. 264 pages.

**A Guide to Field Identification of Seashells of North America* $4.95. R. Tucker Abbott, Western Publishing Co., Inc., Racine, Wisconsin, 1968.
Colored drawings of some 850 shells. 280 pages.

**Seashells of the World* $1.50. R. Tucker Abbott and Herbert S. Zim, Western Publishing Co., Inc., Racine, Wisconsin, 1962.
A golden Press hand-book. Has colored drawings of many of the major shells that can be found in Florida. 160 pages.

The Shell, Five Hundred Million Years of Inspired Design $5.95. Hugh Stix, Marguerite Stix and R. Tucker Abbott, Harry N. Abrams, Inc., Publication, New York, Second Printing, 1973.
A book with beautiful color photographs but not a good book for identification purposes. A good coffee-table book. 137 pages.

Plants

**Marine Algae of the West Coast of Florida* Clinton J. Dawes, University of Miami Press, 1974. An excellent book for keying out the many algae found along the coast of Florida.

Seaweeds, A Color-Coded, Illustrated Guide to Common Marine Plants of the East Coast of the United States C. J. Hillson, The Pennsylvania State University Press, University Park, PA., 1977.
This is highly recommended for identifying the larger algae along our coast. The title is self-explanitory. 194 pages.

A Guide to the Sea Grasses of Florida, the Gulf of Mexico and the Caribbean Region $1.25. Roger Hanlon and Gilbert Voss, University of Miami Sea Grant Program (NOAA Sea Grant No. 04-158-14) Miami, Florida, 1975.
Line Drawings and black-and-white photographs. 30 pages.

Marsh Life

Life in and Around the Salt Marshes $4.95. Michael J. Ursin, Thomas Y. Crowell Co., New York, 1972.
Describes the plant and animal life in and around the temperate Atlantic coastal marches. 110 pages.

Abiotic Factors

Oceanography, A study of Inner Space $3.50. Warren E. Yasso, Holt, Rinehart and Winston, Inc., New York, 1965.
An excellent book for high-school students. Covers the chemistry of the sea, the earth's structure, topography and the currents. 176 pages.

Introductory Oceanography Joseph Weisberg and Howard Parish, McGraw-Hill Book Company, New York, 1974.
An excellent book for high-school students. 320 pages.

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