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4-H FORESTRY

PROJECT OUTLINE

PLANT SCIENCE

UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

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FORESTRY is a fascinating business. We hope that in the California 4-H forestry project you will discover some of the things that make it so fascinating.

The California 4-H forestry project is divided into three major phases, each one intended to cover 2 years of work. **4-H WOODSMAN** is introductory and gives basic training in forestry. In **4-H RANGER**, you will get into the applied skills of forestry. 4-H Club members who complete the 4-H Ranger phase may continue with **4-H FORESTRY SPECIAL INTEREST** units.

4-H—Ag110 Rev.

4-H WOODSMAN

UNIT I

MAKE TWO OR MORE

- ☐ Plant press
- ☐ Collection of bark, foliage, flower, fruit, seed, and twig for 10 forest trees and shrubs, including at least 5 trees
- ☐ Display of bark, foliage, and twig; or flower, fruit, seed, and cone; or facsimile of five forest trees, using 4-H forestry display card
- ☐ Display of three or more trees in gallon cans or pots

DO FIVE OR MORE

- ☐ Plant three trees and study their growth.
- ☐ Build one safe campfire or cooking fire, and carefully extinguish it.
- ☐ Observe fire precautions in the woods at all times.
- ☐ Practice safety in the woods.
- ☐ Sharpen an axe and pocketknife.
- ☐ Use safely an axe, pocketknife, saw, and shovel.
- ☐ Demonstrate how to build a safe campfire or cooking fire.
- ☐ Demonstrate the use of a plant press.
- ☐ Visit a nursery, forest-tree nursery, or a natural forest.

LEARN

- ☐ To identify 15 or more trees and/or shrub species
- ☐ "Words of the 4-H Woodsman"

4-H WOODSMAN

UNIT II

MAKE TWO OR MORE

- ☐ Seed flat for planting seedling trees
- ☐ Forest-seed nursery bed, planting enough seeds to produce 150 seedling trees of 1 conifer species
- ☐ Collection of bark, foliage, flower, fruit, seed, and twig for 10 additional trees and shrubs, including at least 5 new trees
- ☐ Display of three or more trees in cans or pots
- ☐ Exhibit of seed germination test, using 100 seeds (or enough to get 15 to 20 seedlings)
- ☐ Display of five or more kinds of tree or shrub seeds properly identified and labeled

DO FIVE OR MORE

- ☐ Gather at least 400 seeds from 1 conifer species.
- ☐ Make a seed germination test, using 100 seeds of 1 conifer species.
- ☐ Demonstrate fire safety at club meeting.
- ☐ Demonstrate seed planting.
- ☐ Give a talk on fire precautions.
- ☐ Distribute "Keep California Green" signs.
- ☐ Visit a ranger station, lookout, or burned forest area.
- ☐ Use sledge and wedges.
- ☐ Use chain or 100-foot tape.

LEARN

- ☐ How trees grow—the functions of the roots, trunk, limbs, and leaves
- ☐ To interpret a germination test
- ☐ To spot and report forest fires

4-H RANGER

UNIT I

MAKE THREE OR MORE

- ☐ Display of parent rock — exhibit if desired
- ☐ Biltmore stick for exhibit
- ☐ Model of transplant bed for exhibit
- ☐ Map showing the location of your home, giving township, range, section, metes, and bounds — exhibit if desired
- ☐ Miniature profiles of two different soils — exhibit if desired
- ☐ Transplant bed

DO FOUR OR MORE

- ☐ Transplant 35 1-0 stock from your nursery, practicing lifting and spacing.
- ☐ Collect, identify, press, and mount five forage plants and three poisonous plants.
- ☐ Identify two soil series in your area.
- ☐ Use staff compass, planting tools, pruning shears, machete, mattock, McLeod, and Pulaski.
- ☐ Build a fireline.
- ☐ Measure the height and diameter of five trees, using Biltmore stick.
- ☐ Locate a known section corner and run a line "true north" to a quarter corner.
- ☐ Demonstrate one of the following: map reading, nursery practice, soils, use of tools.
- ☐ Use psychrometer and thermometer to determine humidity and temperature.

LEARN

- ☐ About fire control:
  - cooperation of firefighting agencies
  - methods of fire attack, both aerial and ground
  - value of firebreaks and access roads
  - calculating fire index rating
- ☐ About soils:
  - formation from parent material
  - forest soil series, such as Aiken, Cohasset, Dubaxella, Josephine, Mariposa, Windy
  - soils most suitable for timber production
- ☐ Map reading—what is meant by township, range, section, contour lines, map symbols, degrees, minutes
- ☐ "Words of the 4-H Ranger"

4-H RANGER

UNIT II

MAKE THREE OR MORE

- ☐ Collection of 10 pictures of 10 different species of forest wildlife — exhibit if desired
- ☐ Display of bark and wood of four hardwoods, four softwoods — exhibit if desired
- ☐ Map showing results of your survey of survival count on a reforested area — exhibit if desired
- ☐ Scale stick

DO FOUR OR MORE

- ☐ Establish your own forest regeneration plot by:
  - selecting a good forest site
  - determining the site preparation needed
  - using proper methods of transplanting 75 2-0 stock from your nursery, and 25 1-1 stock from your transplant bed
  - controlling competition
- ☐ Treat 10 trees, using the following timber and Christmas tree cultural practices: thinning, pruning, shearing, scarring, and stump culture.
- ☐ Make a survival count on 1 acre of a reforested area. Step off a measured acre (for example 208' × 208').
- ☐ Cruise ¼ acre of timber and estimate the board feet.
- ☐ Scale five logs.
- ☐ Demonstrate one of the following: scaling logs, transplanting trees, tree cultural practices.
- ☐ Visit a forest plantation or reforested area.

LEARN

- ☐ More about fire precautions — county, state, federal regulations about smoking, campfires, burning, and permits required
- ☐ Safe methods of tree felling
- ☐ State forest practice regulations relating to forest management and production in your region
- ☐ Value and/or destructiveness of forest wildlife
- ☐ How to make survival count in a reforested area, using sampling technique of milacres

4-H FORESTRY SPECIAL INTEREST UNITS

SELF-DETERMINED

Members taking one of these projects should prepare a complete plan stating what you plan to do and learn during the year. Have this plan approved by your leader and then carry it out.

Here are some suggested areas of work or study.

1. Develop a fire control plan for a forest area, or homestead adjoining a wooded area.
2. Study forest engineering, road and trail surveying, and construction.
3. Study and practice forest nursery management.
4. Study forest products—production, marketing, etc.
5. Wildlands management—range, timber, watershed and wildlife.
6. Develop cost of production studies for timber or Christmas trees in your area.
7. Develop test or demonstration plot in forest production or Christmas tree production.
8. Develop a management plan for a 500-acre timber stand.
9. Develop a multiple land-use plan for a township or larger area.
10. Any combination of learning activities leading to improvement of your knowledge about forestry or forest land.

Co-operative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture co-operating.
Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914.
George B. Alcorn, Director, California Agricultural Extension Service.

Rev. APRIL 1969

4-H CHRISTMAS TREE GROW AND SELL PROJECT OUTLINE

FORESTRY

COOPERATIVE EXTENSION — UNIVERSITY OF CALIFORNIA

This project can be done by any boy or girl regardless of where he or she lives. It provides a chance to both learn and earn, since marketable trees are produced. If you have a backyard area, you can develop a small Christmas Tree plantation. Even if you only have a spot for a window box, you can take part in this project.

If you would like to learn how trees grow, and how to grow and sell trees, this is the project for you.

OBJECTIVES

To:

- Learn to accept responsibility
- Learn to speak in public
- Develop pride in work
- Develop skills in raising trees
- Be able to function effectively in a group

Cooperative Extension **University of California**
Division of Agriculture and Natural Resources

4-H-6010

4-H CHRISTMAS TREE PROJECT OUTLINE

FIRST YEAR

DO

- ☐ plant 5 to 6 bare root Christmas trees into 1-gallon cans.
- ☐ transplant 5 to 6 seedlings from 1-gallon cans into the ground.
- ☐ sell some seedling Christmas trees in gallon cans.
- ☐ give a demonstration.
- ☐ attend a field trip to a nursery or a "choose and cut" Christmas tree plantation, or a natural forest where Christmas trees are harvested, or a Christmas tree sales lot.

LEARN

- ☐ about 5 species of trees used for Christmas trees.
- ☐ to select the proper species of Christmas tree for your area.
- ☐ to select a proper location to grow your trees.
- ☐ to transplant seedlings from gallon cans into the ground.
- ☐ to plant bare root trees into gallon cans.
- ☐ to care for your trees — irrigation, weed control, pest control.
- ☐ to prune and shape the tree.
- ☐ the parts of the tree.

SECOND YEAR

DO

- ☐ plant enough seed to grow a minimum of 25 seedling trees.
- ☐ prune and shape trees.
- ☐ plant 5 to 6 bare root Christmas trees into 1-gallon cans.
- ☐ transplant 5 to 6 seedlings from 1-gallon cans into the ground.
- ☐ sell — living Christmas tree; some seedlings in gallon cans; some bare root seedlings from this year's seed plantings.
- ☐ give a demonstration.
- ☐ attend a field trip to a nursery, or a "choose and cut" Christmas tree plantation, or a natural forest where Christmas trees are harvested, or a Christmas tree sales lot.

LEARN

- ☐ how to plant seeds.
- ☐ how seeds grow.
- ☐ the proper soil mixture in which to plant seeds.
- ☐ to prune and shape trees.
- ☐ to root prune seedlings.
- ☐ care for your trees — irrigation, weed control; insect and rodent control.

THIRD YEAR

DO

- ☐ plant 5 or 6 bare root trees into 1-gallon cans.
- ☐ transplant 5 to 6 seedlings from 1-gallon cans into the ground.
- ☐ plant enough seed to grow a minimum of 25 seedling trees.
- ☐ prune and shape trees.
- ☐ sell — living Christmas trees; some cut Christmas trees; and some seedlings in gallon cans.
- ☐ give a demonstration.
- ☐ attend a field trip to a nursery or a "choose and cut" Christmas tree plantation, or a natural forest where Christmas trees are harvested, or a Christmas tree sales lot.

LEARN

- ☐ to root prune for living trees.
- ☐ stump culture for cut trees.
- ☐ how to lift trees and plant into containers — for living Christmas tree sales.
- ☐ fertilization of trees.

FOURTH YEAR

DO

- ☐ plant 5 or 6 bare root trees into 1-gallon cans.
- ☐ transplant 5 to 6 seedlings from 1-gallon cans into the ground.
- ☐ plant enough seed to grow a minimum of 25 seedling trees.
- ☐ prune and shape trees.
- ☐ root prune seedlings and trees.
- ☐ stump culture.
- ☐ give a demonstration.
- ☐ attend a field trip to a nursery or a "choose and cut" Christmas tree plantation, or a natural forest where Christmas trees are harvested, or a Christmas tree sales lot.

LEARN

- ☐ about chemical weed control.
- ☐ proper pest control.
- ☐ about various marketing procedures for sale of Christmas trees.
- ☐ how to judge and grade Christmas trees for quality and pricing.
- ☐ to figure costs and returns for your Christmas tree project.

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Jerome B. Siebert, Director of Cooperative Extension, University of California.

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4-H FORESTRY PROJECT MANUAL

University of California Agricultural Extension Service

4-H–Ag112

4-H WOODSMAN

California is a land of forests—they cover almost half the state. There is almost enough standing timber in our California forests to rebuild every wooden building in the United States. With so many forests near or around you, you may want to learn more about the native trees and vegetation in our state. Some of you may go into forestry as a career.

In 4-H WOODSMAN, you will have the opportunity to learn:

- how to identify some of the trees and shrubs in the forests near you
- how to use and care for some basic tools of the forester
- the terms used in forestry
- a little about the careers open to you in forestry.

You will be able to complete the requirements of the 4-H WOODSMAN phase of the 4-H Forestry project wherever you live in California, in town or in the country. The things you learn you will be able to use all your life, whether you become a forester or not. You will gain an appreciation of the forests of our state and the people who work in them.

The authors are Farm Advisors Ray Isle, Mendocino County; Art Scarlett, Plumas-Sierra counties; and William Ruddiman, Siskiyou County; and 4-H Club Specialists Paul Barker and Robert F. Davis.

ACKNOWLEDGEMENTS

Some of the material in this manual was adapted from publications of Oregon State University, Montana State College, United States Department of Agriculture, California Division of Forestry, and the California Small Woodland Council.

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

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Unit I

FOREST TREES AND SHRUBS

A forest is a dense growth of trees and underbrush covering a large area. Many of us, as we go through a forest, find it hard to tell the trees apart. One tree looks pretty much like another. As you become acquainted with the trees, you will find that there are many different kinds, and that it will be easy for you to recognize the differences.

The principal difference between a tree and shrub is size. Both are woody plants that continue to live from year to year. The shrub is low, usually less than 10 feet, frequently bushy, with several stems. A mature tree is usually taller than 10 feet, and has a single stem. This is not a hard and fast rule, because local conditions may cause a change in growth habits of some individual trees or shrubs.

Many forest trees and shrubs have been transplanted to locations around homes, public buildings, and parks. As you become familiar with the different trees, you will find many of them growing near you, and it will be easy for you to collect the specimens you need for your plant collection.

FIGURE 1. California Laurel – *Umbellularia californica* (Laurel family – Lauraceae)

IDENTIFYING TREES AND SHRUBS

There are many things to look for when you are trying to identify a tree or shrub. You will notice whether it has blossoms, needles or leaves, whether it drops or retains its leaves or needles in the wintertime, or whether it has cones, fruit, or some other way of carrying and dispersing the seeds.

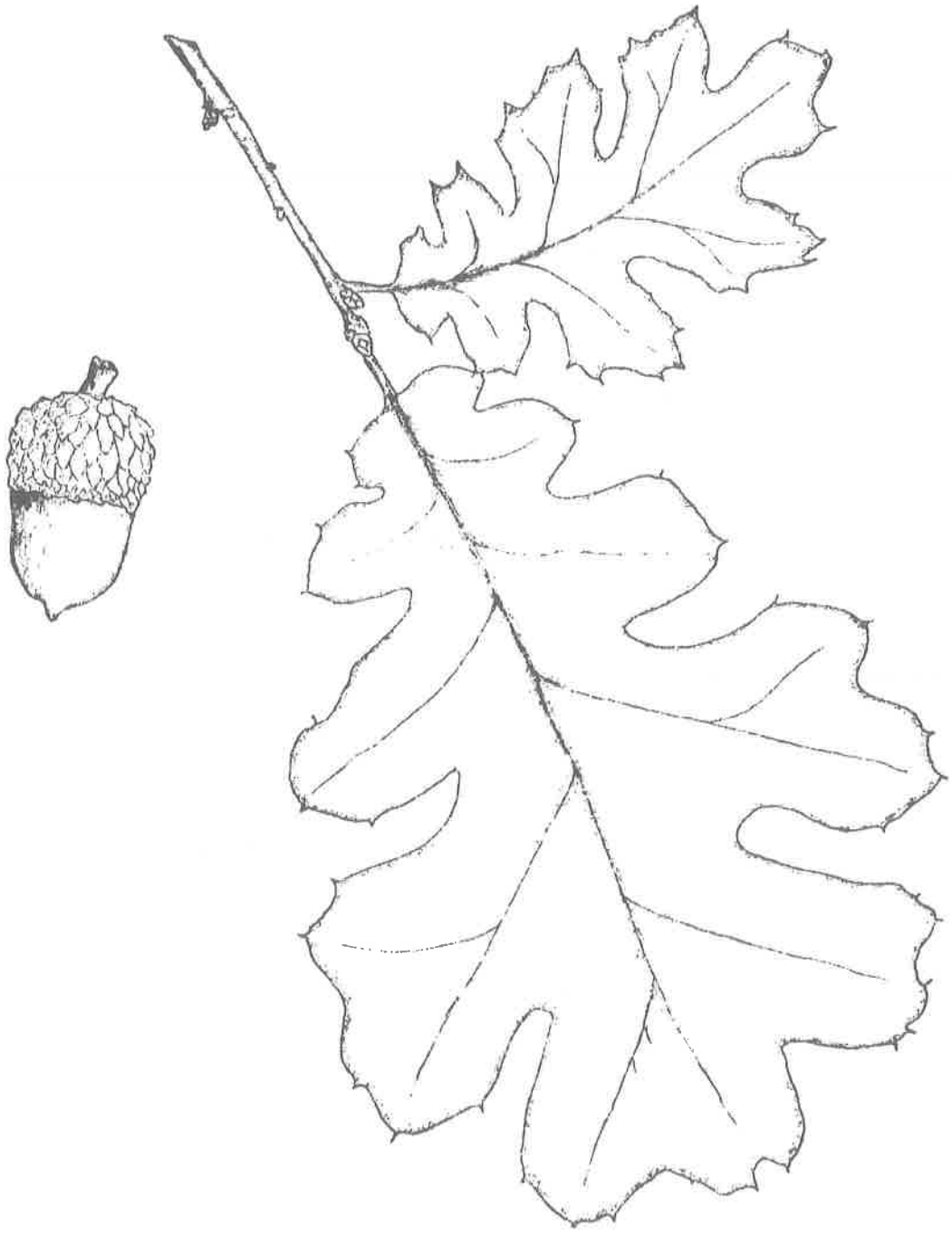


FIGURE 2. California Black Oak – *Quercus kellogii* (Oak family – Fagaceae)

In Unit I of 4-H WOODSMAN, you will be expected to learn to identify 15 or more different species of forest trees and shrubs. You should learn the species of important commercial forest trees of your area. It also might be wise to learn the shrubs in your area that are hazardous to man, for example, poison oak. Do not collect or mount poison oak for your 4-H collection. Your forestry leader, local forester, or farm advisor will help you identify the trees and shrubs in your area. If necessary, your farm advisor can send typical foliage, blossom, twig, and seed specimens to the University of California for identification.

You will find help in identifying the trees and shrubs of your area in a number of publications. If you do not have these publications, you can borrow them from your library, your forestry leader, or your farm advisor. A list of references is given on the back cover of this manual.

The common names given to plants may differ in various parts of the world—or even in our state. For this reason, botanists give Latin names to plants so that they can be recognized and identified anywhere in the world. Every plant belongs to a family, genus, and species. Plants that are identical belong to the same species. Species that appear alike in many respects are grouped together to form a genus. Genera (plural of genus) that have common characteristics are grouped together as families.

FIGURE 3. Coast Redwood – *Sequoia sempervirens* (Redwood family – Taxodiaceae)

For example:

Common Name	Family	Genus	Species	Common Characteristics
Valley Oak	Fagaceae (oak family)	*Quercus*	*lobata*	Leaves have rounded divisions or lobes

List your 15 or more trees and shrubs in this same manner in your 4-H Club Forestry Record Book. Use the spaces provided, and indicate some of the common characteristics.

LET'S MAKE A COLLECTION

Your project requirements for Unit I are to collect, press, and mount the bark, twig and foliage, flower, cone, fruit and/or seeds of 10 or more forest plants, trees, and shrubs, including at least 5 commercial forest trees.

You will need:

- ☐ a plant press
- ☐ newspapers
- ☐ California 4-H Forestry exhibit cards
- ☐ glue and small brush for applying it
- ☐ gummed cloth mending tape

Make and use a cardboard plant press:

This is easy to make and costs nothing. Use corrugated cardboard from large cardboard cartons, such as those you get from any grocery store or supermarket. Cut out 4 pieces of 12- by 14-inch-corrugated cardboard. You will need three or four large rubberbands, which you can cut from old inner tubes.

Place the leaf, flower, or plant part to be pressed flat in folded newspaper. Place newspaper between corrugated cardboards. If you have more than one specimen to press, repeat until press is full (the press will hold three specimens).

Stretch rubberbands around the press with equal spaces between them. Place a wooden board over the press. Place bricks or bags of sand on top of the board to help flatten the specimens. This will help to distribute the pressure evenly over the whole press.

Keep the press in a warm dry place until the specimens are dry. This will take about 5 or 6 days. Remove the specimens and mount them.

Make and use a wooden plant press:

Foresters and botanists use a wooden press for their plant specimens. If you have had any experience in making things with tools, you will find it easy to make wooden frames for the top and bottom of your plant press. Use wood lath, or wooden strips about the same size as laths (¼ by 1½ inches). Smooth the laths, and cut 10 pieces 12 inches long, and 4 pieces 13½ inches long. Assemble as indicated in the drawing. Use small nails or small half-inch round-head screws.

You can use a hand drill to make the holes for the screws or nails, to prevent the laths from splitting.

Use these wooden frames on your cardboard press in place of the board and weights. Large rubberbands or leather straps can be used to hold the press tightly together.

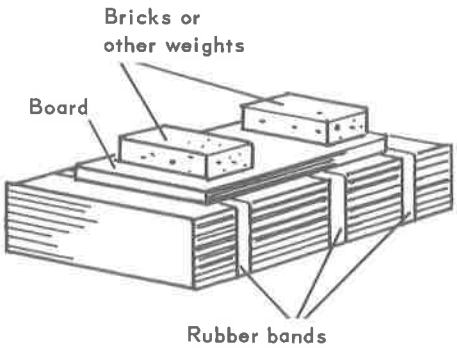


FIGURE 4. Cardboard plant press.

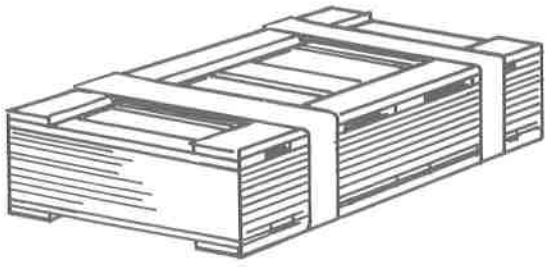


FIGURE 5. Wooden plant press.

Additional ideas for collections:

You will want your specimens to look natural and keep their color. Here are three ideas to help you make good-looking specimens:

First. Select good average specimens that appear fully developed and of average shape and size from mature trees. You may have to return to the same tree or similar trees several times during the year to collect specimens of foliage, flower, fruit, and seed, so you will have a complete collection of representative parts of the tree or shrub.

Second. Take your plant press with you on your collecting trips. Press specimens while they are fresh so they will look natural. Keep them moist until pressed. Lay the material to be pressed on the inside of a folded newspaper or paper towel (never use slick magazine paper). Place several folds of newspapers, large blotters, or linoleum-deadening felt between specimens. Be sure the specimens are flat and smooth. Change the newspapers or dry the blotters if they become damp.

Third. Dry the specimens fast so their colors will be more natural. Keep your plant press where it is warm and dry and where air circulates freely. Here is a way to dry your specimens fast without changing the newspapers. Place one sheet of corrugated cardboard between each of the specimens. Notice the "straws" in corrugated cardboard. Make these "straws" run the same way in your press. If a wood press is tightly bound you can stand it up and down, so warm air can move up through the "straws."

MOUNTING YOUR SPECIMENS

Use two California 4-H Forestry display cards to mount the following from each of the plants you collect:

On one card mount:

- a piece of bark
- a twig, 4 to 6 inches long, with a pressed leaf or two or some needles attached

On a second card, mount:

- a pressed flower from the tree or shrub where possible
- a few seeds from the plant; these can be glued to the card or placed in a small cellophane bag and stapled to the card
- one-half of small cones or fruits, such as those of the oak, redwood, and cedar. You may make a pencil sketch or outline of cones, fruit, or flowers that are too large, bulky, or fragile to mount on the card.

Use one of the two methods described to mount your specimens:

Tape method (good). Hold the specimen in place on the mounting cards by narrow strips of Scotch tape or gummed cloth mending tape. The mending tape is better, because Scotch tape may cause cards to stick to each other later, and does not last as well.

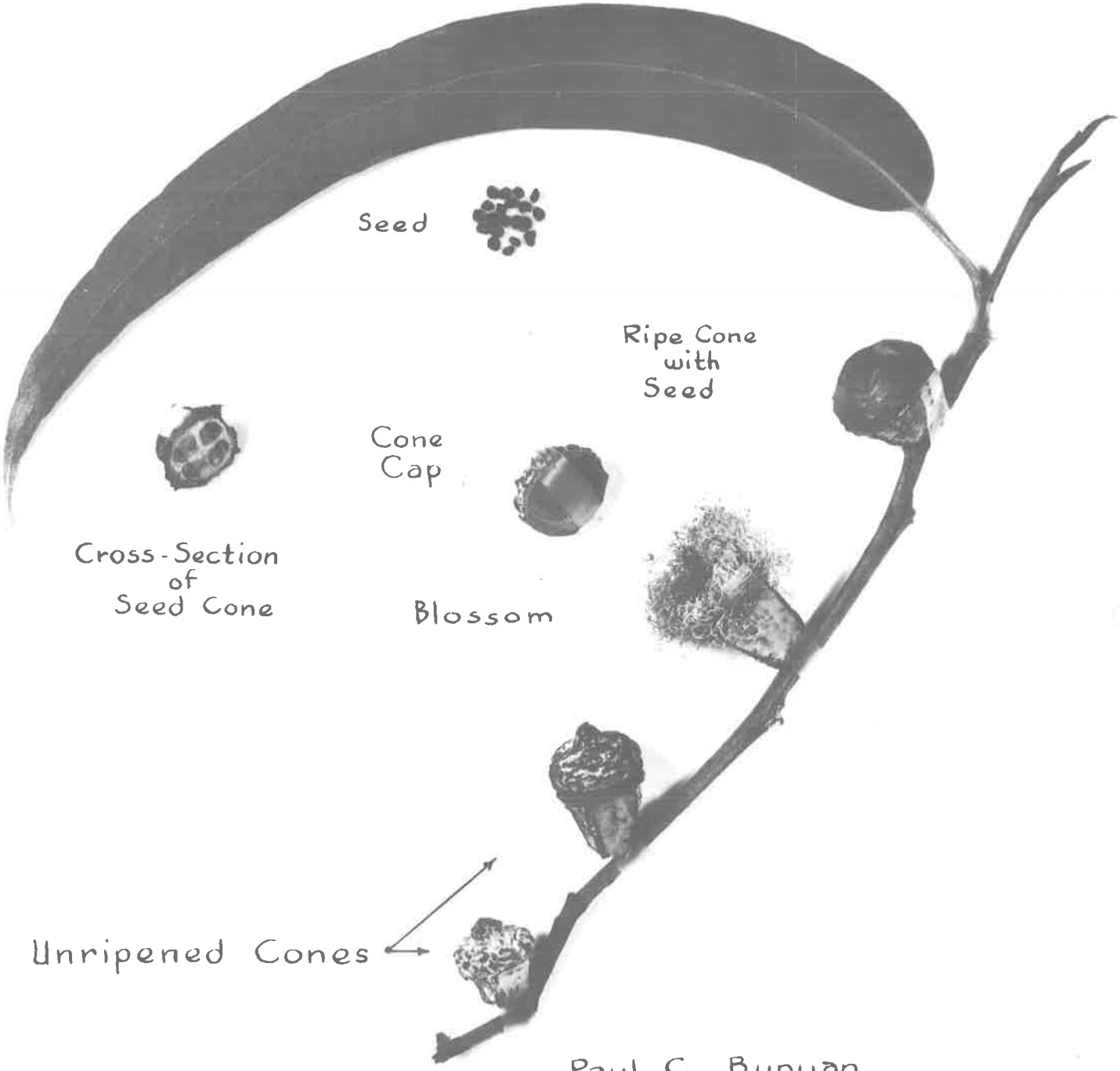
Glue method (better). This gives you more attractive and more durable mounts. Use a good liquid glue, if possible, rather than paste, mucilage, or rubber cement. Rubber cement is too stiff and isn't easy to thin. Thin the glue with water so it will spread freely with a brush. Paint glue on the back of the specimen, then place it on the mounting card. Glue alone will not hold woody stems or heavy parts. Gummed cloth does hold, and looks nicer. Cover the mount with a sheet of waxed paper or newspaper and place a weight on top to provide even pressure. A partially filled bag of sand is best. Mounts prepared in this manner may last a lifetime if you take care of them.

It may help to mount a second specimen, if you have room. This may be a small one, or part of one to show the underneath side of the leaf if it has features that help to identify the species.

You can't mount spruce or hemlock foliage by the tape or glue method, because the needles will fall from the twig. Exhibit spruce or hemlock needles in a small cellophane or plastic bag taped to the card.

4-H FORESTRY PROJECT DISPLAY CARD

FOR FLOWER, FRUIT, SEED, CONE, OR FACSIMILES



Paul C. Bunyan
Collector

Blue Gum
Common Name

Berkeley, Alameda Co.
Collection Location (County)

Myrtaceae Eucalyptus Eucalyptus Globulus
Family Genus Species

2/11/63
Collection Date

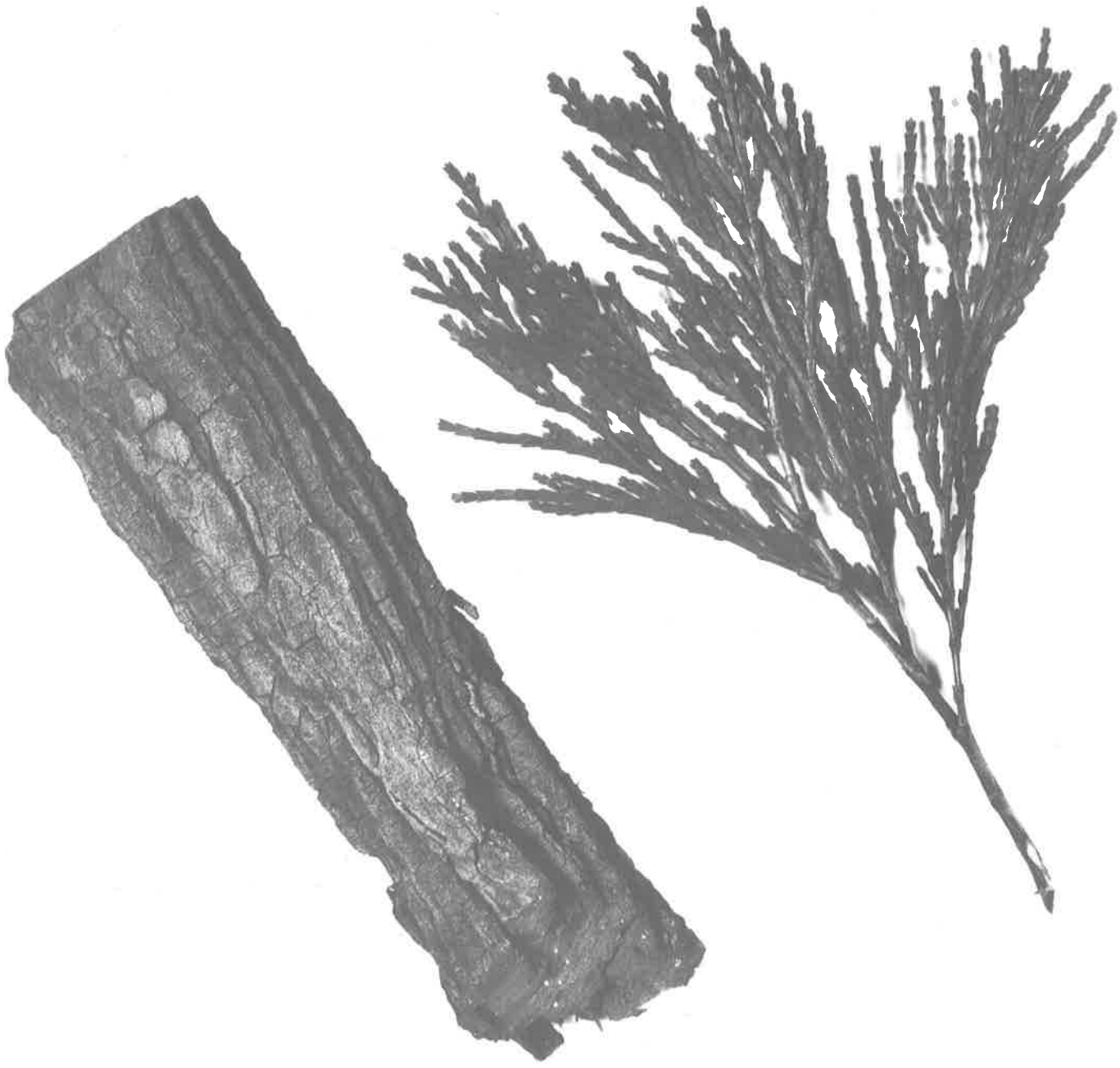
FIGURE 6.

4-H—Ag113

USE ONE SIDE ONLY

4-H FORESTRY PROJECT DISPLAY CARD

FOR BARK, FOLIAGE, AND TWIG



Paul C. Bunyan

Collector

Incense Cedar

Common Name

Berkeley, Alameda Co.

Collection Location (County)

Cupressaceae (Cypress) Libocedrus Decurrens

Family Genus Species

2/11/63

Collection Date

4-H—Ag113

FIGURE 7.

USE ONE SIDE ONLY

PLANTING YOUR TREES

You can learn how a tree grows by planting and caring for some forest trees. One of the requirements for the first year of the 4-H WOODSMAN is to plant and care for three trees. These should be selected from commercial species and, if possible, they should be conifers.

Your seedling trees can be obtained from many sources—your local nursery, from nearby woods if you obtain permission from the owner, or from mail-order nurseries specializing in trees. Check with your nearest ranger or guard station to see if seedling trees might be supplied from the woods.

Use care in handling your seedlings. Avoid exposing the tree roots to the air and sun.

Select a suitable site for planting your trees. Choose a place where they will add to the beauty of the surroundings. Mix peat moss with the soil if it is heavy clay or sandy. Firm the moist soil around the tree roots when you are planting, and water well afterward.

Make a basin around your seedlings to hold the water, and water them whenever the soil becomes dry. Place straw mulch in the basin. This will help keep out weeds. Notice when the buds on the tree start to grow and put out new branches.

It is quite possible that one or more of your seedlings will die, in spite of good care. There are many things which could cause death in tree seedlings, so don't be disappointed. You will be more than repaid by those that do survive.

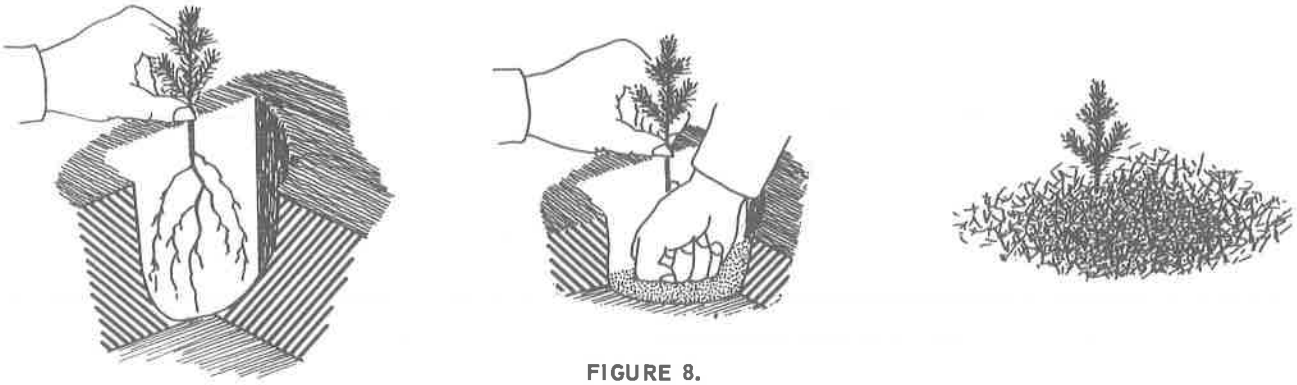


FIGURE 8.

FOREST SAFETY

All kinds of people use the forests of our state. The loggers, forest rangers, and firefighters make their living from the forests. Many others who earn their living in the towns, cities, and farms spend their spare time hunting and fishing in the forests. Every year, more and more of our city dwellers vacation in the natural surroundings of our forests where they can escape the heat and discomforts of city life.

It is important that all of these people know the simple basic rules of forest safety. You, as a 4-H woodsman, should know, practice, and teach these rules.

Don't panic if you are lost

If you are lost in a forest, the best thing to do is stay where you are. Make yourself comfortable, listen for searchers, call if you hear them. In fire season, make a safe fire, and put on green leaves to produce smoke. You'll be found quickly.

Beware of poison oak

"Leaves in three, leave it be," says the warning. Good advice, too. Poison oak is an erect shrub or climber with shiny leaves and greenish white berries. The edges of some leaflets are smooth, others are lobed. In the spring and fall, leaves and stems are reddish in color.

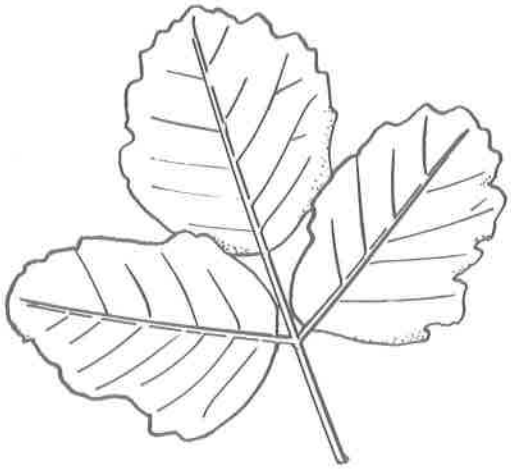


FIGURE 9. Poison oak foliage.

USE YOUR TOOLS PROPERLY

There are four basic tools which every woodsman should know how to use and care for properly. These are the axe, saw, shovel, and pocketknife. Some of these tools can inflict serious and painful wounds if carelessly used. If not properly cared for, they will fail to do the job for which they were intended, or do it poorly or with great difficulty.

Axe

The axe is one of the most important tools in the woods. It is used to cut down trees, trim off branches, split wood for campfires, and for many other purposes. There are many styles and sizes to choose from. Among the commonest types are the double-bitted and single-bitted woodsman's axes. Handle your axe with care. It is a tool that can do a lot of damage if it slips or misses what you are chopping.

Never use a dull axe. Most axe accidents happen because a dull blade fails to bite into the wood. Instead, the axe bounces or slips off the wood into a leg or foot.

Keep the blade sharp. Grind out nicks and dents, and use an oilstone to get a keen edge that will bite into the wood.

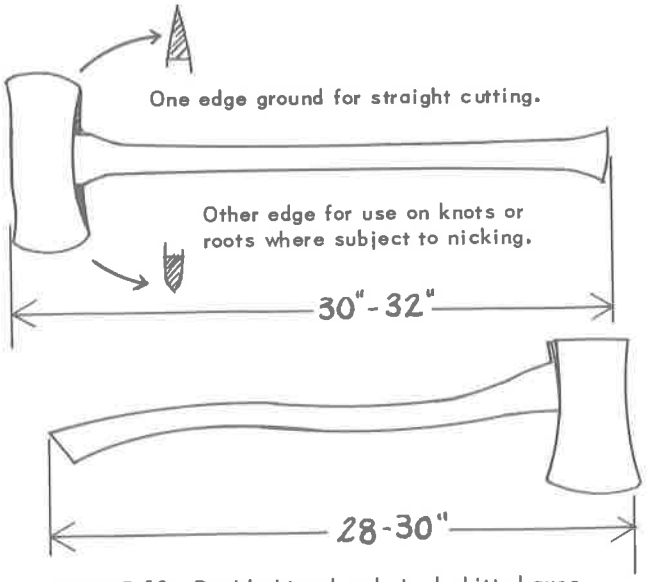


FIGURE 10. Double-bitted and single-bitted axes.

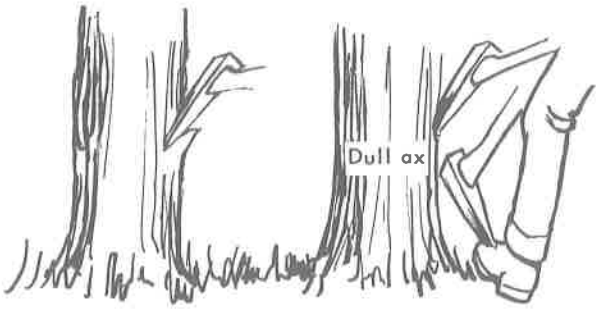


FIGURE 11. A dull axe is more dangerous than a sharp one.

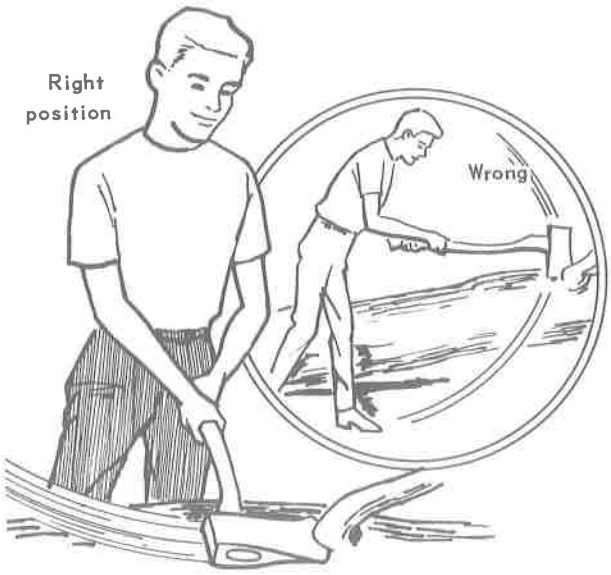


FIGURE 12. Safe and dangerous positions for limbing.

Saw

The gasoline-powered chain saw has taken over most of the jobs done in the past with hand saws. You will have a chance to learn about the use and care of the chain saw in a later forestry unit.

The hand saw most used is the woods today is the bow saw. The bow saw is used to prune trees. Clean the resin from this saw after each use. Keep the saw teeth sharp, so the saw will cut easily. Apply a light coating of oil occasionally to prevent rust on the saw blade.

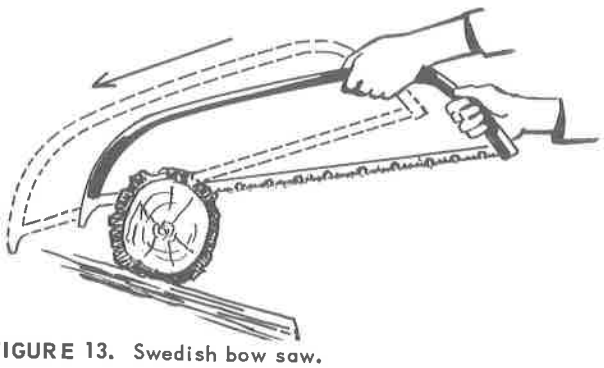


FIGURE 13. Swedish bow saw.

Shovel

The shovel is an indispensable tool in the forest. It is used in firefighting, in planting trees, and in digging holes for garbage pits, latrines, pipelines, etc.

Never use a shovel to pry up rocks or logs. It wasn't designed or intended for this purpose, and you are likely to break the handle or bend the blade if you use your shovel in this manner.

Keep your shovel clean, apply oil to prevent rust, and keep the digging edge sharp by using a file to remove nicks and dull places. These simple precautions will give you a shovel you can rely on and use for a long time.

Pocketknife

Most woodsmen carry pocketknives with them. You will need it for cutting specimen twigs for your collection, and in preparing a frilled stick with which to start a fire. Keep the cutting blades of your pocketknife sharp with a whetstone. Stropping the blade on a piece of leather after sharpening will remove wire edges and give a keen blade. Never use a knifeblade as a screwdriver or to pry nails or tacks from wood. A good knifeblade is tempered to hold a cutting edge, and will snap off or nick with this kind of treatment. Always cut away from you when using your pocketknife.

FIRE SAFETY

Fire is the most dreaded and dangerous threat to the forest. Everyone should know how to use fire so that it is safe and no threat to the trees, animals, and people in the forest.

Every woodsman should know how to make a safe campfire. You can get a permit, required during the fire season, from any U.S. Forest Service or California Division of Forestry Guard or Ranger Station.

Build your fire on mineral soil in the center of a cleared area, away from overhanging branches and flammable material. Keep the fire small, and protect it from wind by selecting a naturally protected site or by shielding it with a pile of rocks.

Remember these points in making a campfire:

- ☐ Pick a fire spot you know will be safe.
- ☐ Never build a fire in or against a rotting log, standing tree, slash, or other place that prevents your complete control of the fire at all times. Be particularly careful on windy days.
- ☐ Don't take a chance with fire under any circumstances. If in doubt about the advisability of building a fire – **don't start it.**

When you are through with the fire, soak the coals with water until no more smoke arises, or cover and mix the coals with mineral soil, not leaf mold. Be sure your fire is dead out when you leave the campfire area.

WORDS OF THE WOODSMAN

The people who live and work in the forest developed some new words, or gave new meanings to some well-known words, to create a forest vocabulary. You will want to know their language if you are to become one of them.

The following list includes many of the words commonly used by woodsmen.

STAND OF TREES: An area of trees that seem to belong together. You can tell one stand of trees from others on nearby areas by their size, species, and how close together the trees are.

NATURAL REPRODUCTION: Little trees that come up from seed which falls in forest openings, or below large trees, are naturally reproduced because no man planted them.

SEED TREE: In the case of conifers, such as fir, pine, cedar, look for a tree with a lot of cones.

SEEDLING: A tree grown from seed, usually not over 1 foot high.

SAPLING: A small tree between 2 inches and 4 inches in diameter.

SECOND-GROWTH TREE: A younger tree on previously timbered land.

OLD-GROWTH TREE: Look for the big, old trees. An old-growth Douglas fir will have a thick, rough bark. It will probably be over 40 inches in diameter and be more than 150 years old.

TOLERANT TREE: A tree species that can live in some shade. Examples: white fir, maples, and hemlock.

SUPPRESSED TREE: This is another name for a starving tree—often it is dying for lack of light and food. It is overcrowded and overtopped by its neighbors.

WOLF TREE: This is a tree that robs space from better neighbor trees. A redwood "wolf" may have big limbs all the way to the ground.

CONIFER (or SOFTWOOD): The botanical group of trees having needles or scalelike leaves, such as on redwoods, firs, pines, and cedars. The fruit of these trees are cones, from which we get the name of "conifer."

HARDWOOD (or BROADLEAF): The broad-leaved trees, such as oaks, madrone, alder, and maples, are known as hardwoods. The term has no reference to the texture of the wood. Nearly all these trees drop their leaves in winter.

SPROUT: Young growth on stumps of broad-leaved shrubs, or at the base of trees such as maple, oak, willow, and coast redwood.

TRUNK: The main stem or body of a tree.

TREE CROWN: The upper part of a tree that has the branches, leaves, and needles.

HEARTWOOD: Look at the end of a log. Heartwood is the dark, inner core of the log. It is the nonliving, inside part of any stem.

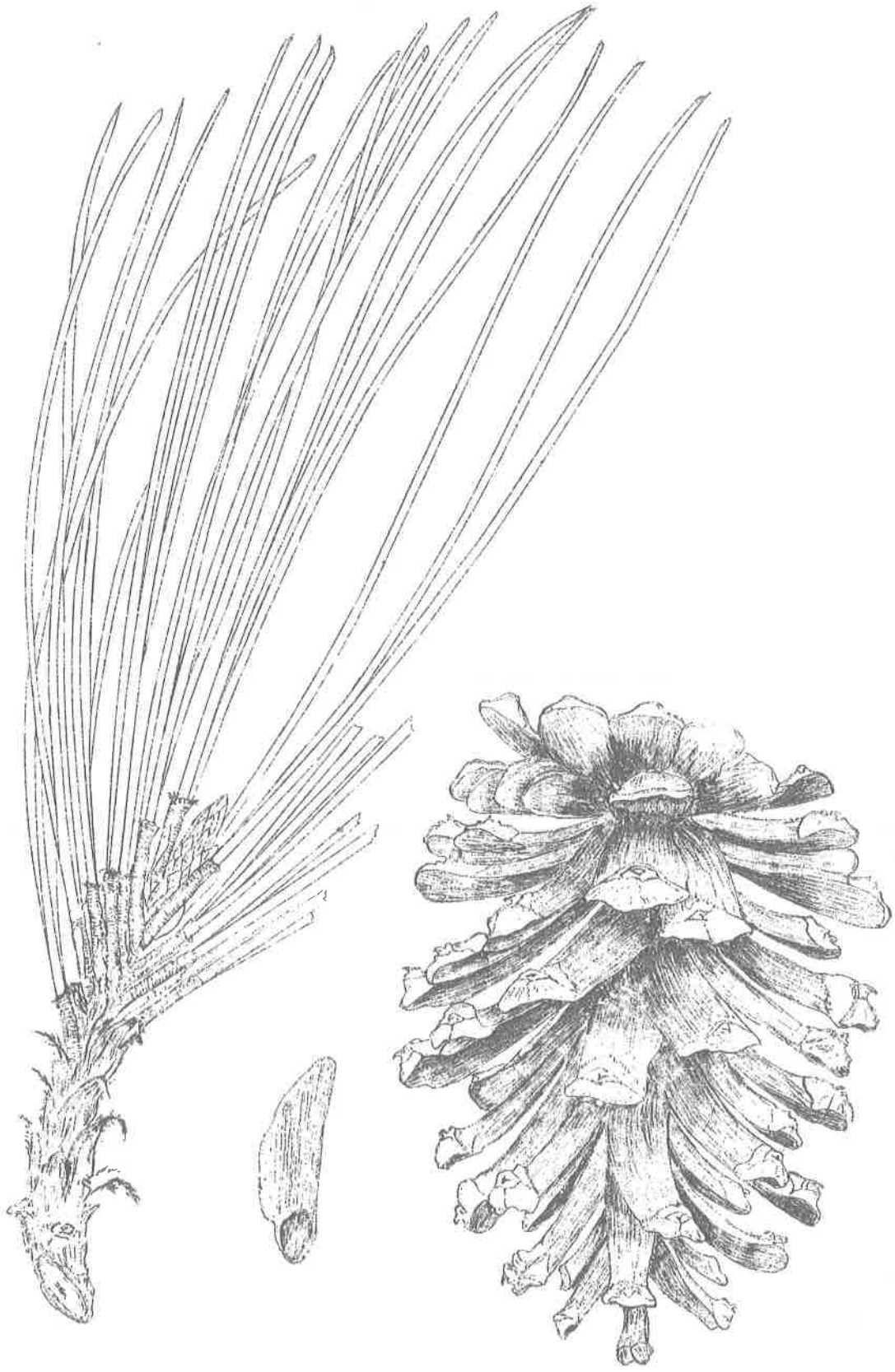


FIGURE 14. Western Yellow Pine – *Pinus ponderosa* (Pine family – Pineaceae)

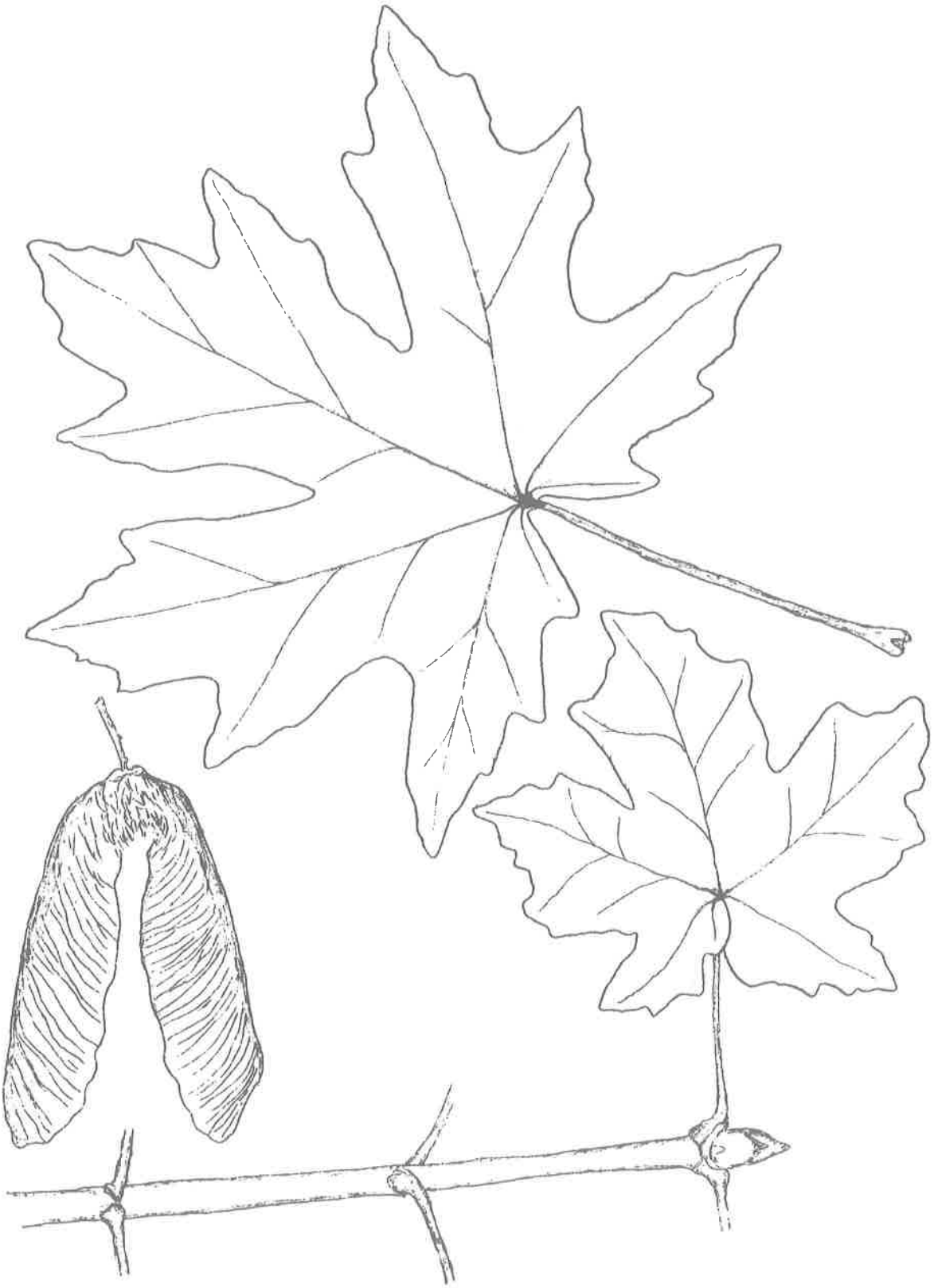


FIGURE 15. Broadleaf Maple – *Acer macrophyllum* (Maple family – Aceraceae)

WORDS OF WOODSMAN – continued

SAPWOOD: Sapwood is the living wood in a tree, found between the bark and the heartwood. It is almost always lighter in color than heartwood. You also see it on stumps, logs, or lumber.

ANNUAL RING: Every stump, log, or piece of lumber shows the annual growth rings. The light-colored part of the ring is known as **springwood**, because its cells are formed with the first growth in the spring. The dark part of the ring is called **summerwood** because it is formed later, in summer.

CONIFEROUS TREE POLLEN: Look for it in April and May. The yellow pollen dust from Douglas fir flowers fills the air when branches are shaken. You may see the pollen on sidewalks, window sills, and other places where it has collected.

CONE CUTTINGS BY SQUIRRELS: The squirrel is your real woodsman. He will drop cones to the ground, and either eat the seeds or hide the cones for his winter food supply. Look for cuttings in the early fall, when cones are "ripe" but haven't opened. You can collect unopened cones and sell them to tree-seed dealers, or extract the seed from them for your project.

GRASS SOD: Grass that forms a solid covering or turf over the ground. Tree seedlings have a hard time getting started in grass sod.

BRACKEN FERN: Everybody knows the big bracken fern. It's very common in field and forest openings. Ferns protect tree seedlings.

FLASH FUEL: Light fuels, such as dry grasses, dead fern, dried twigs, and needles. These catch fire easily and burn rapidly.

FIRE PREVENTION SIGN: Have you seen "Keep California Green" posters? Do you know Smokey, the fire prevention bear?

FOREST CLOSURE SIGN: You will find these along roads or trails during fire season.

GUARD OR RANGER STATION: You report fires and get campfire permits at guard stations of the State Division of Forestry and U.S. Forest Service. These stations have men and equipment for fighting forest fires.

FOREST LOOKOUT: This is usually a tower on top of a mountain, used mainly for locating fires.

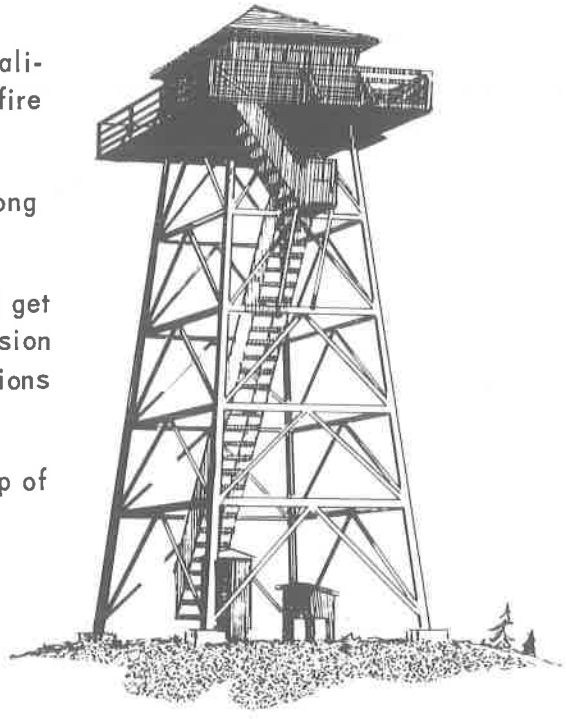


FIGURE 16. Lookout tower.

Unit II

HOW A TREE GROWS

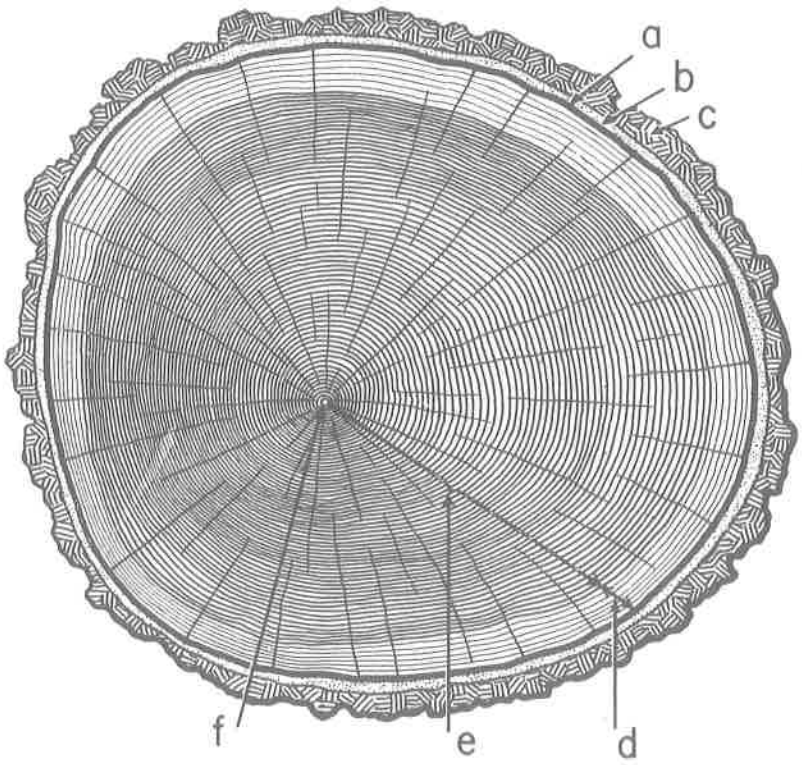
Many people believe that as a tree grows its limbs move upward—up the trunk. As you learn more about how a tree grows, you'll find that this is not the case. Limbs increase in diameter as a tree grows older, but they remain the same distance from the ground as when they were just buds on the trunk.

A tree consists of three main parts—roots, trunk, and crown. The roots anchor the tree in the ground and absorb the water and dissolved minerals which leaf cells change into food for the tree. Roots grow into the soil in much the same way that the branches grow into the air.

Most of the wood that is made into lumber comes from the trunk of the tree. The trunk supports the crown and carries plant nutrients taken in by the roots to the crown. Then it returns the food made by the leaves to the roots.

The crown of a tree consists of branches, twigs, and leaves.

When you look at a freshly cut cross section of a tree trunk or branch, you'll see many concentric rings. Each of these rings represents one year's growth of the tree. The rings in the central part are heartwood. The rings nearest the outside of the trunk are the sapwood. It is through these outer rings that the sap (water carrying dissolved minerals) rises from the roots to the leaves. A single row of cells between the wood and the bark is called the cambium. This is where growth in diameter occurs. The cambium forms annual rings of new wood inside, and new bark outside. Surrounding the cambium is the inner bark which carries food produced by the leaves downward to lower parts of the tree. The outer bark protects the tree from injury. It is rough in some kinds of trees and smooth in others.



a. cambium

b. inner bark

c. outer bark

d. sapwood

e. heartwood

f. pith

FIGURE 17. Cross section of a tree.

The growing parts of a tree are: buds on twigs, branches and trunk; root tips on the roots; and the cambium layer in trunk and branches. The tree grows in height as the buds develop into twigs, then into branches or trunk. The trunk doesn't move upward, but grows from a bud at the tip. Because of this, there is no upward movement of a branch as a tree grows higher.

Some trees naturally grow rapidly or slowly. Rainfall and sunlight can speed growth or slow it down. The quality of the soil also can affect a tree's growth. Competition for space, moisture, and light frequently slows growth in dense stands of trees. Mature trees in forests often are harvested to give the younger trees a chance to make good growth. Dense stands of young trees are thinned to allow the better ones to grow faster.

GROWING YOUR 100 TREES

By this time, you should have some idea how a tree grows. Your next requirement in the 4-H WOODSMAN is to grow 100 seedling trees from seeds that you collect from a commercial conifer species. The trees you grow can be used to help reforest burned-over, or cutover lands, to start a tree farm, or to plant around homes to beautify the grounds.

Collecting Seed

Collect your seed from ripe cones during late August and September. Cones are collected most easily from trees felled during logging operations. Otherwise, you may have to collect the cones from standing trees. Occasionally, you can find squirrel caches, or cones cut down by squirrels, which will make you collecting easier. Be sure to get permission from the landowner before you collect cones.

Collect only cones of **good quality**. To determine the quality of a cone, pick three or more cones from different portions of several trees in an area. Cut the cones lengthwise with an axe and count the number of good seeds. In good seeds the embryo, or future tree, is yellow. The endosperm, or whitish material inside the seed coat on which the future tree will feed, should be firm and not shrunken from the seed coat. In pine and fir, the cone is of good quality when seven or more good seeds can be counted on one face of the split cone. In other species, three or more are sufficient.

Pine cones are ripe when nondefective cones begin to open or "crack." Professional cone gatherers test the ripeness of ponderosa pine and Jeffery pine by floating them in regular SAE 30 motor oil. Freshly picked, nondefective cones float if they are ripe; unripe cones sink. The same test can be used on sugar-pine cones, except that kerosene is used in place of the motor oil.

Seeds can be released from most cones by air drying the cones and then shaking the seeds from the cones when they have opened wide. Cones of the Allepo pine, bishop pine, lodgepole pine, and Monterey pine are usually dried in special kilns, because they normally take several years to open. However, you can open the cones by putting them on aluminum foil on a cookie sheet and placing them in an oven set to the "warm" position for several hours. Check them every hour or so until they are fully open, and then take them out. Do not touch the cones or shake out the seeds until they are cool. Remove the wings on your seeds by hand rubbing or beating them.

You will need many more seeds than the 100 which will become the trees in your nursery. To be on the safe side, collect from 400 to 600 seeds of the species you want to grow. You will use some of these to test the germination, or ability to start growth, and the remainder you will use to sow your nursery bed.

FIGURE 18. Collecting seeds.

Seed Care and Storage

If you are not going to use your seeds right away, you can store them in an airtight jar (a standard fruit jar is good). Place the sealed jar in the refrigerator (not the freezer). Do not break the airtight seal until you are ready to start using the seeds.

Many seeds, including those of most pines and Douglas fir, require special pretreatment before they will germinate. To break their dormancy, you will have to duplicate the conditions of cold and moisture that the seeds would have in their natural locations. This pretreatment is called cold stratification. One method is to place the seeds in moist sand and hold them at a temperature of 32° to 41° F. from 1 to 2 months.

You can stratify your seeds very simply by placing them in a tough polyethelene bag. Put in enough clean tap water to cover your seeds. Close the bag and let the seeds soak for 30 to 40 hours. Keep the bag in a cold place, but don't let it freeze.

Drain off the water at the end of the soaking period, and then partly close the bag, leaving an opening of about one-half inch in diameter to admit air. Place the bag in a cold place at 35° to 40° F., and hold in this cold storage for 4 weeks or longer. The cold section (not the freezer) of your household refrigerator should be a suitable place to hold your seeds in cold storage.

When you are ready to test the seeds for germination, take them from the polyethelene bag and dry them carefully. You can do this indoors or out, but avoid exposing the seeds to a warm sun. The outer surface of the seeds should be dry enough so they won't stick together, but don't let them dry out completely. Dust the seeds with a fungicide, such as Spergon, Ortho 75, or some similar recommended fungicide. You can hold your seeds for later planting in this half-dry condition by putting them back in cool storage. If you do, watch for mildew. Fir seeds mold faster than other seeds, so more care must be used to prevent molding.

Germination Tests

You can determine fairly accurately how many seeds you will need to produce 100 trees in your nursery by using either one of the following tests:

Cutting test. You can make this cutting test either before or after stratification. After mixing the seeds well, count out 100 of them at random and cut them in half with a sharp knife. The seeds that probably will germinate will be yellowish to white inside, firm, and completely filled. Poor seeds will be empty, dark, or shriveled inside. Count the number of good seeds. This will give you the approximate germination percentage.

Sowing test. A more reliable test will be to take 100 seeds at random from your stratified seeds, and sow them in peat moss, sawdust, soil, or some other material that holds water well. Use a shallow box, about 1 foot square. If you want to save the seedlings, you can use a deeper, larger box. Since you will be doing this in the winter, keep the planting material moist, and the seedbox inside the house or where the temperature will range between 65° to 80° F. Practically all of the good seeds will start growth within 30 days. The number of seedlings that develop out of the 100 sowed gives you the germination percentage.

Here are some approximate average percentages to give you some idea of what to expect. While individual seed lots can vary widely, these are fairly common.

Pines	70–80%		
Douglas fir	50–65%	Coast redwood	10–20%
True fir	40–50%	Sierra redwood	10–20%

Now you can see the reason for collecting a lot more seed than you would think necessary to produce 100 trees. In the germination test you ran, you determined the number of good seeds that will grow into seedling trees, if everything is successful. If your test shows that 50 or more seeds per 100 planted probably will germinate, you can get by with 200 or less seeds after the test. If your germination test showed that only 5 seeds per 100 germinated, you would need 2,000 or more seeds to produce 100 seedlings.

A quick method to find the number of seeds to plant after you run the germination test is to divide the number 10,000 by the number of seeds that germinated. This will give the minimum number of seeds that should produce 100 seedlings. For example, if 85 seeds of the 100 germinated, divide 10,000 by 85 and you will get 117.65, or 118 in round numbers. It will take 118 seeds to produce your 100 trees if everything goes right. To be on the safe side, add a few more seeds to guarantee your minimum number of trees. Add 25 seeds if your test showed that 75 or more seeds will germinate. Add 50 seeds to your minimum number for 50 to 75 seeds that germinate, and increase the minimum number by 100 to 200 if less than 50 seeds germinate.

Nursery Seedbed

A deep, loose, sandy soil is the most desirable for your seedbed. Loosen the soil to a depth of about 8 inches with a shovel or spading fork. Remove any rocks or hard lumps, and level the bed so that water will drain to the side. Rake

the surface until smooth, and gently press it down with a board to give a uniform surface on which to sow the seed.

A bed 4 by 4 feet will accommodate 100 seedlings of most conifers up to 2 years of age with some space to spare. A seedbed frame of 1- by 6-inch boards can be built around the bed to support a lath frame cover for shade in the hot summer months, or a wire mesh cover to protect your seedlings from rodents and birds.

Beds usually are easier to care for if the seeds are planted in rows, instead of scattered at random. Press the edge of a ¾-inch board into the soil to a depth of slightly more than the diameter of the seeds you are planting. Make your rows 6 inches apart.

Plant your seed in early spring, as soon as the frost danger is past. Most seeds will germinate within 60 days if sown at this time. Some will even push through the soil in about 2 weeks.

Space your seeds in the row about 1 to 1½ inches apart. In the row space left over, you can plant the rest of your seed, or seed from other trees. Cover the seed with either soil, sand, peat moss, or clean sawdust to about twice the diameter of the seed.

Caring for the Nursery Seedbed. After the seeds are planted, water frequently with a mist spray to keep a moderate amount of moisture on the surface and in the top foot of soil. When the seeds sprout, do not water in the afternoon. The soil surface should be dry by nightfall to prevent "damping off" fungi from killing the tender seedlings. Stop watering about mid-August above 2,000 feet elevation, and mid-September at lower elevations, to allow the seedlings to harden off before cold weather begins.

Keep weeds out of your seedbed. Weed often. Weeds will slow the growth of your trees. Weeds higher than 1 inch should be cut off, rather than pulled. Larger weeds usually have larger root systems, and pulling them may damage the roots of your trees.

Shade your trees about 50 per cent of the time during the first growing season. A lath frame cover kept in place over your seedbed will do this without any attention on your part. The laths should be spaced a lath width apart and running north and south.

In the colder areas of California, plants are sometimes lifted or heaved out of the ground as the ground freezes and thaws. A mulch consisting of a layer of straw 4 to 6 inches deep will keep your trees from being heaved from the ground. Apply the mulch before the worst of the frost season occurs, and remove after it is past.

Seedlings to be transplanted to forest planting sites usually are kept in the nursery bed until 2 years old. When they are transplanted, they are known as 2–0 stock. Most seedlings are transplanted at 2 years, either to their permanent location or to a new spot in the nursery with more room in which to develop. Normally, pine species do not have to be held for 2 years before planting out in the field.

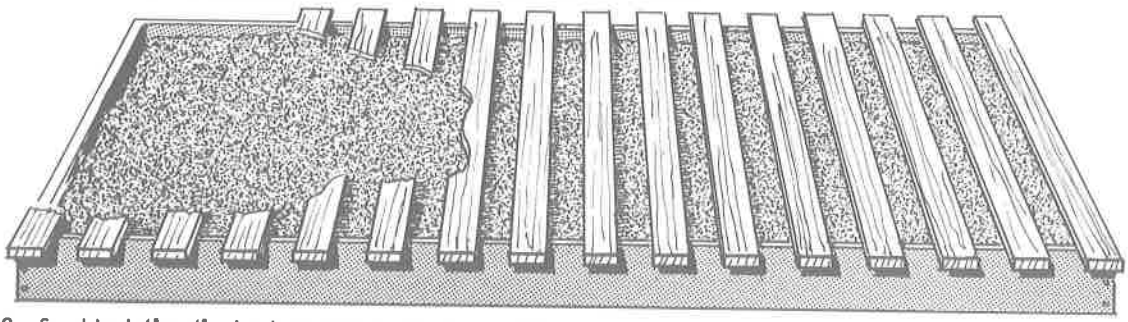


FIGURE 19. Seed bed 4' x 4'. Lath or screen may be used for top.

If seedlings are to be held for 2 years in the seedbed, it is recommended that you prune the roots. Otherwise, the 2-year-old root system will be too long and spindly for good planting technique and survival. Roots normally are pruned in the early spring. Water the bed immediately afterward to settle the soil.

If the seedbed is properly prepared and the soil is loose and sandy, you can prune the roots by inserting a long knife or machete about 3 inches from the row of seedlings, at about a 20° angle from the vertical, and cutting underneath the small trees at an angle on both sides. This prunes the roots to a depth of about 7 to 8 inches. The rows of seedlings in the seedbed should be approximately 6 inches apart.

Another method requires a long and narrow seedbed, raised above the ground level. To make the sides of the bed, place a 1 by 2 inch board on the ground and above this place 1 by 8 inch boards, leaving a crack between the boards wide enough to insert a large knife blade. To root prune, insert the knife into the slit between the two boards and draw it down the full length of the bed. If a raised seedbed is used, soil should be mounded up against the outside edges of the boards to prevent the sides of the bed from drying out. This can be shoveled aside for the root pruning procedure and then replaced.

If root pruning can not be done it is suggested that the 1-year seedlings be lifted and placed in a transplant bed.

Nursery plantings sometimes are bothered by various types of pests. Cutworms will cut off newly germinated seedlings close to the soil. To control cutworms treat the soil surface with a 10 per cent DDT or toxaphene dust at the rate of ½ pound per 1,000 square feet. Deer and rabbits can be fenced out of nursery plots. Rodents can be controlled with poison baits or trapping. Check with your farm advisor for the best materials and methods to use in controlling them.

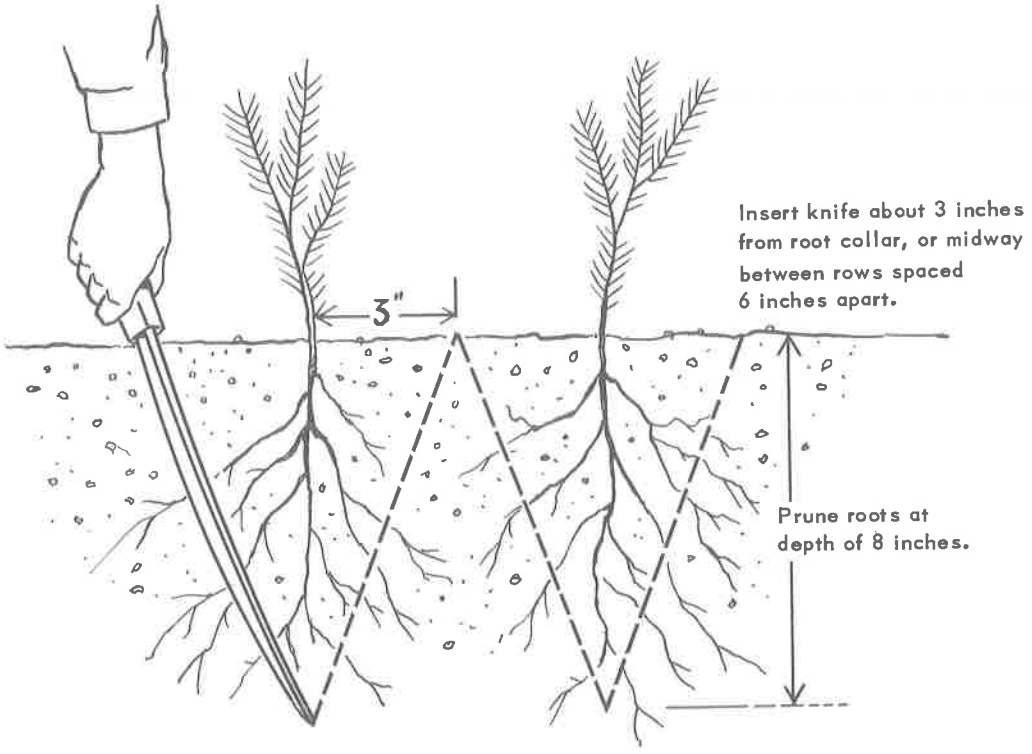


FIGURE 20. Pruning roots of seedlings with a knife.

FIRE — THE MOST SERIOUS THREAT TO THE FOREST

Each year, enough wood to build many homes is lost because the trees that would product the lumber are damaged or destroyed. The causes of the destruction are many — insects, severe weather, poor lumbering practices, fire from natural causes, and manmade fires. Some of these causes are difficult to avoid, although forest scientists are making great progress in controlling some of these serious threats to our standing timber. Manmade fires, however, are inexcusable. Most of them are the result of carelessness.

A 4-H woodsman appreciates the forest, its natural beauty, its recreational advantages, its values as a natural resource. He seeks to acquaint others with these values, and to impress on them the need for greater care while in the forest.

FIGURE 21. Back-pack sprayer.

There are many organizations concerned with the preservation of our forests. They will welcome your help in telling others of the need to use care, and to observe safe practices in the woods. You have many opportunities to tell others what some of these safe practices are, and to remind them to be careful with fire in the forests.

To meet the requirements of this project, you should plan to give at least one demonstration and one talk about fire safety during the year. Plan, too, to distribute "Keep California Green" and "Prevent Forest Fires" stickers to remind others to be careful with fire in the forest.

To become better acquainted with the need and reasons for fire safety, meet the representatives of the California Division of Forestry and the U.S. Forest Service in your area who are responsible for fighting fires in the forests. From them you can learn why it is so important to be careful with fire. They can tell you how to get to forest lookouts, so you can visit one and learn at first hand how our forests are guarded constantly against the spread of fire. Most of these folks will be glad to show you how they spot and report fires.

While you are visiting ranger or guard stations, ask to see the equipment used to fight and control fires. The tools for fighting fire are many. They include aircraft equipped to dump fire-controlling chemicals, back-pack sprayers, shovels, and specially devised hoes that firefighters use to stop the flames.

A good woodsman not only does his best to prevent fires, he also knows how to alert the firefighters immediately and properly when a forest fire starts. Consult the forest rangers for the best way to report fires, and learn from them what to include in a fire report.

WHERE TO GET HELP FOR YOUR PROJECT

You will find many sources of information and help in the forestry project. Your forestry project leader has some of the information that you will need, and he will help you in starting the project. Your farm advisor also will be able to help you with information, bulletins, circulars, and reference books on forestry. He also has the full resources of the University of California School of Forestry and the USDA to help you with technical questions and problems.

Foresters and rangers with the California Division of Forestry and US Forest Service frequently are nearby. Most of the lumber mills in the timber areas of our state employ trained foresters who also can assist you in your forestry project.

REFERENCES

The Small Woodland Council has prepared a number of one-sheet publications called "Timber Tips" that cover nearly every aspect of forestry. These are highly suitable for use in the forestry project. They can be secured through your farm advisor, or through the nearest ranger unit of the California Division of Forestry.

Don't overlook your city or county library as a place to find the following reference books:

Trees – Yearbook of Agriculture, 1949, USDA Government Printing Office, Washington, D. C.

Interesting Trees in California, 1956, Woodbridge Metcalf, University of California Extension Service, Berkeley

The Tree Identification Book, 1958, Symonds M. Barrows and Company, New York

Native Woody Plants of the United States, 1938, USDA Miscellaneous Publications No. 303

Trees, Golden Nature Guide 1956, Herbert S. Zim, Simon and Schuster, New York

Forest Trees of the Pacific Coast, 1938, Eliot Putnam and Sons, New York

Trees of California, 1923, Jepson, Sather Gate Bookshop, Berkeley

Pacific Coast Trees, 1937, McMinn and Maino, University of California Press, Berkeley

An Illustrated Manual of California Shrubs, 1929, McMinn, J. W. Stacey, Inc., San Francisco

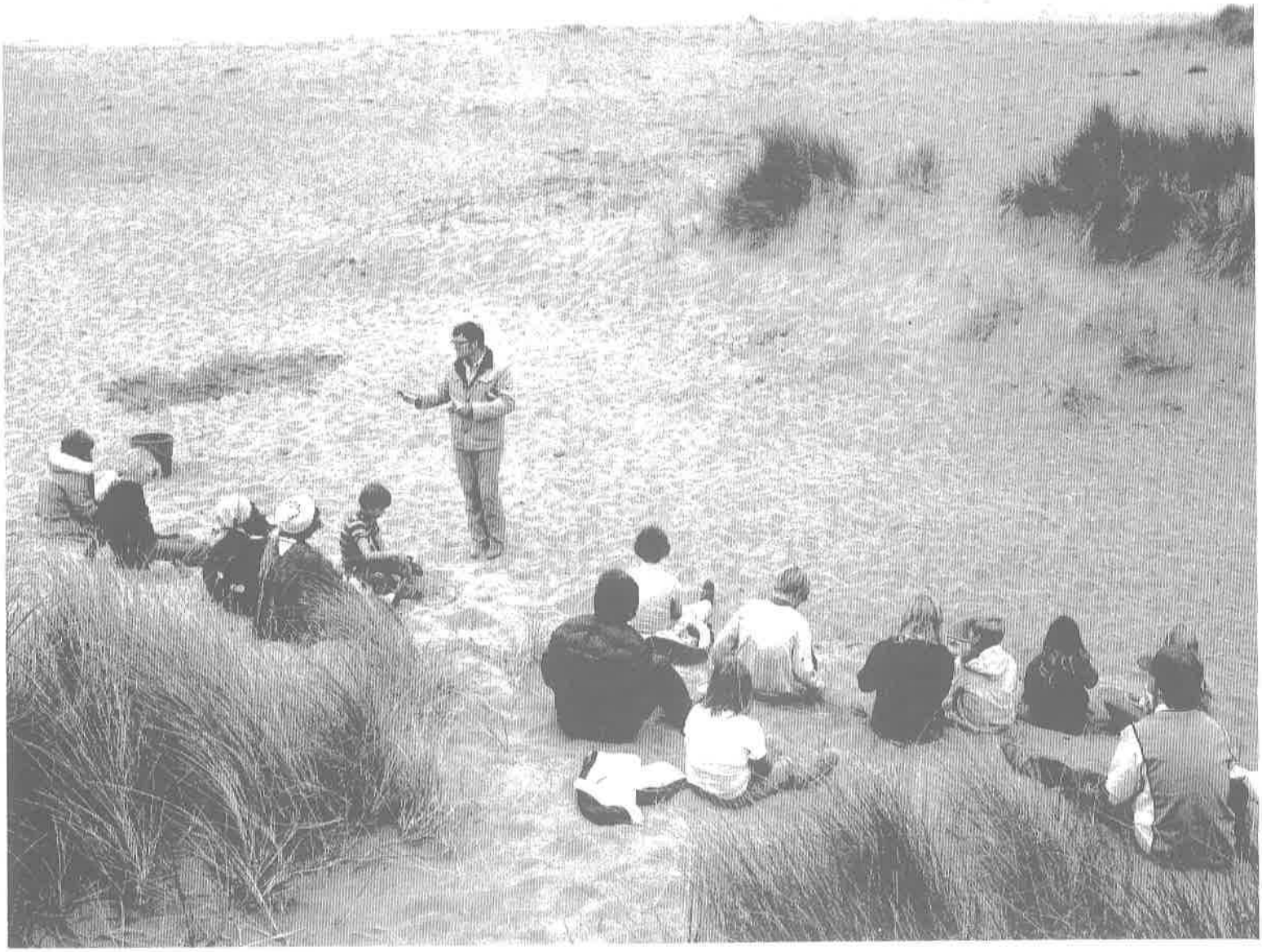
The Redwoods of Coast and Sierra, 1937, Shirley, University of California Press, Berkeley

Manual of Cultivated Trees and Shrubs, 1927, Rehder, The MacMillan Company, New York

Knowing Your Trees, 1955, Collingwood and Brush, American Forestry Association, 919 Seventeenth St., N.W. Washington, D. C.

Trees Every Boy and Girl Should Know, drawings by Calvin Foder, American Forestry Association, 919 Seventeenth St., N.W., Washington, D. C.

4-H MARINE SCIENCE
Leaders' Manual



Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

4-H–7016

PRINTED JUNE 1982

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PERFORMANCE OBJECTIVES

Each 4-H member should complete at least 8 out of the 11 following objectives:

1. Put together a beach safety kit and list seven beach safety tips.
2. Explain to others basic concepts of oceanography such as tides and waves.
3. Identify the most common seashore plants and animals.
4. Name at least ten food products from the sea.
5. Prepare a low cost seafood dish.
6. Describe one important local commercial fishery.
7. Rig and use recreational fishing equipment.
8. Do at least one type of marine-oriented art or craft.
9. Identify and discuss at least one marine policy issue.
10. Name at least five marine careers and the qualifications for these careers.
11. Name and describe to others one presently exploited ocean energy resource and one potential ocean energy resource.

At the end of this publication there is a list of additional publications that will provide more in-depth information on marine resources. Other marine resources information will be developed, so check with your local 4-H Youth Advisor or Marine Advisor about new and useful materials.

CONTENTS

DON'T Join the Bucket Brigade

LEAVE TIDE POOL LIFE ALONE!

California law extends protection to all animal forms. Enjoy your heritage; don't destroy it by taking more than the law allows. Consult current sport fishing regulations.

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INTRODUCTION—WHY STUDY THE MARINE ENVIRONMENT?

People are intimately tied to the marine environment. Approximately 80 percent of California's residents live in coastal counties, and many of them make their livelihood in such occupations as marine recreation, commercial fisheries, ocean-related energy development, shipping, and the marine sciences. Further, all Californians rely on the sea as a source of food—directly from fish and shellfish, and indirectly as a source of high protein feed for meats such as poultry. The ocean also strongly influences climate by supplying cooling breezes and fog during summer months, by generating storms, and by moderating winter temperatures. California's large agricultural and tourism industries benefit greatly from the moderating effects of the Pacific Ocean. Millions of Californians utilize the coast for recreation. California is truly a marine-oriented state, and it is important that our citizens increase their knowledge about the marine environment.

The purpose of the 4-H Marine Resources Project is to promote wise management of marine resources by increasing California youths' awareness of the marine environment. This Leaders' Manual provides three units, each with ten activities designed to fulfill performance objectives. With increased knowledge about the marine environment, today's youth will be able to make wiser decisions about marine issues.

HOW TO USE THE LEADERS' MANUAL

The manual is divided into Beginning, Intermediate, and Advanced Units. Each unit has activities for ten 4-H sessions (approximately 1 year of 4-H meetings). The resources available for each activity (publications, slide sets, etc.) are listed at the end of the manual. In some subject matter areas where available resources don't exist, additional teaching ideas are supplied to assist the leader.

Because of the great variation in the ages, interests, and needs of 4-H youth groups, this project is designed to be very flexible. Often, more than one activity is suggested for each session. Choose the activities your group prefers, and don't feel restricted to the basic outline of the workbook. If the interests and capabilities of your 4-H group are varied, you can select activities from any of the three units or put together new learning activities that meet your needs and utilize local resources. Several of the activities discussed in this manual were developed by creative 4-H marine science groups. Many of the activities can be adapted to the freshwater environment and resources available to inland counties.

Often, marine education is dominated by sciences such as biology, geology, and oceanography. We feel that people's relationship to the sea is important. Many of the activities in this manual highlight the importance of the marine environment in the arts, literature, Native American culture, and environmental policy making. It is important to provide a marine element in many aspects of youth education.

RESOURCES AVAILABLE TO 4-H MARINE RESOURCES LEADERS

The Sea Grant College Marine Advisory Program, a part of UC Cooperative Extension, has developed numerous publications and audio-visual aids that are utilized in the 4-H Marine Resources Project. These materials are available through your 4-H Youth Advisor in your county's Cooperative Extension (Farm Advisor's) Office. All the publications and audio-visual materials used in this manual's activities are available through your County Cooperative Extension Office unless otherwise noted.

Cooperative Extension's Marine Advisors and Marine Specialists are another valuable resource. The Marine Advisors are located in coastal counties, and three Specialists are located on the UC Davis Campus; another UC Specialist is located at California State University at Long Beach. These people can supply information on local marine education resources, and they can help your group get started.

There are numerous other sources of good marine information and activities. The California Department of Fish and Game has a Conservation Education Program that includes materials on marine topics. A few individuals might give talks or help arrange activities. Offices are located in Bishop, Blythe, Eureka, Fresno, Long Beach, Menlo Park, Monterey, Morro Bay, Rancho Cordova, Redding, Sacramento, San Diego, Stockton, and Yountville. A list of Department of Fish and Game publications is available from the Office of Procurement, Publication Section, General Services, P.O. Box 1015, North Highlands, CA 95660.

There are numerous other potential sources of marine materials, activities, and expertise that could help you develop your local 4-H Marine Resources Project. Some of these are listed below.

1. The National Marine Fisheries Service has offices in La Jolla, Terminal Island, and Tiburon. They are good sources of fisheries information.
2. Universities and colleges have staff and students interested in marine subjects. Some campuses with particularly active public marine education programs are: University of California at San Diego (Scripps Institution of Oceanography), Santa Barbara (Marine Science Institute), and Santa Cruz (Long Marine Lab); Humboldt State (Fred Telonicher Marine Laboratory), Moss Landing Marine Laboratories, College of Marin, UC Bodega Bay Marine Laboratory, and Long Beach State (Southern California Ocean Studies Consortium).
3. County, state, and national parks in coastal areas often have educational materials, facilities, and programs.
4. Other governmental agencies such as the U.S. Fish and Wildlife Service, Army Corps of Engineers, State Department of Boating and Waterways, and the Bureau of Land Management have available environmental education materials and programs.
5. Environmental organizations such as the Oceanic Society are a good resource.
6. Many school districts have marine education programs. Schools in San Diego, Orange, Los Angeles, Alameda, Contra Costa, Sacramento, and Marin Counties are especially active.
7. Members of local sportsfishing, scuba, and yacht clubs can be helpful.

8. Representatives of local marine industries can supply insight into their industries and the career outlook. Some examples include commercial fishing, seafood processing, boatyards, marinas, environmental consulting firms, and oil companies.
9. The Southwest Marine Education Association, a chapter of the National Marine Education Association, is a good source of ideas and contacts through their journal, "Currents." Information on the Association is available from Ruth Symonds, 5400 Halbrent Avenue, Van Nuys, CA 91411.
10. An "Inventory of Non-Technical Marine Resources, Publications, and Audio-Visual Materials" is available from Sea Grant Communications, 418 Administrative Services Building, Oregon State University, Corvallis, OR 97331. Ask for PASGAP Publication No. 5.

BEGINNING UNIT

Session I—Introduction and Beach Safety

I. **Performance Objectives.** After completing this session's activities the 4-H members should be able to:

a. Name seven beach safety tips.
b. List four items in a beach safety kit.
c. Name four dangerous marine animals and explain why they may be dangerous.

A. This is the introductory meeting. Help everyone get to know each other. Discuss what you would like to accomplish during the year. Have the group set goals for the year.

B. Discuss beach safety. Several of the group's activities will be at the seashore and building good beach safety habits will carry over into future years. The seashore is an interesting but potentially dangerous place. Care and planning can lessen the danger.

BEACH SAFETY TIPS

1. Use a "buddy system" so all participants operate in pairs. It is advisable to have several adults along as helpers for each group of 4-H members on the beach.

2. When near the surf, don't allow anyone to turn their back to the ocean—a large breaker could sweep you off your feet. If swept off your feet, grab and hold onto the nearest rock if possible. If swept out to sea, don't fight against the current; drift or swim with or across the current until help arrives.

3. Keep a life ring (or inner tube) and a 40-foot rope in a handy spot on the beach and mark it with a red flag.

4. For tidepool trips, check the tide book for the times and heights of the tides. Stay aware of the time and tide level so you won't be trapped on the outer part of a reef.

5. Don't allow anyone to run or jump on algae-covered rocks. They are extremely slippery.

6. On trips to rocky areas, don't wear shorts or bathing suits because there are many sharp edges on rocks and many abrasive organisms such as barnacles. Be sure to wear rubber-soled shoes or boots because the rocks are wet and slippery.

7. Take along a first-aid kit.

8. Dress warmly, especially in northern California, because our coastal waters and climate can be quite cool. Subnormally low body temperature (hypothermia) reduces alertness and increases the probability of an accident.

9. Protect your skin from excessive exposure to sun and wind.

10. Know how to spot and avoid rip currents, especially if you plan to be in the water. Ninety percent (90%) of all lifeguard rescues are made of people caught in rip currents. Rip currents tend to be near jetties, piers, coves, and rock groins. Rip currents often have brown, murky waters that are choppy and foam-covered. Look at people and objects in the water; if they are floating out to sea, they are probably in a rip current.

    If you get caught in a rip current, don't panic and don't fight the current. Determine which way the long shore current is moving and swim in a 45-degree angle toward shore, swimming with the long shore current. Another way out of a rip current is to swim in at a 90-degree angle to the current until you are out of the rip; then swim toward shore. If you can't get out of the rip current, yell and look for help.

C. Put together a beach safety kit for future field trips. Some items to include are: a first-aid kit, life-rings or inner tube, a 40-foot rope, drinking water, and waterproof matches. You may want to add other items, such as warm clothes and blankets, depending on the nature of your trip.

D. Discuss dangerous marine animals, such as jellyfish, using the following reference: Halstead, B.W. 1970. *Poisonous and Venomous Marine Animals of the World.* U.S. Government Printing Office, Washington, D.C. (available at many libraries).

Session II—Oceanography

I. **Performance objectives.** After completing this session's activities 4-H members should be able to:

a. Answer correctly all seven tide table questions;
b. Give two examples of marine food chains.

A. Teach the group how to understand and use tide tables. Tide tables are usually available through local marine business such as sporting goods stores, bait shops, and boating equipment dealers for free or a minimal charge. Newspapers often print tide tables.

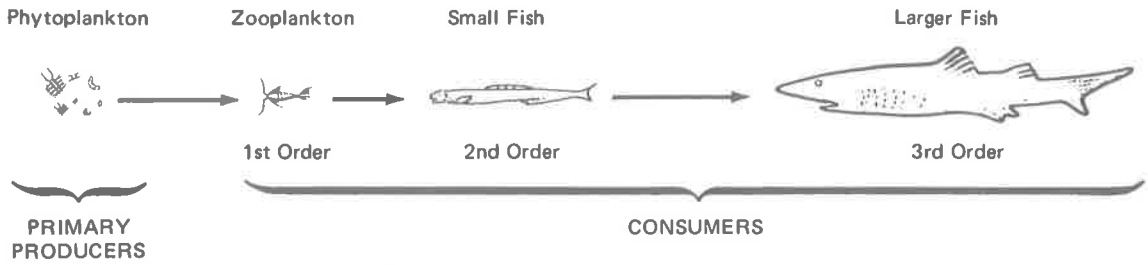


Fig. 1. A food chain in the ocean

Knowledge of tides is essential to people who make a living or enjoy recreation at the coast. For example, ability to use a tide table is necessary to determine the best fishing or clamming tides or to plan a boating trip to take advantage of the tidal current.

California has mixed tides, which means that there are two high and two low tides of unequal heights. Tide tables will show the time (0000 = midnight, 1200 = noon) and height of the tide.

Most tide tables have appendices that give the differences in times and heights of high and low water at various locations along the coast. Some tide tables also include tidal current tables which give time and flow rate of incoming and outgoing tides as well as the time of slack current. Tidal current information is especially useful to boaters.

For a more complete explanation of tides, consult one of the textbooks listed under Oceanography at the end of this publication. Another good reference is "Understanding Tides" (SG 25). It is available from Sea Grant Communications, 418 Administrative Services Building, Oregon State University, Corvalis, OR 97331.

The following tide table quiz can be used to test and enhance the 4-H members' ability to use tide tables.

Tide Table Quiz

1. What are mixed tides? How many high and low tides are there per day on the California Coast?
2. How is 3:20 a.m. written in the tide table? 7:30 p.m.?
3. Which is the lower tide: −1.1 or 1.1?

4. Find what the tides are on your birthday.
5. Find a good day for a tidepool field trip. Why is it good?
6. Why are tides important to boaters?
7. List the time and tide level for all four tides today.

B. Another activity for the group is to place a pole or mark on an existing structure in the intertidal zone and watch the water rise and fall throughout the tidal cycle. Compare the observed difference between low water and high water with the difference listed in the tide table. If you can't get to the seashore, graph the tides out of the tide tables for a week on graph paper. Notice how the times of high and low water change each day.

C. A third oceanography activity is to utilize U.C. Cooperative Extension Leaflet 2255, "Biological Oceanography," to discuss ocean food webs and the transfer of energy from primary producers (phytoplankton) to higher order consumers (zooplankton and fish). To illustrate the interdependence of the organisms involved, play the food chain game described below. Predator-play relationships are often more complex and dynamic than illustrated by this game.

D. Play the "food chain game." (Adapted from: Bagnall, N. 1980. *Children's Literature and the Sea.* Texas A&M Sea Grant College Program [TAMU-SG-80-401.].)

Materials:

Cloth streamers, about 2" × 18" in three different colors.

24 to 30 plastic sandwich bags, and plastic produce bags.

Dried beans or styrofoam packing material.

Scoreboard and magic marker.

Leader's instructions:

1. This is an outdoor game to illustrate a food chain and to show how it can change.
2. Mark the sandwich bags with two strips of tape or magic marker at one-inch intervals from the bottom.
3. Mark the produce bags approximately two-thirds from the bottom.

Members' instructions:

1. Set the boundaries for the playing area and a 5-minute time limit.
2. Divide into three teams: anchovies, mackerel, and tunas (or a food chain of your choice). Tie a different colored streamer to the wrist or belt to identify team members.
3. Anchovies and mackerel have plastic sandwich bags to represent their stomachs. Tunas, which are larger, use plastic produce bags.
4. Spread the beans or styrofoam packing material, which represent plankton, around the area.

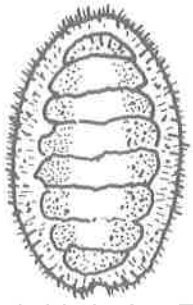
5. Anchovy stomachs are filled when the beans or styrofoam reaches the first line on the sandwich bag. Mackerel stomachs are filled when the captured anchovy stomachs reach the second line on the bag. Tuna stomachs are filled when the captured mackerel stomachs reach the line on the produce bag.
6. Players tagged are out of the game.
7. One of each species must survive to maintain the food chain. Survivors are those left in the game at the end of the time limit whose stomachs (or bags) are filled to the line indicated. Record the number of survivors on the scoreboard.
8. After the first game, players can change one rule to see if they can balance the system so there will be survivors in each group.

Session III—Marine Biology

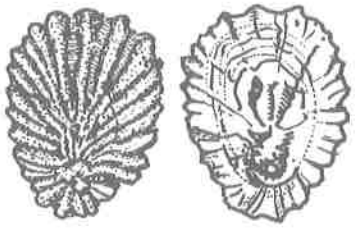
I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:
   a. Select a good tidepool field trip time by consulting a tide book.
   b. Explain laws protecting tidepool organisms.

A. Plan a tidepool field trip. Look for a convenient date with a low tide. Minus tides are best, but with any tide less than 1.0 feet there will be many interesting organisms to see. Select a rocky intertidal area by consulting local experts.

Chiton



Limpet



B. Discuss field trip tips. These include reviewing and using beach safety tips and taking along equipment such as a hand lens, binoculars, tidepool identification books, notebook and pencil, a camera, and extra clothes and shoes.

C. Using U.C. Cooperative Extension Leaflets 2246, "Ecology of the Intertidal Zone", and 2549, "Identifying Intertidal Plants and Animals", and other references if desired, discuss tidepool ecology and conservation. Review the laws about protection of tidepool organisms in the Sportsfishing Regulations. Put emphasis on observing; California law prohibits collecting almost all tidepool organisms. California tidepool resources are limited and could be ruined by collecting and disturbing by the thousands of visitors each year.

D. Show and discuss the slide-cassette tape set "Introduction to Intertidal Plants and Animals". It is available from Visual Media, University of California, Davis, CA 95616, (916) 752-0590. This slide-tape set will introduce the members to the common organisms they will encounter.

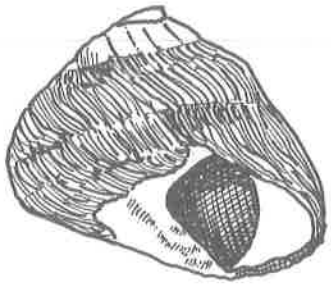
Session IV—Marine Biology

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

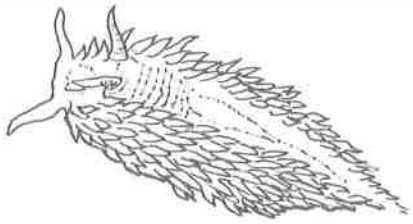
a. Locate and identify five intertidal animals and three intertidal plants.

A. Take the group on the tidepool field trip. Give members Extension Leaflet No. 2549, "Identifying Intertidal Plants and Animals", and other note paper to record notes about the organisms discovered. Don't collect organisms; enjoy observing them.

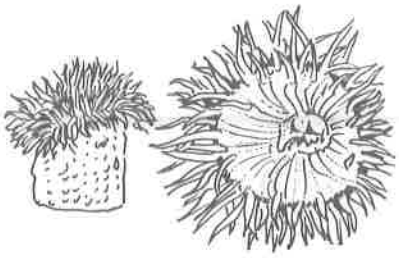
Turban Snail



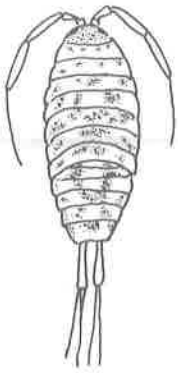
Nudibranch



Sea Anemone



Rock Louse



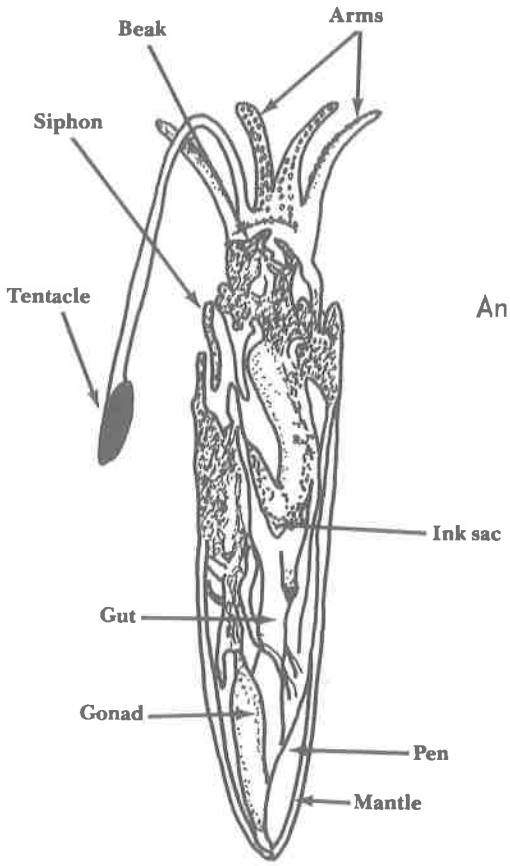
Session V—Food from the Sea

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Clean and cook squid;

b. List thirty seafood products.

A. Using U.C. Cooperative Extension Leaflet 21112, "Catching, Cleaning and Cooking Squid", obtain and have the members prepare squid for eating. Squid is a good example of a tasty, economical, underutilized seafood. Squid is being used more and more as a substitute for scarce and expensive abalone.



Anatomy of a squid

B. Take your members on a "Supermarket Seafood Treasure Hunt". The object of this activity is to make the members aware of the many different seafood products available. In an average supermarket, the members should find a minimum of 30 seafood products. Some of the areas to look are the meat counter, frozen food section, canned food, pet food, gourmet section, soups, and delicatessen. The members can either work together to compile a list or divide up into teams. Comparing prices of different products and discussing where and how these seafood products were caught would add depth to the activity.

Session VI—Fisheries

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Construct, rig, and use simple fishing gear.

A. Find out about and discuss fishing licenses and regulations. In California, everyone 16 years of age and older must possess a license when fishing except from public piers, jetties, and attached breakwaters. Booklets containing sportsfishing regula-

tions are available from anywhere fishing tackle and bait are sold. Review the regulations for fishing in your area and have a group discussion about the reasons for these regulations.

B. Construct and use Armstrong fishing reels for a fishing trip. This is a low cost, easily-built device which can be made from recycled materials. It can be used from a pier, boat, or shore. An alternative, if you don't want to construct fishing gear, is purchasing simple, inexpensive droplines from a tackle shop.

Materials:

One size 10 tin can (often available from restaurants and food service businesses).

One board ¾" × 1½" × 6".

Four galvanized shingle nails size 3d (1¼").

100 feet or more of line 10- to 40-pound test dacron or braided nylon line, or size 9 nylon seine twine—use the heavier line if fishing in rocky areas.

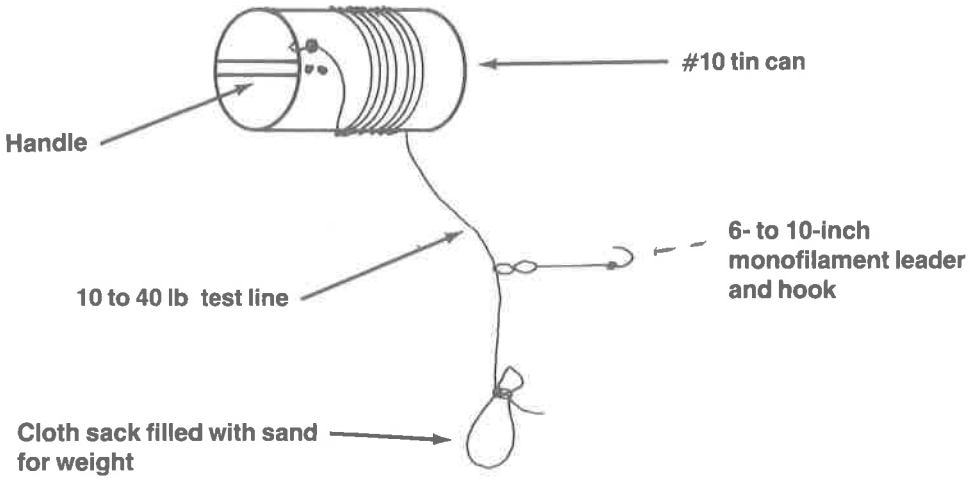
One 10-inch monofilament leader for hooks—leaders are 2- to 4-pound test (lighter than the main line).

One or two size 2 to 6 hooks for pier fishing—size 6 to size 2/0 for rocky areas.

One weight made with a 6" × 6" piece of heavy cloth to contain sand (see instructions, which follow).

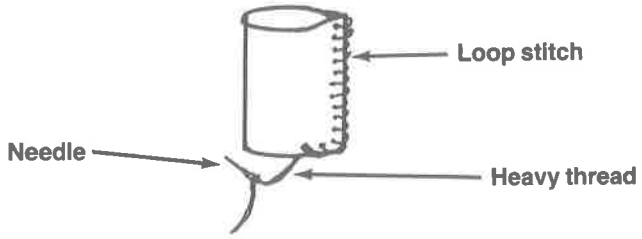
Building the Armstrong Reel:

1. Wash the can and remove label. Drill or punch a small hole in the lip of the open end of the can to secure the fishing line.
2. Plane or sand the edges of the board (handle) to make it slightly rounded for a comfortable grip.
3. Insert the handle across the opening of the tin can. It should fit snugly. Turn the can on its side and nail the handle in place with two nails on each side.
4. Attach the fishing line to the hole in the lip to secure it. A ½" split ring can be used in the hole to prevent wear on the line. Most tackle shops carry split rings. Wind the line around the outside of the can.
5. Tie a loop using an overhand knot about 15" from the end of the main line. Attach a 6- to 10-inch monofilament leader and hook to the loop in the main line. Tie the cloth sack filled with sand to the end of the main line. Vary the amount of sand according to the strength of the ocean current.



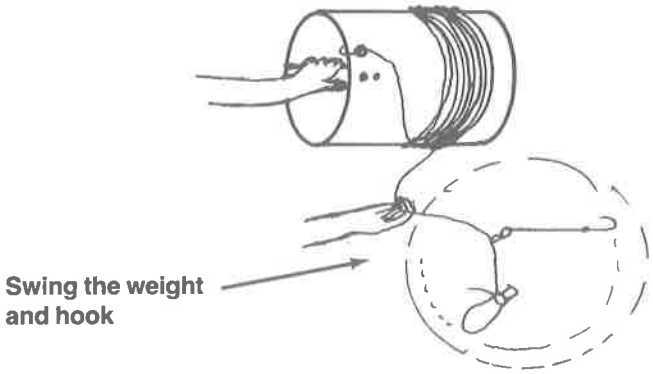
Making Cloth Sack Weights

1. Make the cloth sack weight with a 6" × 6" piece of cloth. Recycled denim trouser scraps make good sack material, but any strong cloth will do. Fold the cloth in half and sew the side and one end with heavy thread. Use the loop switch or a sewing machine.



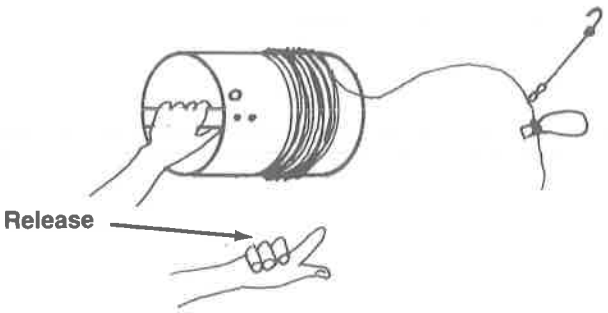
Turn the sack inside out after sewing. The sack is filled with sand and acts as an expendable weight. If it is caught on a rock and tears, you lose only sand. Make several sacks to take fishing.

How to Use the Armstrong Reel



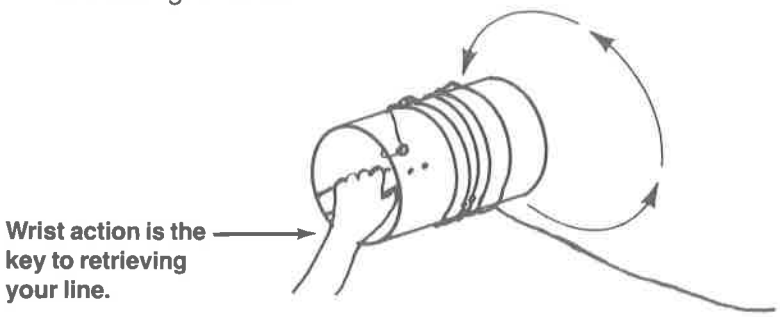
1. Right-handed persons should grasp the *handle* of the Armstrong reel with the *left* hand. The line should be held in the right hand ready for casting. Left-handed persons should reverse this procedure. Point the end of the can toward the area you want to fish.

2. Swing the sack-weight and hook in a circular motion and release. With practice, you will be able to release most of your line and accurately hit the area you wish to fish.



Reeling In

Retrieve the line by using a circular wrist motion with the left hand while guiding the line back on the can with the right hand.



Fishing Tips

The Armstrong reel, which is guaranteed to develop a strong arm if used each day, can be used on piers, boats, and the shore. Consult with local fishing experts and your local fishing tackle shop about where to take youngsters fishing. Select a location with a high probability of success, regardless of the size of the fish, rather than a locale with only a few large fish.

One of the best times to fish is on the early morning incoming tide. Check your tidebook for a mid-morning high tide. The best baits include: shrimp, marine worms, mussels, clams, squid, and pieces of anchovy. Make sure everyone dresses warmly and wears tennis shoes, especially when fishing on the rocks. Take a gunny sack for your catch. Keep it wet and shaded. Keep only the fish you plan to eat and return all others to the ocean alive. Nearly all of the fish you catch are delicious. Consult the references under Recreational Fisheries at the end of this manual for sources of fishing information.

(Adapted from "The Armstrong Fishing Reel", Santa Barbara County Cooperative Extension Publication by John Richards, UC Area Marine Advisor.)

C. Obtain and view "The Grunion Story" movie. It is available from the Department of Fish and Game regional headquarters in Redding, Sacramento, Yountville, Fresno, and Long Beach (addresses are listed under "Audio-Visual Materials" at the end of this manual). Grunion are small (6") silversides and spawn on southern California beaches on the nights of the highest tides.

D. In southern California, plan and participate in a grunion fishing or viewing trip. Check with your local fishing tackle shop or California Department of Fish and Game Office about the best nights and times for fishing. Check the sportsfishing regulations concerning seasons. Grunion can only be captured with your bare hands. Keep only as many as you plan to eat.

E. In northern California, plan and participate in an outing to catch herring (winter months) or surf smelt (rest of the year). Check with local tackle shops about the best times, locations, and gear. Surf smelt are captured in nets in the surf on beaches, and herring are caught while spawning in rocky areas in southern California's bays. Check the sportsfishing regulations.

Session VII—Ocean Arts and Humanities

I. **Performance objectives.** After completing this session's activities 4-H members should be able to:
   a. Create a beach casting.
   b. Create a sand painting.

A. Have the members do beach castings either at the beach or in sand-filled containers.

Materials:

Plastic basins or buckets.
Plaster of Paris packed in watertight bags.
Shells, driftwood, sticks, stones, and other objects.

Methods:

Dig a shallow area in wet, firm sand (about one square foot) and create any design you want by molding the sand and decorating with the collected objects. Mix the plaster with equal amounts of sea or fresh water and plaster. Mix gently until plaster has dissolved; excessive mixing will cause the plaster not to harden. Slap the side of the container to bring air bubbles to the surface.

Blow on the bubbles to burst them. Pour the milkshake-thick mixture onto the design. If there is enough plaster left, other youngsters can fill their molds. Stop as soon as the plaster begins to harden in your container; rinse out container and mix a new batch.

Before the plaster is too hard, have the makers initial their casting for future identification. When the plaster has hardened, carefully remove the casting from the mold and brush off the sand. The castings can be mounted on canvas or burlap-covered boards or hung as they are using picture hangers. Explore creative ways to use the beach castings for decorations.

(Adapted from "Beach Casting: You Don't Really Need a Beach to do It" by Katie Sallos. National 4-H News, June-July, 1974, pp 22-23.)

B. Make Sand paintings. This can be done at home or at the beach.

Materials:

White glue.
Cardboard pieces or paper plates.
Pencils and a brush.
Sand (several colors and/or textures preferable).
Tempera powdered paints (optional).

Methods:

On a piece of cardboard or paper plate, draw a simple design. If tempera colors are used, mix them with the sand. With white glue paint the portion of the interior of the outline that you want in one texture or color of sand. Sprinkle one color or texture of sand over the picture. Let dry. Brush off excess sand. Repeat the process for each texture or color of sand used. Simple designs are best.

(Adapted from "4-H Ocean Adventures" by Vicki Osis and Don Giles, Oregon State University Cooperative Extension.)

C. Collect flotsam and jetsam as well as non-living natural marine items along the beach. Try to figure out where these items came from. Discuss the problem of ocean litter. Discuss the currents that carried these items to that beach. Discuss the power of waves and how the shapes of the items on the beach have been changed by the ocean's forces.

Session VIII—Marine Politics

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Explain one ocean public policy issue to others.

A. Collect and discuss newspaper clippings on ocean public policy issues. This activity will increase the participants' awareness of the importance of ocean affairs. Some examples of topics include: offshore oil development, pollution, coastal land use planning, local marine recreation opportunities, seafood products, habitat protection, and international maritime incidents. Additional information on offshore oil development is contained in the Ocean Energy Unit, listed under "Additional Activities."

B. Invite a speaker to discuss an important marine issue or legislation. Speakers on timely issues may be available through local government agencies, educational institutions, conservation organizations, or industry.

C. Make a world map with territorial limits and fishery economic zones drawn in. Discuss possible conflicts.

Session IX—Marine Public Service

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. Assist with a habitat improvement project.
   b. Assist in preparation of a marine education display.

A. Organize a seashore cleanup project. There may be marshes, beaches, and bays in your area that are visually degradated by trash. Consult with local officials who manage the area to plan your project. Possible coordination of efforts with other youth groups or service organizations should be explored as well as opportunities for recycling the discarded materials.

B. Plan and prepare a marine education display. Your local 4-H Youth or Marine Advisor may be able to help with this project. The display should present well documented information about marine resources. Some ideas for display topics include: local fisheries, biology of local marine organisms, underutilized seafood products, 4-H marine projects, and marine issues. A well prepared display could be placed in a location with substantial public exposure such as banks, fairs, stores, schools, and libraries.

Session X—Career Exploration

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. Name five marine careers and their qualifications.

A. Brainstorm with the group to come up with a list of marine careers and the type of background needed to qualify for these careers. Do these careers exist in your area? Why are the members interested in these careers? What careers do you think will exist in the future.

B. View and discuss one of the films about a marine career listed at the end of this manual.

INTERMEDIATE UNIT

Session I—Introduction and Beach Safety

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. List eight beach safety tips.
   b. List five causes of boating accidents and explain how they can be avoided.

A. This is the introductory meeting. Help everyone get to know each other. Discuss what the group would like to accomplish this year. Have the group set goals.

B. Review the beach safety rules outlined in the Beginning Unit. Check or put together the beach safety kit.

C. Invite a speaker to demonstrate marine safety equipment such as life preservers, life rafts, and marine safety procedures such as the prevention of hypothermia and water safety. Speakers are often available through local Coast Guard Auxiliaries/ Power Squadrons, yacht clubs, Red Cross, Sheriff's Departments, safety equipment manufacturers and retailers.

D. Discuss boating safety. A list of basic publications on boating safety is available from the Department of Boating and Waterways, 1416 Ninth Street, Sacramento, CA 95814.

Session II—Oceanography

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

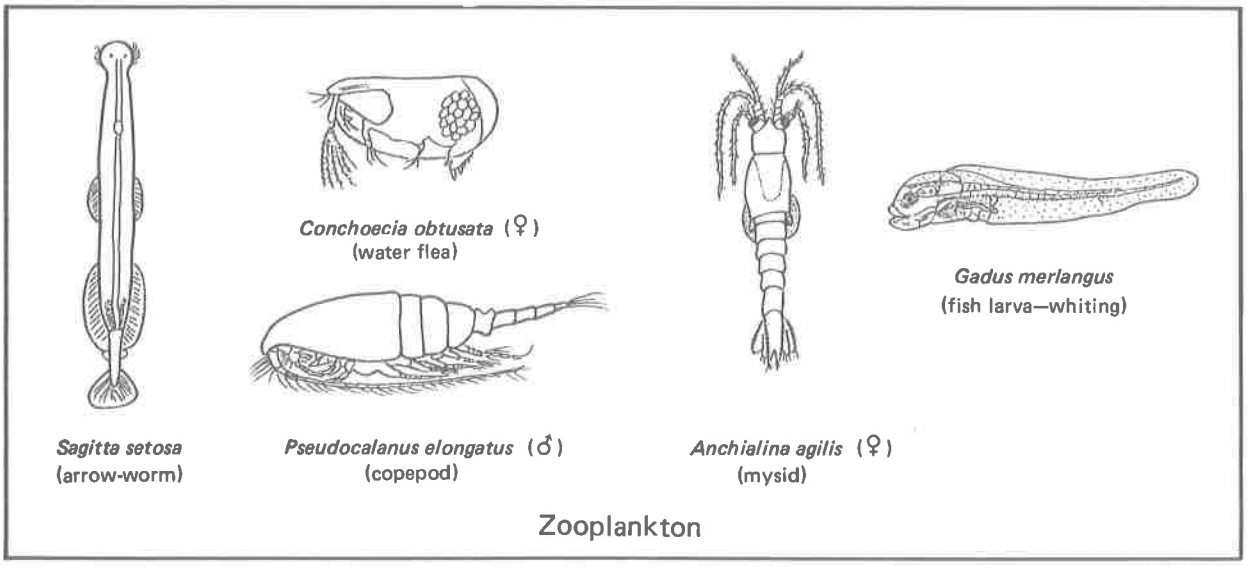
a. Collect and identify three types of zooplankton.

b. Explain upwelling to others.

c. Demonstrate the differences in sand particles between beaches.

A. Using the instructions in Leaflet 2557, "Sampling Plankton", construct and use a plankton net.* View the zooplankton (animal plankton) collected with a hand lens or a dissecting scope. Plankton are the tiny plants and animals that serve as food for larger animals. This activity will help members understand ocean food webs. Try to identify a few of the common types of zooplankton using the guides listed in "Sampling Plankton" or other identification guides available through your library.

*(All leaflets referred to are U.C. Cooperative Extension Leaflets unless otherwise identified.)



Zooplankton

B. Study ocean currents. Learn about their causes, types, and location. Have the group make a world map with all of the major ocean currents on it. Oceanographic texts listed at the end of this manual will show the major currents. Check for them at your library. Study the major currents off the California coast. Using Leaflet 2939, "Upwelling in California Coastal Waters", learn about upwelling. Discuss the effect of upwelling on weather, water temperature, fishing, and marine life.

C. Using Leaflet 2554, "Ocean Currents", do the exercise demonstrating the effects of salinity and temperature in ocean waters. Are there local areas where differences in salinities or temperatures might occur.

D. Make a sand collection, using clear plastic pill bottles (purchased from a druggist) or small plastic bags. Collect sand from different beaches and label the containers. Sands will vary from beach to beach because they come from different sources. Examine the sand with a magnifying glass or hand lens to see the different types of sand particles (quartz, jasper, etc.) and compare the relative composition of the sands from different beaches. Discuss why sand from different beaches is different. Another activity is to set up a beach sand exchange with 4-H groups or others in different parts of California or the United States. A film which will help in understanding the dynamics of beaches is "Beach, A River of Sand" available from Extension Media Center, University of California, Berkeley, CA 94720.

E. Using the Ocean Energy Unit described under "Additional Activities" have the group draw and discuss potential ocean energy resources using currents, salinity, and temperature differentials.

Session III—Marine Biology

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. Identify and press three species of marine algae.

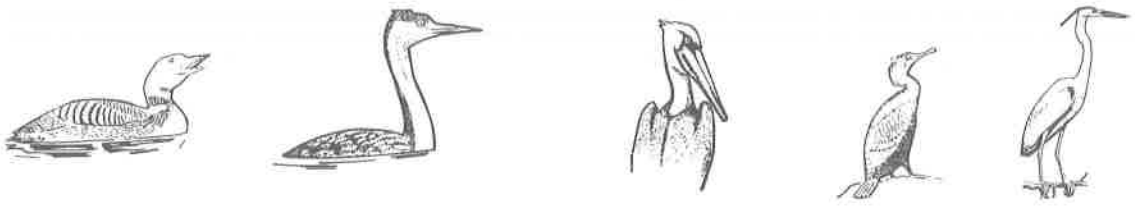
A. Learn about the different types of algae and their utilization. Leaflet 21110, "Marine Algae", presents a general introduction to marine algae identification and utilization. The references at the end of that leaflet will supply more in-depth information for intermediate members.

B. Using Leaflet 2556, "Pressing Algae", collect, identify, and press algae. Consult the sportsfishing regulations about algae collecting laws. The group can make an educational display of their algae pressings or frame them individually for decorations or gifts.

Session IV—Marine Biology

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Identify ten species of seashore birds.



A. Learn to identify common seashore birds. Leaflet 2550, "Identifying Seashore Birds", and bird identification guides available in most libraries will help the beginning birder. The slide-tape cassette set on "Seashore Birds", available from Visual Media at University of California, Davis, CA 95616, will help in preparation for a field trip.

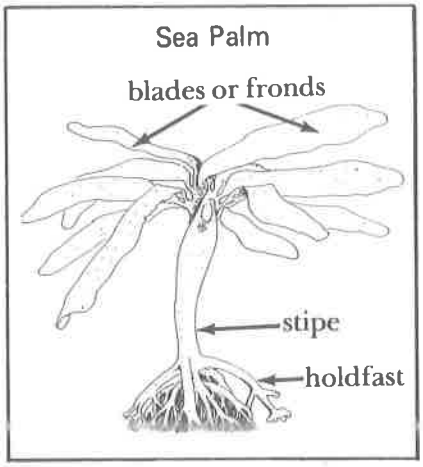
B. Take a field trip to a bay, marshland, or beach to view and identify seashore birds. Take along binoculars, your bird identification materials, and a clipboard with Leaflet 2550 and additional paper to record your sightings. It is best to go with someone who knows birds well. Often the local chapter of the Audubon Society or other environmental organizations will organize trips and bird counts. Early morning is usually best for bird watching, and many seashore birds are most visible at low tide when they feed along mudflats.

Session V—Food from the Sea

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Prepare one food dish from marine algae.

b. Explain paralytic shellfish poisoning to others.



Seaweed Parts

A. Make and eat the seaweed bread and/or other algae-based foods from recipes in the "Marine Algae" Leaflet 21110. Other sources of marine algae recipes include:

Abbott, I.A. and W. Williamson. 1974. Limu. . . Pacific Bot. Garden (2nd Edition).
Loggins, P. 1975. The Uncommon Cookbook. Sea Grant Bulletin #8. University of Maine: Orono, Maine.
Madlener, J.C. 1977. The Seavegetable Book. Clarkson-Potter Pub. Co.: New York, New York.

B. Organize and/or participate in a food festival with marine foods. This could be a 4-H event, an event planned with the Cooperative Extension Home Economist, or a fair.

C. Learn about paralytic shellfish poisoning by reading Leaflet 21117, "Paralytic Shellfish Poisoning and Red Tides". Discuss the precautions necessary to ensure that you are harvesting shellfish that are safe to eat.

D. Learn about new marine products. Visit a seafood market and ask about new and unusual products.

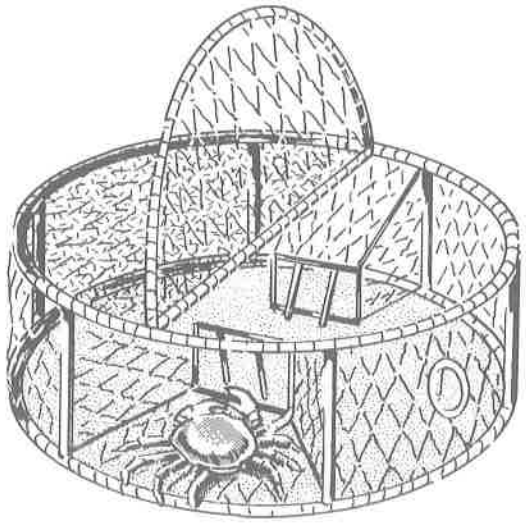
Session VI—Fisheries

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

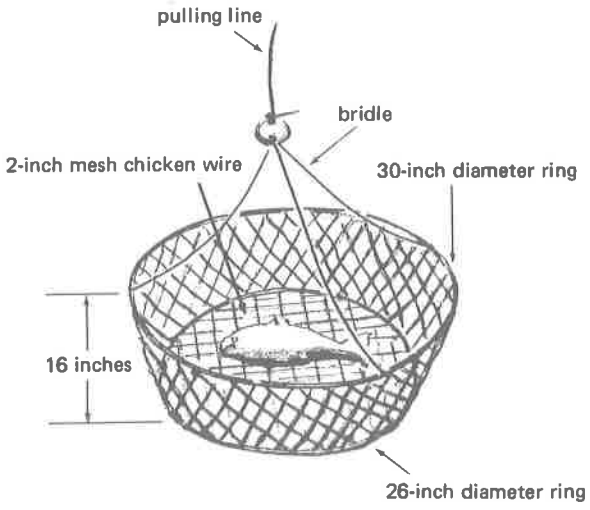
a. Construct and use a crab or crayfish trap.

b. Describe four major types of commercial fishing methods to others.

c. List five types of fish and shellfish produced by aquaculture.



Crab pot



Crab hoop net

A. Construct and use crab or crayfish traps. Leaflet 2546, "Catching and Cooking Crabs", supplies a trap design, fishing hints, and cooking instructions. If you live in an inland area, crayfish can be trapped in many lakes and streams. Check with your local fishing tackle shop about designing crayfish traps. Cylindrical crayfish traps can be made out of small-mesh chicken wire with a funnel-shaped entrance at each end. Be sure to check the sportsfishing regulations for seasons, size limits, bag limits, and gear restrictions. Cook and eat the crabs or crayfish you keep.

B. Learn about commercial fisheries through films and videotapes. Invite a commercial fisherman to talk about his industry. Some available films and videotapes include:

"Oregon Trawler"—16 mm color, sound

"Making Waves"—four 15-minute, ¾-inch cassette videotapes with question sheets.

1. "Commercial Bottom Fishing"
2. "Seafood Processing"
3. "Coastal Estuaries"
4. "Oyster Farming"

(Available from Sea Grant MAP Extension, University of California, Davis, CA 95616.)

C. Visit a hatchery to learn about aquaculture and fisheries. The California Department of Fish and Game and other government agencies operate hatcheries throughout the state. Contact the one nearest you to find out about hours, best seasons, and public education programs. Some private aquaculture companies may allow visitors. They are usually listed in the phone book. Several films on hatchery operations are available from the Department of Fish and Game. These are listed at the back of this manual.

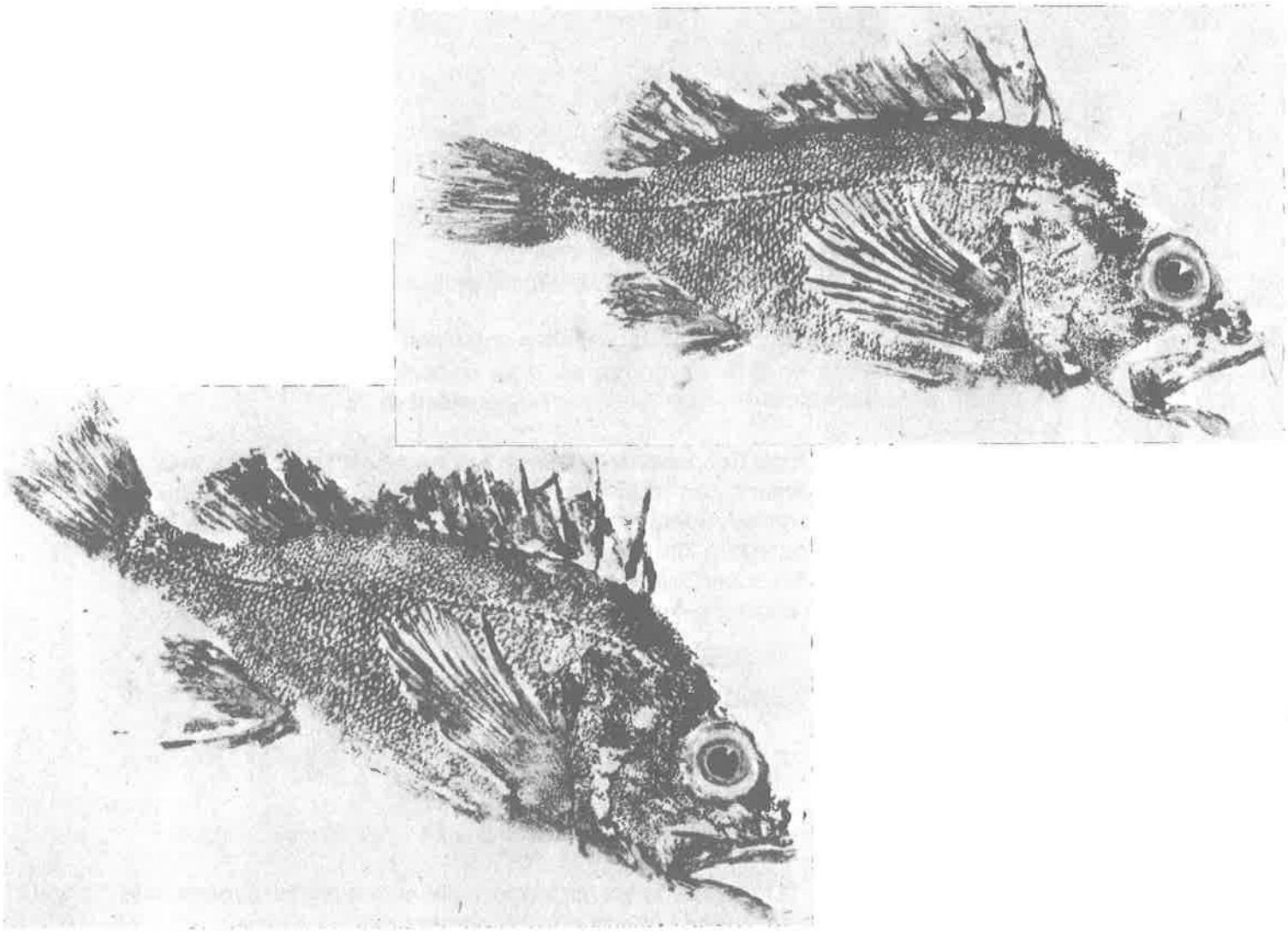
Session VII—Ocean Arts and Humanities

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Create a fish print.
b. Explain both sides of a marine policy issue to others.

A. Make fish prints using the techniques described in Leaflet 2548, "Gyotaku—Japanese Fish Printing". This activity will teach the members about external fish anatomy. The fish prints can be used for displays at fairs, as home decorations, or as gifts. Using fish caught in a group fishing trip is a good idea.

B. Use the mass media (television documentations, magazine articles, local talks) as a source of information about marine issues. For example, collect newspaper and magazine clippings on marine issues for a month. Have the 4-H group discuss the programs or articles Do they present a balanced argument with documented facts?



Session VIII—People and the Marine Environment

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. Simulate fisheries regulations and their impact on fish populations.
   b. Give one example of Native Americans' historical use of marine resources.

A. Do the activities contained in Leaflet 2553, "Marine Resource Laws and Regulations". Discuss how the activities relate to current commercial and sportsfishing regulations. Environmental variability, economics, fishermen behavior, and politics combine to make resource management complex. List reasons and cite examples showing that this leaflet's activity greatly simplifies the real world situation.

B. Visit museums or invite a speaker to discuss maritime history or Native Americans' utilization of marine resources.

Session IX—Marine Public Service

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Assist local organizations with a public service project.

A. Participate in local bird counts which are often organized by local Audubon Society chapters, schools, or other environmental organizations. Use the skills acquired from your earlier Marine Biology Session on seashore birds.

B. Offer to assist your local Cooperative Extension Marine Advisor with public service projects. Marine Advisors can be contacted through the Cooperative Extension offices in coastal counties. Some types of public service projects that have been done include: marine education displays at open houses, underutilized seafood demonstrations at fishermen's festivals and fairs, assisting at county fairs, and providing training to beginning 4-H Marine Project groups.

Session X—Career Exploration

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. List ten marine careers and their qualifications.

A. Organize and/or participate in a career fair that includes ocean-related careers. This can be either a 4-H event or part of your school's career day.

B. Invite a speaker to talk about their marine career. Some common types of careers include: boat repairmen, fishermen, marine biologists, shipping, Navy and Coast Guard, energy development, and marine recreation businesses.

C. Read and discuss the helpful publication "Today's Youth in Tomorrow's Sea". It is available from Sea Grant MAP Extension, University of California, Davis, CA 95616. Another helpful reference is "Careers in Oceanography: Romance versus Reality" by John McManus (Neritic Enterprises, P.O. Box 5485, Santa Barbara, CA 93108).

ADVANCED UNIT

Session I—Introduction and Beach Safety

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. List nine beach safety tips.

b. Define hypothermia and demonstrate the H.E.L.P. and HUDDLE positions.

A. This is the introductory meeting. Help everyone get to know each other. Discuss what the group would like to accomplish during the year. Have the group set goals.

B. Use the slide set "Survival in Cold Water" to learn about combatting the effects of hypothermia. The slide-tape set is available from Visual Media, University of California, Davis, CA 95616, (916) 752-0590. If you have a swimming pool available, the group can practice the procedures outlined in the slide set.

C. Invite a speaker to talk about first-aid with an emphasis on marine medical problems.

D. Review the beach safety rules from the Beginning Unit. Check or put together your beach safety kit.

Session II—Oceanography

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

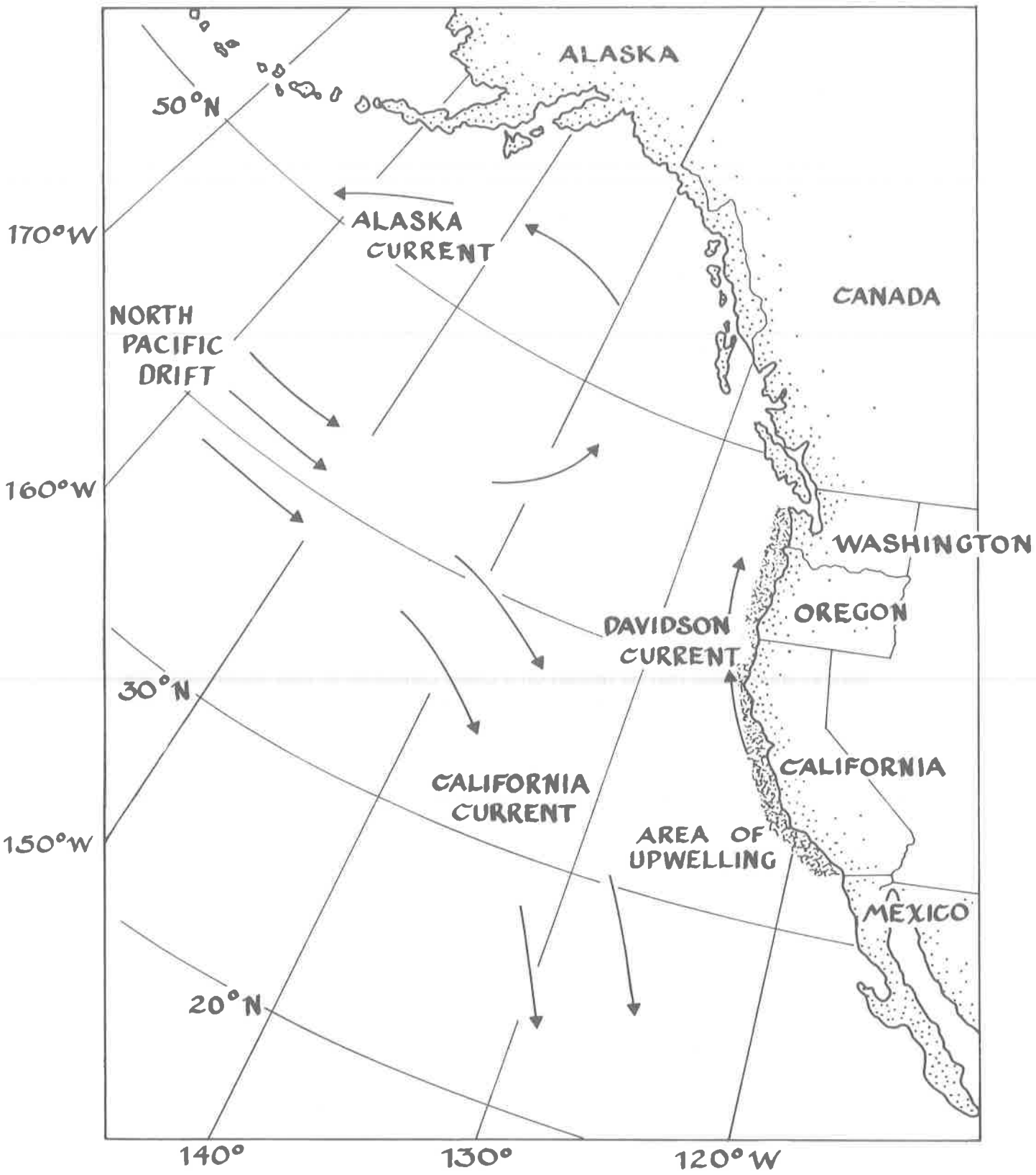
   a. Diagram the major currents in the North Pacific Ocean.

   b. Identify five prey items from fish stomachs.

   c. Compare the food habits of two species of fish.

A. Closely following the instructions in Leaflet 4-H-7004, "Using Drift Bottles to Measure Ocean Currents", conduct a study of coastal currents. Chart the results and discuss them. Periodically, a summary of all of the 4-H drift bottle experiments will be sent to you. These can be plotted on a chart, compared to your experiment, and discussed. Be sure that the members send thank you letters to those who return the cards. The results of your study can make an attractive educational display or a good report.

B. Use Leaflet 2255, "Biological Oceanography", to learn more about ocean food webs. Collect stomachs from fish caught at piers or on boats. Examine and record the types of food items found in different types of fish. Use the fish and invertebrate identification keys listed at the end of this manual to determine the types of food consumed. Identify the food items as best as you can; don't worry if you can't figure some of them out. Compare the food habits of different types of fish. What can you say about the habits of the fish from their stomach contents?



Major currents of the northeastern Pacific Ocean.

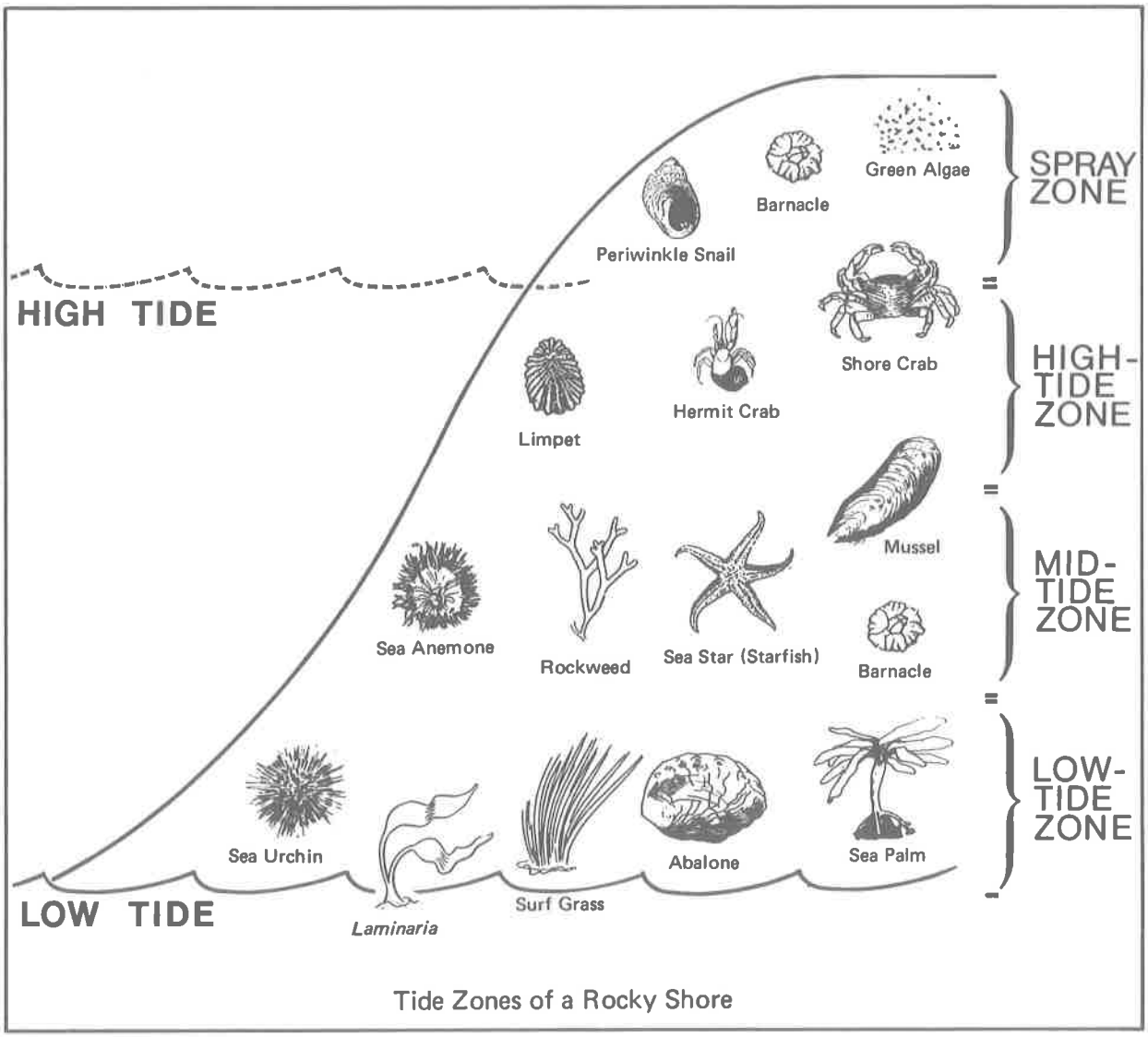
Session III—Marine Biology

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Statistically analyze the distribution of one organism across the four intertidal zones.

b. Describe one marine research project to others.

A. Do the activity outlined in Leaflet 2551, "Intertidal Zonation". This will give the advanced members a deeper understanding of the unique ecology of the intertidal zone as well as a very basic introduction to the use of statistics in research. This should be a challenging exercise.



Tide Zones of a Rocky Shore

B. Learn more about marine research through speakers, films, and publications. If you live near a university or college campus, find out when marine scientists are going to give presentations about their research. A list of technical publications about current University of California Sea Grant research is available from Sea Grant MAP Extension, University of California, Davis, CA 95616. Obtain the list and order a few publications of interest to you. Another source of current marine research information is journals in large libraries. Journals such as *Oceanography and Limnology, Marine Fisheries Review, California Department of Fish and Game, Copeia, Ecology,* and *Fishery Bulletin* contain technical papers. Magazines such as *Oceans, Sea Frontiers,* and *Outdoor California* present popular articles summarizing marine research. Read and discuss articles of interest.

Session IV—Marine Biology

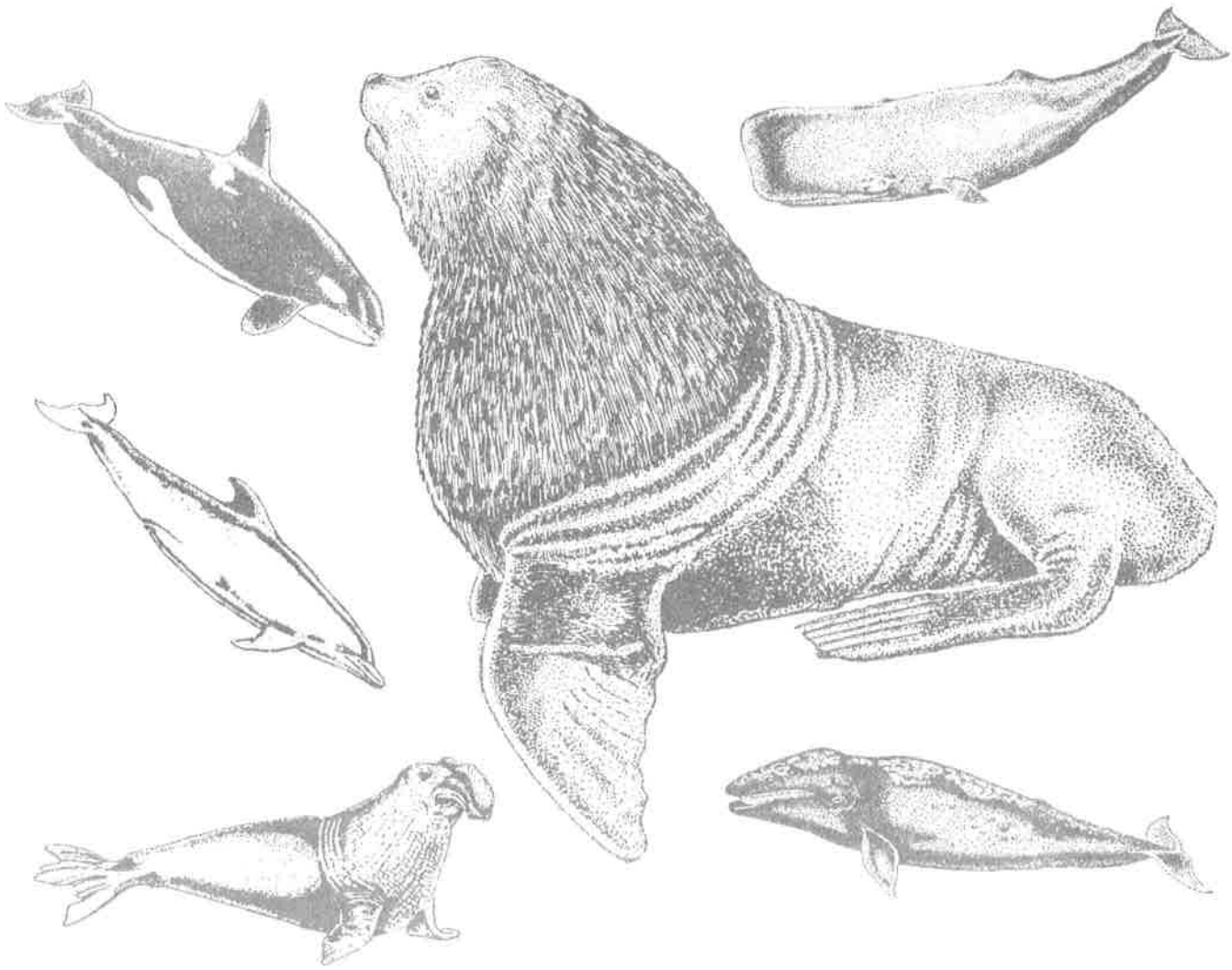
I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Identify three species of marine mammals.
b. Describe the life history of one marine mammal to others.

A. Learn the identification of and stimulate interest in marine mammals. Leaflet 2274, "Marine Mammals", will supply much of this information plus useful references. A more thorough booklet, "Marine Mammals of California", is available from Sea Grant MAP Extension, University of California, Davis, CA 95616. Have each member of the group select an animal or group of animals of their choice and have them give a brief report to the group.

B. Plan and participate in a whale-watching trip. The gray whale, *Eschrichtius robustus,* makes the longest known migration of any mammal. They make a 12,000-mile round trip between Arctic waters and the lagoons on the Pacific coastline of Baja California. The gray whales migrate close to shore, and are visible from boats and rocky headlands. Numerous sportsfishing vessels run whale-watching trips during the winter months. Check with local sportsfishing landings, environmental groups such as the Oceanic Society, or the yellow pages for local trips. The whales can be seen from shore also. Rocky headlands all along the coast are the best spots. Take along binoculars. The best months are December through May. The whales migrate southward during December, January, and February to their Mexican breeding grounds. By late May they usually have completed their migration northward to feed in the Bering Sea and Arctic waters.

C. Visit one of the public or private marine exhibitions. Examples include Marineland, Steinhart Aquarium, Sea World, Cabrillo Marine Museum, and Marine World/Africa, U.S.A. These exhibits often have educational displays about marine mammals, and you will get a chance to view them close up.

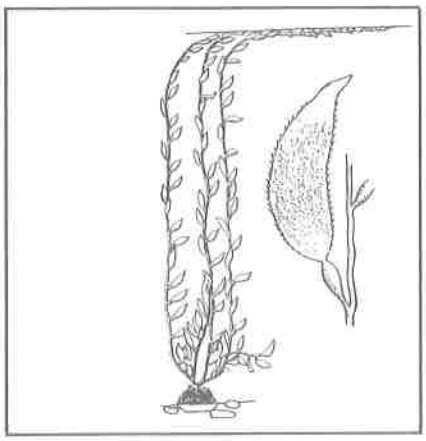


Session V—Food from the Sea

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. Prepare one food dish from marine algae.

   b. Use two methods of home preservation of seafoods.



Giant kelp, *Macrocystis pyrifera,* a brown alga.

A. Prepare seaweed pickles or other seaweed recipes contained in Leaflet 21110, "Marine Algae".

SEAWEED SWEET PICKLE RECIPE

4 cups of rings or rectangles cut from fresh stems of kelp
¾ cup white vinegar
1½ cups sugar
1 teaspoon whole cloves
1 tablespoon mixed pickling spice

Remove the outer skin of the kelp with a vegetable peeler and slice into thin rings, or cut into longitudinal strips and then into rectangles. Soak the cut kelp in fresh water for three days, changing the water several times a day to remove the bitter-tasting salts.

Enclose the spices in a cheesecloth bag and place in simmering vinegar and sugar for five minutes. Remove spices and pour the hot syrup over the sliced kelp. Let stand overnight.

On the following day, remove syrup and heat to boiling. Cook in covered pot to save energy. Place kelp slices in hot jars, cover with boiling syrup and seal, or store the pickles in a covered crock.

For dill seaweed pickles, handle the kelp in the same manner, but substitute your favorite dilling process for the above syrup.

(From: "4-H Ocean Adventures", Cooperative Extension, Oregon State University.)

B. Learn about safe handling of seafoods. Read and discuss Leaflets 21119, "Safe Handling and Storing of Seafoods"; 21120, "Seafood Myths and Misconceptions"; and 21111, "Buying Quality Seafood".

C. Visit a seafood-processing plant and a fish market to learn how different kinds of fish are unloaded, processed, and sold.

D. Construct and use a fish smoker. Learn about smoking fish from Leaflets 2669, "Smoking Fish at Home"; and 21121, "Smoked Shark and Shark Jerky". Compare the different types of fish you smoke.

Session VI—Fisheries

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Rig and use a poke pole.

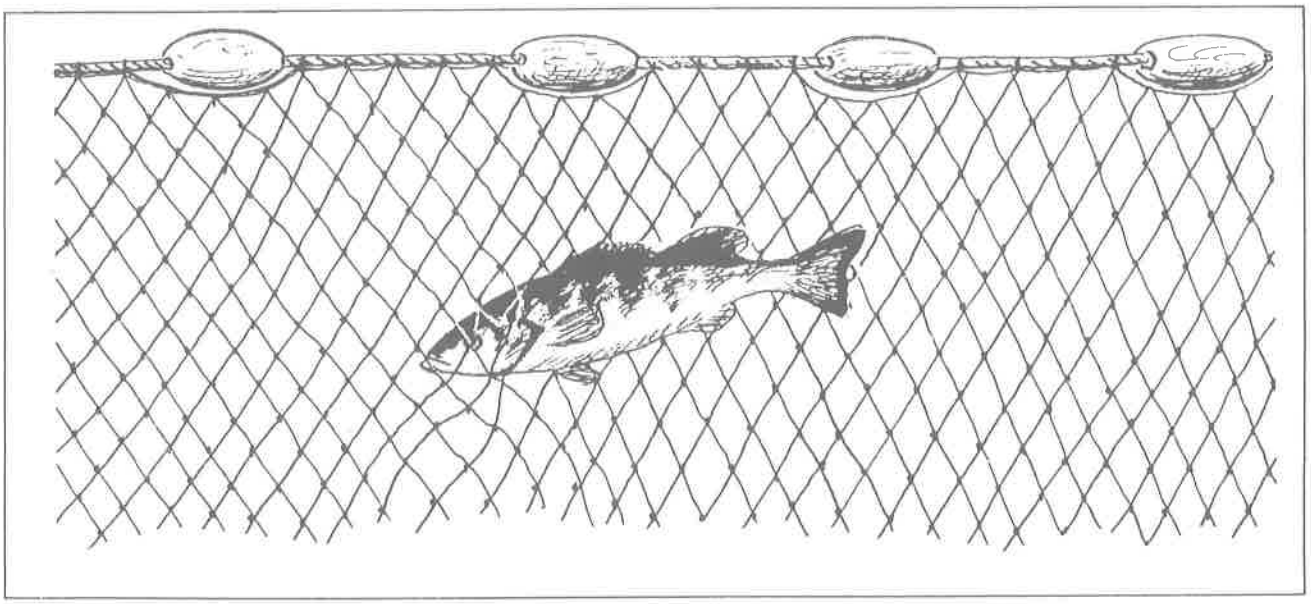
b. Draw a fish and label all fins, lateral lines, and nostrils.

c. Sketch three types of commercial fishing gear and describe how they function to others.

A. Using Leaflet 2555, "Poke Pole Fishing", construct and use poke poles. Poke pole fishing is an inexpensive way to fish rocky nearshore waters. All that is needed is a long bamboo pole, a piece of heavy wire, and a fish hook. Because the fishing is in rocky intertidal areas at low tide, be prepared to get wet, and be sure to observe your beach safety rules. You are likely to catch greenlings, perch, rockfish, blennies, and cabezons.

B. Using instructions in Leaflet 2548, "Gyotaku—Japanese Fish Printing", make fish prints out of the fish you catch with your poke poles or use fish from another source. Use the fish printing activity to learn more about the fishes' external anatomy.

C. Invite a commercial fisherman or a professional fishing guide to your meeting to discuss his lifestyle, fishing methods, and gear. Perhaps you can visit his vessel for the meeting. The film "Oregon Trawler" and the videotape "Commercial Bottom Fishing" are available from Sea Grant MAP Extension, University of California, Davis, CA 95616. Both films illustrate fishing methods and lifestyle. Other films and publications listed at the end of this manual will help you learn more about commercial fishing.



D. Take a field trip to a harbor which has a fishing fleet. Note the differences between recreational and commercial fishing vessels. Note and try to identify the different types of commercial fishing vessels (i.e. troller, trawler, etc.). Look for different types of fishing gear such as gill nets, longlines, traps, etc. Photograph or draw the different types of gear and vessels. Useful references for this activity include Leaflet 2272, "Major Commercial Fisheries of California", and *Fisheries of the North Pacific* by Robert Browning (Pacific Northwest Publishing, Anchorage, Alaska).

Session VII—Ocean Arts and Humanities

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Identify and press five species of marine algae.

b. Describe one local marine policy issue to others and recommend at least one possible solution.

c. Describe one use of marine resources by Native Americans.

A. Do the algae pressing activity described in Leaflet 2556, "Pressing Algae". The group can use this method to start a collection of local marine algae. Framed, pressed algae also make attractive decorations or gifts.

B. Learn about and discuss Native Americans and their relationship with the marine environment. Local libraries and museums, especially natural history museums, are good sources of information. Discuss current utilization of marine resources by Native Americans such as their subsistence fisheries for salmon and marine mammals.

C. Have a group discussion or brainstorming session about man's use and/or abuse of the marine environment. You can make the discussion cover man's interaction with the marine environment in general, or you can focus on specific issues such as power plant or factory siting, coastal wetlands, coastal land use planning, fishing regulations, etc. Supply each member with a pencil and paper and have them write down and then share their thoughts with the group.

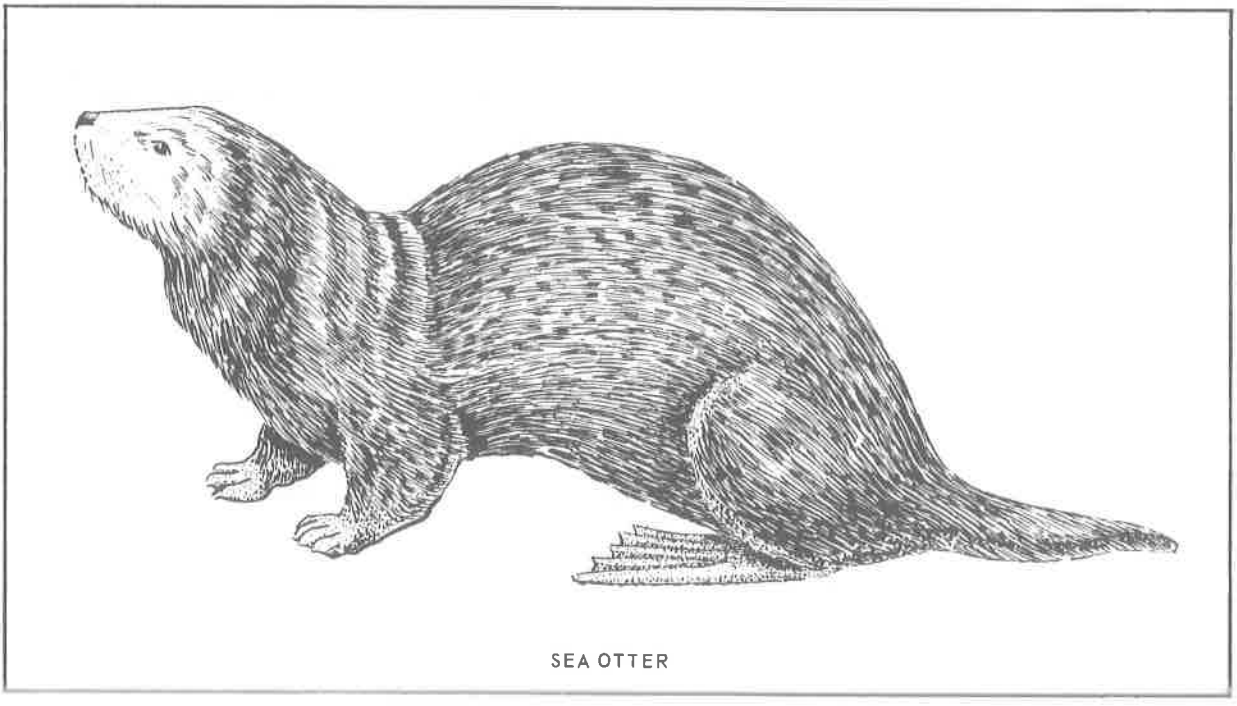
Session VIII—Marine Resources Management

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

a. Simulate a hearing on sea otter management.

b. List three reasons for and against restricting the sea otters' range.

c. Debate one marine policy issue.



SEA OTTER

A. Have the group play the sea otter simulation game which is available from Sea Grant MAP Extension, University of California, Davis, CA 95616. The game places the players in the roles of the different interest groups concerned with sea otter and shellfish fishery management in California. The members act out a simulated hearing on whether the range of the sea otter should be restricted. The game gives the members an understanding of the many viewpoints about marine mammal—fishery conflicts. A summary of the issues involved is included with the game (summary from "California's Environment Newsletter", #59: January-February, 1981, U.C. Cooperative Extension, Ray Coppock and Roy Rauschkolb, Editors).

B. Debate an important marine issue. Have the group pick a topic, divide up into debate teams, gather information on the issue, and debate the issue. Some of the topics under Activity "C" of Advanced Unit VII would make good debate topics. Viewing the film "Mammals of the Sea" would be an excellent discussion starter.

C. Discuss current marine research. Have each member select a topic of their own and have them find out about current research through local marine researchers or through library magazines and journals such as *Outdoor California, Oceans, Marine Fisheries Review, Fisheries, Copeia, Journal of the Fisheries Research Board of Canada, Oceanography and Limnology,* and *California Fish and Game.* Information on current University of California Sea Grant College research is available from Sea Grant MAP Extension, University of California, Davis, CA 95616. Each member can then give a brief report about the research and its relevance.

Session IX—Marine Public Service

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. Assist local organizations with a marine project.

A. Participate in a habitat restoration project in cooperation with the appropriate agency. If you have a local Cooperative Extension Marine Advisor, he or she may be able to direct you toward a suitable project. Many state agencies (Department of Fish and Game, etc.), environmental groups, and local governments are involved in habitat restoration or enhancement projects.

B. Assist in a local marine research project. Local researchers may need help in taking measurements or monitoring research projects. Check with your Marine Advisor, college researchers, environmental groups, or government agencies about areas in which you can help.

Session X—Career Exploration

I. **Performance objectives.** After completing this session's activities the 4-H members should be able to:

   a. List five locations for academic or vocational training in the marine field of interest to them.

   b. Identify five potential ocean-related summer jobs.

   c. Write a resume and fill out a job application.

A. Find out about schools offering marine training. An excellent reference for this is "University Curricula in the Marine Sciences and Related Fields". This is available at libraries or for free (limited supply) from Office of Sea Grant, NOAA, 6010 Executive Boulevard, Rockville, MD 20852. If there are local community colleges or universities offering marine courses, find out more about their programs.

B. Find out about vocational training for marine careers. Land-based skills such as engine repair, hydraulics, welding, boat building, energy-resource management, business administration, cooking, and refrigeration are examples of valuable skills for marine careers. Read "Today's Youth in Tomorrow's Sea" for ideas on careers (available from Sea Grant MAP Extension, University of California, Davis, CA 95616).

C. Explore ocean-related summer jobs. This is a way to find out if you enjoy working on or near the ocean. Some examples of summer jobs are fishing boat deckhand, seafood processing, seasonal help for government agencies, marine construction, and marine recreation (sailing instructor, boat maintenance, etc.). In some cases you may want to work as a volunteer just to gain experience. "Hands-on" experience is an important factor to your future employers.

D. Improve job application skills. Learn about and practice writing resumes, interviews, filling out applications. Critique each other's job application skills. Use the skills to find summer jobs.

OTHER ACTIVITIES

Additional activities have been suggested as we developed this Leaders' Manual. Because these are major activities that would take up the bulk of a project year, they have been listed separately. In some cases the added resources needed for these activities may make it necessary to undertake some fund-raising activities.

Sailing

The sport of sailing teaches valuable skills, develops confidence, and illustrates the importance of teamwork. Sailing instruction is often available through yacht clubs, city recreation departments, scouting organizations, universities, and parents who actively sail. Sailing instruction and practice can be done periodically during the school year or for intensive one- or two-week sessions during the summer. Water and boating safety skills should be emphasized. The publications listed under "Safety" at the end of this manual should be helpful.

Boat Building

There is a growing interest in building small skiffs and dories. Such long-term projects will teach valuable wood-working skills as well as an appreciation for traditional boat design. A completed boat could be used for boating activities by the group, or it could be sold to recover expenses for materials. The key to this project will be locating a skilled boat builder or wood worker to instruct the group. Ideas for boat designs and plans can be found in periodicals such as *Wooden Boat Magazine, National Fisherman,* and in books on boat design (at your local library).

S.C.U.B.A.

Many youths and adults are attracted to the ocean by diving. S.C.U.B.A. diving instruction is available through dive shops, schools, recreation departments, and other organizations. Be sure that you use only instructors who are certified to teach S.C.U.B.A.. Swimming skills and water safety instructions are essential.

Ocean Energy

The ocean is an important energy resource. We currently extract much of our oil from reserves located offshore. Today our society is trying to resolve conflicts between the economic benefits of offshore oil extraction, and the environmental risks involved in use of this resource.

Utilization of alternative ocean energy resources is still primarily in the research and development stage. These resources include energy derived from waves, currents, temperature differentials, water pressure, and water salination. Some of these energy sources will become more important in the future as our petroleum reserves dwindle and become more expensive. An understanding of present ocean energy issues and potential new energy sources is important to California citizens.

An Ocean Energy Unit encompassing several sessions has been developed by Carolyn Cook Grassi. This unit will be helpful to 4-H groups who would like to take an in-depth look at ocean energy problems and potentials. It is available from Sea Grant MAP Extension, University of California, Davis, CA 95616.

SELECTED REFERENCES

AQUACULTURE

Bardach, J.E., J.H. Ryther, and W.O. McLarney. 1972. *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms.* New York, N.Y.: Wiley-Interscience.

Brown, E.E. 1977. *World Fish Farming: Cultivation and Economics.* Westport, Connecticut: AVI Publishing.

Leitritz, E. and R.C. Lewis. 1976. *Trout and Salmon Culture.* Bulletin 164. Richmond, California: Division of Ag. Sciences, University of California.

COMMERCIAL FISHERIES

Browning, R.J. 1980. *Fisheries of the North Pacific.* Anchorage, Alaska: Northwest Publishing Co.

Frey, H.W., ed. 1971. *California Living Marine Resources and Their Utilization.* Sacramento, California: California Dept. of Fish and Game.

Higgins, J. 1978. *The North Pacific Deckhands' and Alaska Cannery Workers' Handbook.* Eastbound, Washington: Albacore Press.

Nedelec, C., ed. 1975. *Catalogue of Small-Scale Fishing Gear.* Surrey, England: Fishing News Books, Ltd.

United Nations Food and Agriculture Organization. 1972. *F.A.O. Catalogue of Fishing Gear Designs.* Surrey, England: Fishing News Books, Ltd.

FISHERIES BIOLOGY

Fitch, J.E. and R.J. Lavenberg. 1968. *Deep-Water Teleostean Fishes of California.* Berkeley–Los Angeles, California: University of California Press.

1971. *Marine Food and Game Fishes of California.* Berkeley–Los Angeles, California: University of California Press.

Gotshall, D. 1981. *The Fishwatcher's Guide to Inshore Fishes of the Pacific Coast.* Los Osos, California: Sea Challengers.

Hart, J.L. 1973. *Pacific Fishes of Canada.* Bulletin 180. Ottawa, Canada: Fisheries Research Board of Canada.

Herald, E.S. 1961. *Living Fishes of the World.* Garden City, New York: Doubleday.

Joseph, J., W. Klawe, and P. Murphy. 1980. *Tuna and Billfish—Fish Without A Country.* La Jolla, California: Inter-American Tropical Tuna Commission.

Miller, D.J. and R.N. Lea. 1972. *Guide to the Coastal Marine Fishes of California.* Sale Publication 4065. Richmond, California: Division of Ag. Sciences, University of California.

Moyle, P.B. 1976. *Inland Fishes of California.* Berkeley–Los Angeles, California: University of California Press.

Moyle, P.B. and J.J. Cech. 1982. *Fishes: An Introduction to Ichthylogy.* New Jersey, Inglewood Cliffs: Prentice-Hall.

Robins, C.R., *ed.* 1980. *List of Common and Scientific Names of Fishes from the United States and Canada.* Spec. Publication #12. Washington, D.C.: American Fisheries Society.

Royce, W.F. 1972. *Introduction to Fishery Sciences.* New York, New York: Academic Press.

Thomson, D.A., L.T. Findley, and A.N. Kerstitch. 1979. *Reef Fishes of the Sea of Cortez.* New York, New York: John Wiley and Sons.

MARINE ALGAE

Abbott, I.A. and E.Y. Dawson. 1978. *How to Know the Seaweeds.* Dubuque, Iowa: Wm. C. Brown.

Abbott, I.A. and G.J. Hollenburg. 1976. *Marine Algae of California.* Stanford, California: Stanford University Press.

Chapman, V.J. 1970. *Seaweeds and Their Uses.* London, England: Methuen and Co., Ltd.

Dawson, E.Y. 1966. *Marine Botany, an Introduction.* New York, New York: Holt, Rinehard and Winston.

1966. *Seashore Plants of Southern California.* Berkeley–Los Angeles, California: University of California Press.

1966. *Seashore Plants of Northern California.* Berkeley–Los Angeles, California: University of California Press.

Madlener, J.D. 1977. *The Seavegetable Book.* New York, New York: Clarkson-Potter Pub. Co.

Newell, G.E. and R.C. Newell. 1963. *Marine Plankton—A Practical Guide.* London, England: Hutchison Educational.

North, W.J. 1976. *Underwater California.* Berkeley–Los Angeles, California: University of California Press.

Smith, G.M. 1944. *Marine Algae of the Monterey Peninsula.* Stanford, California: Stanford University Press.

MARINE BIRDS

Alexander, W.B. 1963. *Birds of the Ocean.* New York, New York: Putnam.

Brown, V., H. Weston, and J. Buzzell. 1979. *Handbook of California Birds.* Happy Camp, California: Naturegraph Publishing.

Cogswell, H.L. 1977. *Water Birds of California.* Berkeley–Los Angeles, California: University of California Press.

Matthieson, P. 1973. *The Wind Birds.* New York, New York: Viking Press.

Nelson, B. 1979. *Sea Birds—Their Biology and Ecology.* New York, New York: A&W Publishing.

Paca, L.G. 1961. *Sea Gulls and Such, Shorebirds of the Pacific Coast.* Palo Alto, California: Pacific Books.

Peterson, R.T. 1961. A Field Guide to Western Birds. Boston, Massachusetts: Houghton Mifflin.

Robbins, C.S., B. Bruun, and H.S. Zimm. 1966. *Birds of North America.* New York, New York: Golden Press.

Stout, G.O., ed. *The Shorebirds of North America.* New York, New York: Viking Press.

MARINE ENVIRONMENTAL STUDIES AND POLICY

Barbour, M.G., R.B. Craig, F.R. Drysdale, and M.T. Cheselin. 1973. *Coastal Ecology—Bodega Head.* Berkeley–Los Angeles: University of California Press.

Crutchfield, J.A. and G. Pontecorvo. 1969. *The Pacific Salmon Fisheries, A Study of Irrational Conservation.* Baltimore, Maryland: John Hopkins Press.

Dasmann, R.F. 1966. *The Destruction of California.* New York, New York: MacMillan Publishing Company.

Douglas, P.A. and R.H. Stroud. 1971. *A Symposium on the Biological Significance of Estuaries.* Washington, D.C.: Sport Fishing Institute.

Jones, J.R.E. 1964. *Fish and River Pollution.* London, England: Butterworth & Co.

Orbach, M.K. 1977. *Hunters, Seamen, and Entrepreneurs: The Tuna Seinermen of San Diego.* Berkeley–Los Angeles, California: University of California Press.

Watt, K.E.F. 1968. *Ecology and Resources Management.* New York, New York: McGraw-Hill.

MARINE INVERTEBRATES

Abbott, R.T. 1968. *Seashells of North America.* New York, New York: Golden Press.

Behrens, D.W. 1980. *Pacific Coast Nudibranchs, A Guide to the Opisthobranchs of the Northeastern Pacific.* Los Osos, California: Sea Challengers.

Berrill, N.J. and J. Berrill. 1957. *1001 Questions Answered About the Seashore.* New York, New York: Dodd, Mead and Co.

Gotshall, D. and L. Laurent. 1980. *Pacific Coast Subtidal Marine Invertebrates, A Fishwatcher's Guide.* Los Osos, California: Sea Challengers.

Hedgpeth, J. 1962. *Introduction to Seashore Life of the San Francisco Bay Region and the Coast of Northern California.* Berkeley–Los Angeles, California: University of California Press.

Hinton, S. 1966. *Seashore Life of Southern California.* Berkeley–Los Angeles, California: University of California Press.

Howorth, P.C. 1978. *The Abalone Book.* Happy Camp, California: Naturegraph Publishers.

Light, S.F. *et al.,* 1967. *Intertidal Invertebrates of the Central California Coast.* Berkeley–Los Angeles, California: University of California Press.

McDonald, G.R. and J.W. Nybakken. 1980. *Guide to the Nudibranchs of California.* Melbourne, Florida: American Malacologists, Inc.

Morris, R.H., D.P. Abbott and E.C. Haderlie. 1980. *Intertidal Invertebrates of California.* Stanford, California: Stanford University Press.

Richetts, E. and J. Calvin. 1962. *Between Pacific Tides.* Stanford, California: Stanford University Press.

MARINE LITERATURE

Anderson, H.C. 1971. *The Little Mermaid.* New York, New York: Harper and Row.
Darwin, C. 1958. *The Voyage of the Beagle.* New York, New York: Harper and Row.
Defoe, D. 1962. *Robinson Crusoe.* New York, New York: MacMillan.
Heyerdahl, T. 1950. *Kon-Tiki.* New York, New York: Rand McNally.
Kipling, R. 1964. *Captains Courageous.* New York, New York: Airmont.
Linklater, E. 1972. *The Voyage of the Challenger.* New York, New York: Doubleday.
London, J. n.d. *Sea Wolf.* New York, New York: Bantam.
O'Dell, S. 1960. *Island of the Blue Dolphins.* New York, New York: Houghton Mifflin.
Steinbeck, J. 1950. *A Log of the Sea of Cortez.* New York, New York: Viking Press.
Stevenson, R.L. 1975. *Treasure Island.* New York, New York: Dutton.
Taylor, T. 1969. *The Cay.* Garden City, New York: Doubleday.
Yashima, T. 1967. *Seashore Story.* New York, New York: Viking Press.

MARINE MAMMALS

Anderson, H.T., ed. 1969. *The Biology of Marine Mammals.* New York, New York: Academic Press.
Haley, D., ed. 1978. *Marine Mammals.* Seattle, Washington: Pacific Search Press.
Kenyon, K.W. 1975. *The Sea Otter in the Eastern Pacific Ocean.* New York, New York: Dover Publ.
Norris, K.S., ed. 1966. *Whales, Dolphins and Porpoises.* Berkeley–Los Angeles, California: University of California Press.
Orr, R.T. 1972. *Marine Mammals of California.* Berkeley–Los Angeles, California: University of California Press.
Scammon, C.M. 1969. *The Marine Mammals of the Northwestern Coast of North America and the American Whale Fishery.* Riverside, California: Manessier.
Scheffer, V.B. 1976. *A Natural History of Marine Mammals.* New York, New York: Charles Scribner's Sons.
Slijper, E.J. 1976. *Whales and Dolphins.* Ann Arbor, Michigan: University of Michigan Press.

OCEANOGRAPHY

Barkley, R.A. 1968. *Oceanographic Atlas of the Pacific Ocean.* Honolulu, Hawaii: University of Hawaii Press.
Bascom, W. 1964. *Waves and Beaches.* Garden City, New York: Doubleday.
Borancazio, P.J. and A.G.W. Cameron, *eds.* 1964. *Origin and Evolution of Atmosphere and Oceans.* London, England: John Wiley and Sons.
Curl, H. 1971. *Phytoplankton, Grass of the Sea.* Corvallis, Oregon: Oregon State University Sea Grant Program.
Deacon, M. 1971. *Scientists and the Sea: 1650–1900.* New York, New York: Academic Press.
Defant, A. 1958. *Ebb and Flow.* Ann Arbor, Michigan: University of Michigan Press.
Gross, M.G. 1972. *Oceanography, A View of the Earth.* Inglewood Cliffs, New Jersey: Prentice Hall.
Hardy, A.C. 1956. *The Open Sea, Part 1. The World of Plankton.* Boston, Massachusetts: Houghton Mifflin Co.
Hardy, A.C. 1959. *The Open Sea, Part 2. Fish and Fisheries.* Boston, Massachusetts: Houghton Mifflin Co.
Hedgpeth, J. 1963. *Treatise on Marine Ecology and Paleocology.* New York, New York: Geological Society of America.
Ingmanson, D.E. and W.J. Wallace. 1979. *Oceanography: An Introduction.* Belmont, California: Wadsworth Publication Co.
Oxenhorn, J.M. and B.I. Goldfeld. 1975. *Oceanography and Our Future.* New York, New York: Globe Book Co.
Sverdrup, H.U., M.W. Johnson, and R.H. Fleming. 1942. *The Oceans.* New York, New York: Prentice Hall.
Taber, R.W. and H.W. Dubach. 1972. *1001 Questions Answered About the Oceans and Oceanography.* New York, New York: Dodd-Mead.

RECREATIONAL FISHERIES

Cannon, R. 1967. *How to Fish the Pacific Coast; A Manual for Saltwater Fishermen.* Menlo Park, California: Lane Publishing.
Davis, C. 1977. *Hookup: A Complete Guide to Southern California Sportfishing.* Seattle, Washington: Outdoor Empire Publishing, Inc.
Squire, J.L. and S.E. Smith. 1977. *Anglers' Guide to the United States Pacific Coast.* Publ. #003-020-00113-1. Washington, D.C.: National Marine Fisheries Service.

SAFETY

Adkin, J. 1973. *The Craft of Sail.* New York, New York: Walker and Company.
Chapman, C.F. 1976. *Piloting, Seamanship and Small Boat Handling.* New York, New York: Motor Boating and Sailing Books.
Eastman, P.F. 1972. *Advanced First Aid Aboard.* New York, New York: Collier Books.
Scott, R.W. 1969. *Handy Medical Guide for Seaferers, Fishermen, Trawlermen, Yachtsmen.* London, England: Fishing News Books.

SEAFOODS

Howorth, P. 1977. *Foraging Along the California Coast.* Santa Barbara, California: Capra Press.
Loggins, P. 1975. *The Uncommon Cookbook.* Orono, Maine: University of Maine, Sea Grant Bulletin #8.
Madlener, J.C. 1977. *The Seavegetable Book.* New York, New York: Clarkson-Potter Publ.
McClane, A.J. 1977. *Encyclopedia of Fish Cookery.* New York, New York: Holt, Rinehard, Winston.
Sunset Books. 1972. *Seafood Cookbook.* Menlo Park, California: Lane Books.

SEAFOOD PROCESSING

Browning, R.J. 1980. *Fisheries of the North Pacific.* Anchorage, Alaska: Alaska Northwest Publishing Co.
Stansby, M. 1976. *Industrial Fishery Technology.* New York, New York: Robert E. Krieger, Inc.

AUDIO-VISUAL MATERIALS

Available from: Sea Grant MAP Extension
554 Hutchison Hall
University of California
Davis, CA 95616

"Oregon Trawler" (describes commercial bottom fishing).
"From the Edge of Extinction" (sea otter management).
"Silvers for San Francisco Bay" (describes salmon enhancement project).
Four ¾" videotape cassettes

1. "Commercial Bottom Fishing
2. "Seafood Processing"
3. "Coastal Estuaries"
4. "Oyster Farming"

Available from: Motion Picture Library
Cooperative Extension
University of California
Riverside, CA 92521

"Mammals of the Sea" (marine mammal conflict) #27-819.
"Canning and Freezing Fish at Home" (describes methods) #27-109

Available from: California Department of Fish and Game Regional Offices.*

"To Save a Heritage" (overview of the Department of Fish and Game).
"Up the Down Stream" (Feather River Salmon Hatchery).
"From the Edge of Extinction" (sea otter management).
"Life at the Edge of the Sea" (tidepool conservation).
"Science Gets the Facts—The Anchovy Project" (anchovy fishery management).
"Fish in the Sea" (Fish and Game ocean sportfishing projects).
"The Grunion Story" (grunion spawning and hatching).
"Hatcheries to Save Fish Runs" (Feather River Salmon Hatchery).
"Salmon—Today and Tomorrow" (salmon habitat problems).
"Whys of Fish and Game Laws" (reasons behind the regulations).

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407 West Line Street, Bishop, CA 93514

Available from: Extension Media Center
University of California
Berkeley, CA 94720

(A fee is usually charged. Send for a list of films and prices.)

"Beach, A River of Sand" (beach dynamics).
"Challenge of the Oceans" (ocean research in the 1950's).
"Fish Out of Water" (grunion biology).
"Ocean Tides" (explains tides).
"Plankton and the Open Sea" (importance of plankton in food chains).
"Sea" (marine biology and research).
"Sea Lions and Fur Seals" (describes behavior).
"Three Fishermen" (compares lives of fishermen).
"Waves on Water" (describes sources and structure of waves).
"What is a Fish?" (describes different types of fish).

Available from: Visual Media
University of California
Davis, CA 95616

(Slide-cassette tape sets with scripts. Send for a catalogue showing prices.)

"Canning Fish at Home" (Spanish and English).
"Smoking Fish at Home" (Spanish and English).
"Freezing Seafood at Home" (Spanish and English).
"Seafood Facts and Bargains"
"How to Eye and Buy Seafood"
"Handling and Storing Seafoods"
"Survival in Cold Water"
"Introduction to Intertidal Plants and Animals"
"Seashore Birds"

U.C. COOPERATIVE EXTENSION
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(Available from the Cooperative Extension office in your home county)

Leaflet number	Title
2246	Ecology of the Intertidal Zone
2255	Biological Oceanography
2272	Major Commercial Fisheries in California
2274	Marine Mammals
2546	Catching and Cooking Crabs
2548	Gyotaku—Japanese Fish Printing
2549	Identifying Intertidal Plants and Animals
2550	Identifying Seashore Birds
2551	Intertidal Zonation
2552	Marine Photography
2553	Marine Resource Laws and Regulations
2554	Ocean Currents
2555	Poke Pole Fishing
2556	Pressing Algae
2557	Sampling Plankton
2784	Marine Education Bibliography
2911	Sharks—An Annotated List of Selected References
2939	Upwelling in California Coastal Waters
21110	Marine Algae
21111	Buying Quality Seafood
21112	Catching, Cleaning, and Cooking Squid
21113	Cleaning and Cooking Octopus
21114	Fish Eggs for Caviar and Bait
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21117	Paralytic Shellfish Poisoning and Red Tides
21118	Preparation of Shark and Skate
21119	Safe Handling and Storing of Seafoods
21120	Seafood Myths and Misconceptions
21121	Smoked Shark and Shark Jerky
21122	Spiced and Pickled Seafoods
21155	The Sablefish Fishery
4-H-7004	Using Drift Bottles to Measure Ocean Currents

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture, Jerome B. Siebert, Director, Cooperative Extension, University of California.

1m–6/82–VL/LAM