COASTAL MANAGEMENT LESSON PLAN

Where's the Point?

NOS Topic
Coastal Management

Theme
Polluted Runoff

Links to Overview Essays and Resources Needed for Student Research
http://oceanservice.noaa.gov/topics/coasts/management/
http://www.ocrm.nos.noaa.gov/czm/6217/

Subject Area
Life Science/Earth Science

Grade Level
9-12

Focus Question
What are causes, impacts, and solutions to contaminated runoff?

Learning Objectives
- Students will be able to explain at least five sources of contaminated runoff.
- Students will be able to describe at least five impacts that contaminated runoff may have on coastal ecosystems and resources.
- Students will be able to describe and discuss at least five actions that can be taken to reduce or eliminate contaminated runoff.
- Students will be able to construct a three-dimensional model of an actual watershed, and use this model to provide information on contaminated runoff to a specific target audience (that is, an audience that causes or is affected by a specific type of runoff pollution).

Materials Needed

- (optional) Materials for constructing a three-dimensional watershed model (see Worksheet), and one copy of the Worksheet for each student group
- (optional) Computers with internet access; if students do not have access to the internet, download copies of materials cited under "Learning Procedure" and provide copies of these materials to each student or student group.

Audio/Visual Materials Needed

- Chalkboard, marker board, or overhead transparency, and appropriate marking materials

Teaching Time

Three or four 45-minute class periods, plus time for student research and preparation; an additional eight hours should be allowed if you want to have students construct a watershed model as described on the Worksheet (this could also be done as an out-of-class activity, term project, etc.)

Seating Arrangement

Groups of 3 – 4 students

Maximum Number of Students

32

Key Words

Polluted runoff
Nonpoint source
Watershed

Background Information

Coastal ecosystems provide human communities with food, economic opportunities, recreational resources, and aesthetic enrichment. But despite their importance, these systems are under increasing stress from human activities. More than half of the U.S. population lives in coastal counties, and this population continues to grow. Each year, degradation of coastal resources costs millions of dollars. While significant progress has been made in reducing pollution from point sources such as discharge from industrial facilities or sewage treatment plants, nearly half of U.S. coastal waters continue to be degraded by rainwater and snowmelt that becomes contaminated as it moves over and through the ground. Pollutants include

- fertilizers and pest control chemicals from farms and home landscapes;
- oil, grease, and toxic fluids from roads, parking areas, leaking underground storage tanks, and improper disposal of used motor vehicle lubricants;
- sediments from poorly managed construction sites, forest lands and stream banks;
- acid drainage from abandoned mines; and
- bacteria and nutrients from livestock, pet wastes, and faulty septic tanks.

A key concept closely linked to runoff pollution is the idea of "watershed." The simplest definition of a watershed is the area of land that catches precipitation and channels this water into a marsh, stream, river, lake, or underground reservoir (groundwater). These water bodies can be contaminated by runoff that carries pollution from land surfaces anywhere within the watershed. Every location on land is part of one or more watersheds, which can range in size from a few acres to millions of square miles. Most watersheds are part of larger watersheds. All watersheds in the United States have a specific name and an identifying number known as a "watershed address." Visit *http://www.epa.gov/win/address.html* to find the watershed address for any location in the U.S., as well as information on pollution and other issues related to specific watersheds.

Because it is a serious and pervasive problem, contaminated runoff (also known as nonpoint source pollution) has been the focus of numerous state, local, and national efforts. A key element of many initiatives is education and information, because contaminated runoff can come from such a wide variety of human activities that almost everyone contributes to the problem in some way, often without realizing it.

In this lesson, students will design a model of a local watershed and develop a plan to use the model in an educational program about contaminated runoff for one or more specific audiences. Optionally, you may wish to have your students actually construct models from their designs, and possibly present their program to an appropriate audience.

Learning Procedure

1\.

Briefly introduce the concept of watersheds, contaminated runoff, and ask students to brainstorm potential sources of this type of pollution.

2\.

Tell students that their assignment is to design a scale model of a local watershed and develop a plan for using the model to provide information about causes and prevention of contaminated runoff. Discuss the idea of "target audiences." Students should realize that because there are so many potential sources of contaminated runoff, there are also many different groups of people ("target audiences") who need specific information about what they can do to reduce this problem. In addition, the most effective way to communicate this information depends upon the target audience. In a watershed contaminated by pesticides, an information program on nontoxic methods of pest control might be targeted to local farmers and homeowners, and might be presented at grange meetings or homeowner associations. But if contamination was the result of mining activities, the information, target audience, and probably the best method of communication would all be different.

You may want to assign a target audience to each group, or allow students to make their own choice. As part of their plan, each group should create a brochure or poster that could be distributed to their audience. To get an idea of specific contaminated runoff issues that are relevant to your area, visit *http://www.epa.gov/win*. Information about various sources of contaminated runoff can be found at *http://www.epa.gov/owow/nps/categories.html*. Examples of "success stories" that have been achieved by state nonpoint source programs can be found at *http://www.epa.gov/owow/nps/Success319/*, *http://www.epa.gov/owow/nps/Section319II/*, and *http://www.epa.gov/owow/nps/Section319III/*.

Discuss the idea of using a three-dimensional watershed model in programs to provide information about runoff pollution. Demonstrations using this type of model typically involve placing various "pollutants" on the the model, and then causing these to run off into one or more simulated water bodies by "raining" onto the model surface with small watering cans, spray bottles, or large sponges. This approach allows hands-on audience involvement and provides a memorable experience; but students may have ideas about other ways to use their model. Be sure students understand that the design for their model should be based on a real watershed, and real sources of contaminated runoff in that watershed. Students should complete their research and plan their informative presentation before designing the model, so they will know which features and processes will need to be demonstrated.

3.

Have each student group make a presentation about their watershed model design and planned information program. Have each group add to a running list of suggestions for preventing contaminated runoff on a chalkboard, marker board, or overhead transparency. Suggestions should include:

- keeping trash, pet waste, chemicals, etc., out of storm drains, since these typically drain directly to lakes, streams, rivers, or wetlands;
- always follow instructions when using lawn and garden chemicals, and minimize their use with natural alternatives and by planting native species;
- properly dispose of used oil and hazardous household chemicals;
- control soil erosion by stabilizing erosion-prone areas and planting buffer strips of trees, shrubs, and ground cover next to water bodies;
- have home septic systems inspected and pumped at least every 3 – 5 years;
- purchase detergents low in phosphorus to reduce nutrient loads to natural water bodies;
- manage farm wastes to minimize contamination of surface water and ground water;
- minimize the use of pesticides through integrated pest management;
- minimize impermeable surfaces in landscaping by using porous pavers instead of solid asphalt or concrete; and
- dispose of pet wastes in the garbage or toilet.

Additional ideas can be found at *http://www.epa.gov/owow/nps/whatis.html* and *http://www.epa.gov/owow/nps/dosdont.html.*

4. (optional) Have students construct their models and (possibly) present their programs to the intended target audiences. Alternatively, students could make their presentation to a class of younger children, or to a group of adults such as the school PTA.

The Bridge Connection

http://www.vims.edu/bridge/ – In the "Site Navigation" menu on the left side of the page, click on "Ocean Science Topics," then "Human Activities," then "Enviro-concerns," then "Pollution" for links to resources about marine pollution.

The Me Connection

Have students write a brief essay describing how they contribute to the contaminated runoff problem in their own community, how their actions impact their own lives, and how they might act to reduce this problem.

Extensions

Visit *http://www.epa.gov/owow/estuaries/monitor/* for a manual on volunteer water quality monitoring in estuaries.

Resources

http://www.ocrm.nos.noaa.gov/resource.html#education – NOAA Office of Ocean and Coastal Resource Management, Resources, Publications and Outreach Materials

http://www.epa.gov/win/ – U.S.E.P.A. Watershed Information Network

http://www.epa.gov/owow/nps/eduinfo.html – U.S. EPA website with education resources about polluted runoff

http://www.epa.gov/owow/nps/kids/ – nonpoint source kids page

National Science Education Standards

Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science
- Interdependence of organisms

Content Standard D: Earth and Space Science
- Geochemical cycles
- Origin and evolution of the earth system
- Origin and evolution of the universe

Content Standard F: Science in Personal and Social Perspectives
- Personal and community health
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Links to AAAS "Oceans Map" (aka benchmarks)

5D/H3 – Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

COASTAL MANAGEMENT REVIEW SHEET

How to Construct a Three-Dimensional Watershed Model

Three-dimensional watershed models are constructed by cutting out selected contours shown on a topographic map of the area being modeled, and then stacking the cutouts together. If you are not familiar with topographic maps, you may want to visit *http://interactive2.usgs.gov/learningweb/teachers/mapsshow_lesson4.htm* for some background information. Demonstrations using this type of model typically involve placing various "pollutants" on the the model, and then causing these to run off into one or more simulated water bodies by "raining" onto the model surface with small watering cans, spray bottles, or large sponges. You may want to visit *http://www.pyr.ec.gc.ca/EN/IPM/index.shtml* and *http://clubs.ca4h.org/sanluisobispo/r2rwe/pdf/jr_high.pdf* for some examples of watershed models and how they have been used in information programs about contaminated runoff.

Materials:

- topographic map covering the area of your watershed (available from stores that sell outdoor or camping equipment, as well as from the U.S. Geological Survey at *http://topomaps.usgs.gov/ordering_maps.html*; maps typically cost between six and eight dollars)
- plywood, foamcore, or heavy cardboard for base
- material for constructing contour cutouts; suitable materials include cardboard, foamcore, corrugated plastic used for signs, or foam used for carpet underlayment
- tools for cutting selected material
- waterproofing: either exterior latex paint, or polyester resin, or plaster-of-paris and cheesecloth
- materials for model details (e.g., toy animals, people, buildings, sponges, floral foam, dried moss, colored fleece fabric, asphalt shingles; see step 12)
- small watering cans or spray bottles

Step 1
Determine the desired overall size of the finished model. Larger models can accommodate more detail, but are heavier and more awkward to transport than smaller models. Typical models range in size from a 2 ft square to a full sheet of plywood (4 ft x 8 ft).

Step 2
Make one or more copies of the topographic map for your watershed, enlarging or reducing if necessary to the desired size.

Step 3
Decide whether the horizontal and vertical scales of the model will be the same or different. Many models exaggerate the vertical scale by a factor of 3 or 4 to make topographic features more visible. On the map in Figure 1, a distance of 6000 ft is represented by one inch, so a hill 1000 ft high would be 1000 ÷ 6000 = 0.166 inch high without any vertical exaggeration; with a 4-fold exaggeration the hill would be 0.66 inches high on the model.

Step 4
Decide which contour lines will be used to construct the model. This will usually depend upon the overall range of elevations represented on the map, and how much time is available for cutting out the individual contours. Most models will need at least five contours; the more contours there are, the smoother the slopes will be on the finished model. So, if the highest point on the topographic map is 2300 ft and the lowest point is 200 ft, the overall range of elevations is (2300 ft – 200 ft) = 2100 ft, and the minimum interval would be (2100 ft ÷ 5) = 420 ft. Use a colored marker to trace the selected contour lines on the map copy to make the lines easier to follow when cutting.

If the contour interval on the map does not match the desired interval, use a smaller interval that will match the map interval. For example, if the desired interval is 420 ft and the interval between contour lines on the map is 100 ft, use 400 ft instead of 420 ft. So, using the map of Figure 1, we would use the 400 ft, 800 ft, 1200 ft, 1600 ft, and 2000 ft contours.

Step 5

Determine the proper thickness of material from which the contours will be constructed. The scale of the map in Figure 1 is one inch = 6000 ft, so a 400 ft contour interval would be represented by a thickness of 400 ft ÷ 6000 ft/inch = 0.0667 inch. If we use a 4-fold vertical exaggeration, the required thickness would be 4 x 0.0667 inch = 0.267. So one-fourth inch thick foamcore display board would be a suitable material for this model. In some cases, more than one layer of the material may be needed for each contour.

Step 6

Cut the map copy along the lines representing the next-to-lowest elevation, since the lowest elevation is the base on which the model will be built (plywood, etc). In the example of Figure 1, the lowest elevation is 200 ft, so the first cutout would be done along the 400 ft contour line (see Figure 2).

Step 7

Trace the outline of the cutout onto the material that will be used to construct the contours, and cut along the traced line (see Figure 3).

Step 8

Place the cutout on the base, but don't glue it down yet. You may want to glue another copy of the topographic map onto the base to help position the cutouts.

Step 9

Repeat steps (e), (f), and (g) for the next contour interval (which would be along the 700 ft contour line in the example). Continue until all contours have been cut.

Step 10

Starting with the lowest (largest) contour, carefully glue successive contours together to build the three-dimensional model. Some contours may be in several pieces (See Figure 4).

Step 11

Waterproof the model. There are several ways to do this, depending upon the material used to construct the contours. Exterior latex paint or polyester resin are the simplest options, but it may be difficult to cover the model thoroughly if porous material (such as foam) has been used to make the cutouts. A more elaborate technique, that gives smoother results, is to drape the model with pieces of cheesecloth soaked in a plaster-of-paris mixture. The plaster is added to approximately 2 liters of water in a bucket until the mixture is smooth and thick, but still pourable. The cheesecloth is pressed into the bucket until it is completely coated with plaster, then draped over the model. The process is repeated until the entire model is covered with at least two layers. The "stair-steps" of the contours can be smoothed out with additional plaster. After the plaster has dried, the model can be painted with exterior latex paint. Sand can be sprinkled over the wet paint to provide texture.

Step 12

Add details to the model, according to the features and processes to be demonstrated. Students may be willing to contribute toy animals, people, buildings, etc. from model kits. Sponges, floral foam, or dried moss may be cut into appropriate shapes to simulate structures and vegetation. Colored fleece fabric can represent vegetation as well as bare earth. Asphalt shingles can simulate paved areas. If students plan to use the model to simulate runoff conditions as described above, they will need to decide on materials that will simulate pollutants. Some commonly used options are cocoa powder (motor vehicle exhaust), chocolate syrup (motor oil), colored drink powder (chemical runoff), and chocolate cake sprinkles or chips (animal waste).

Figure 1:

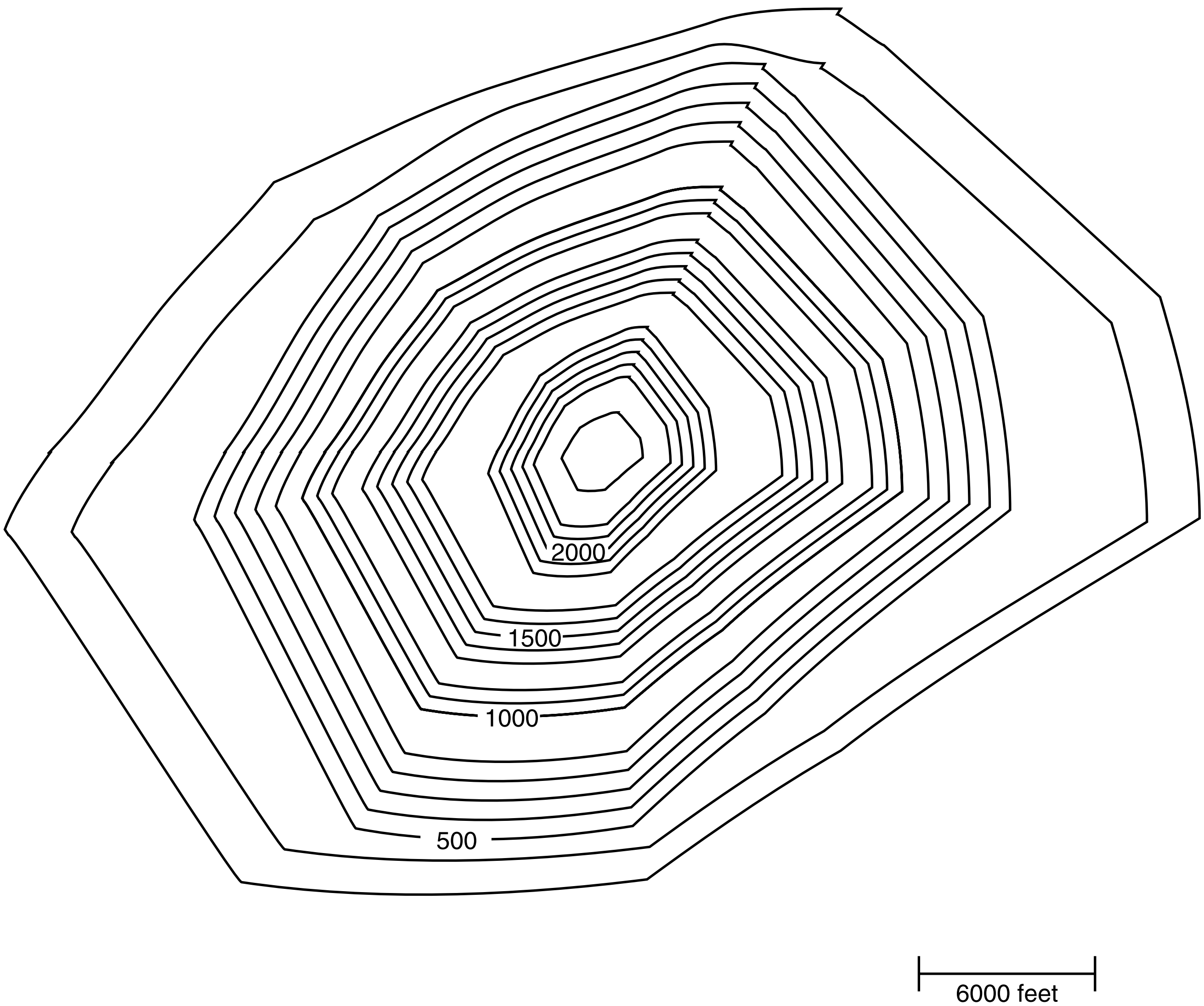


Figure 2:

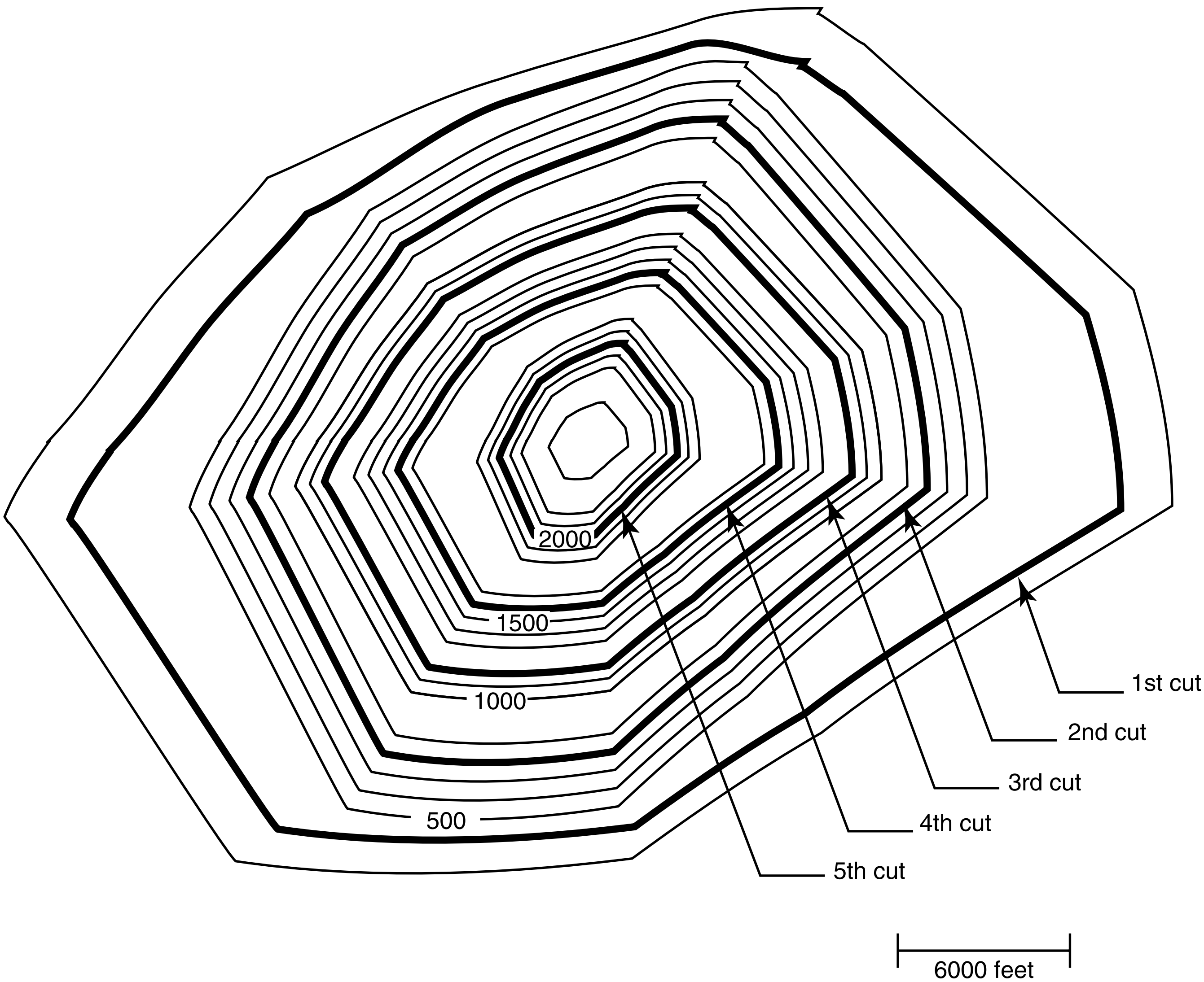

2000
1500
1000
500
1st cut
2nd cut
3rd cut
4th cut
5th cut
6000 feet

Figure 3:

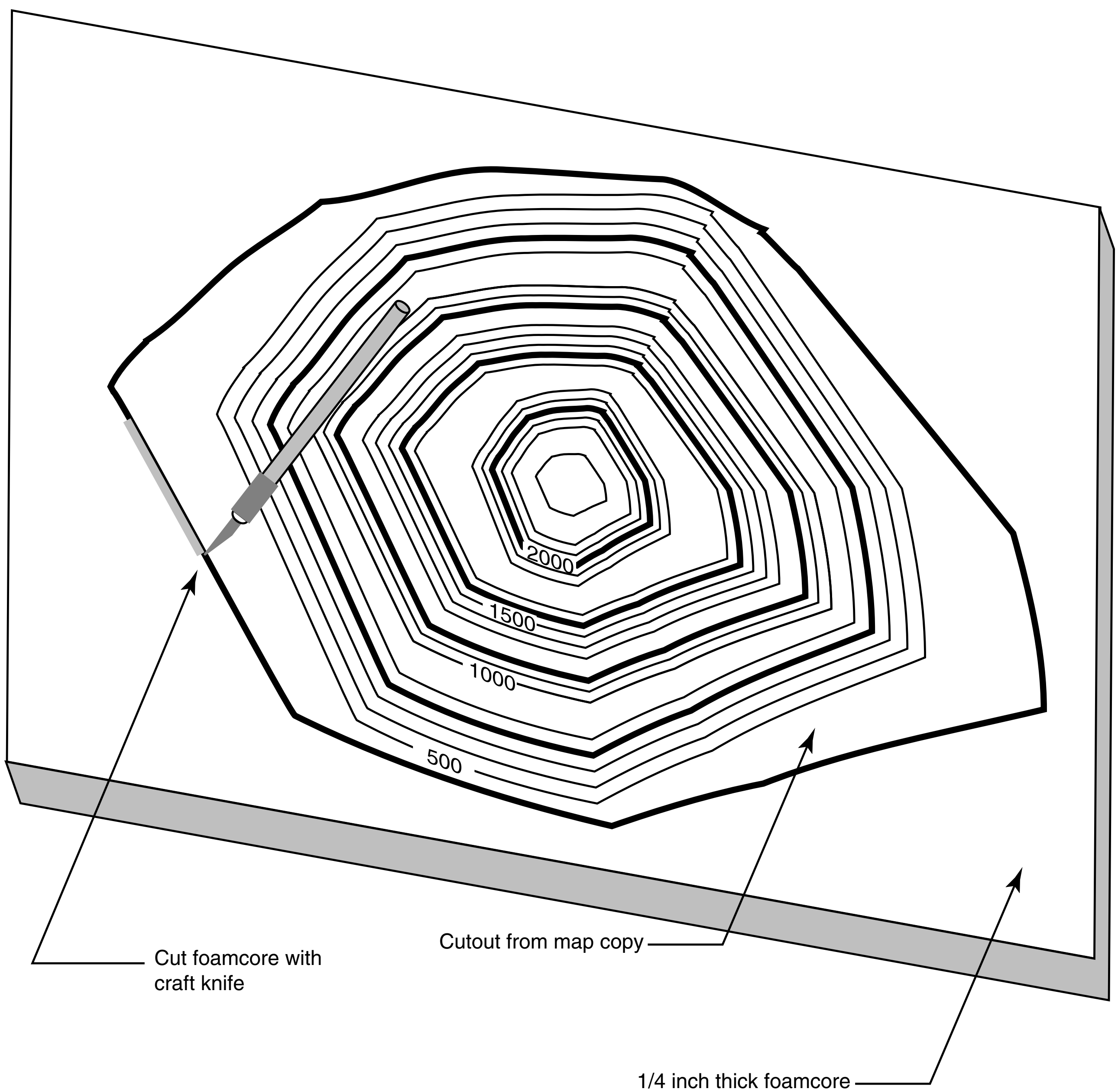
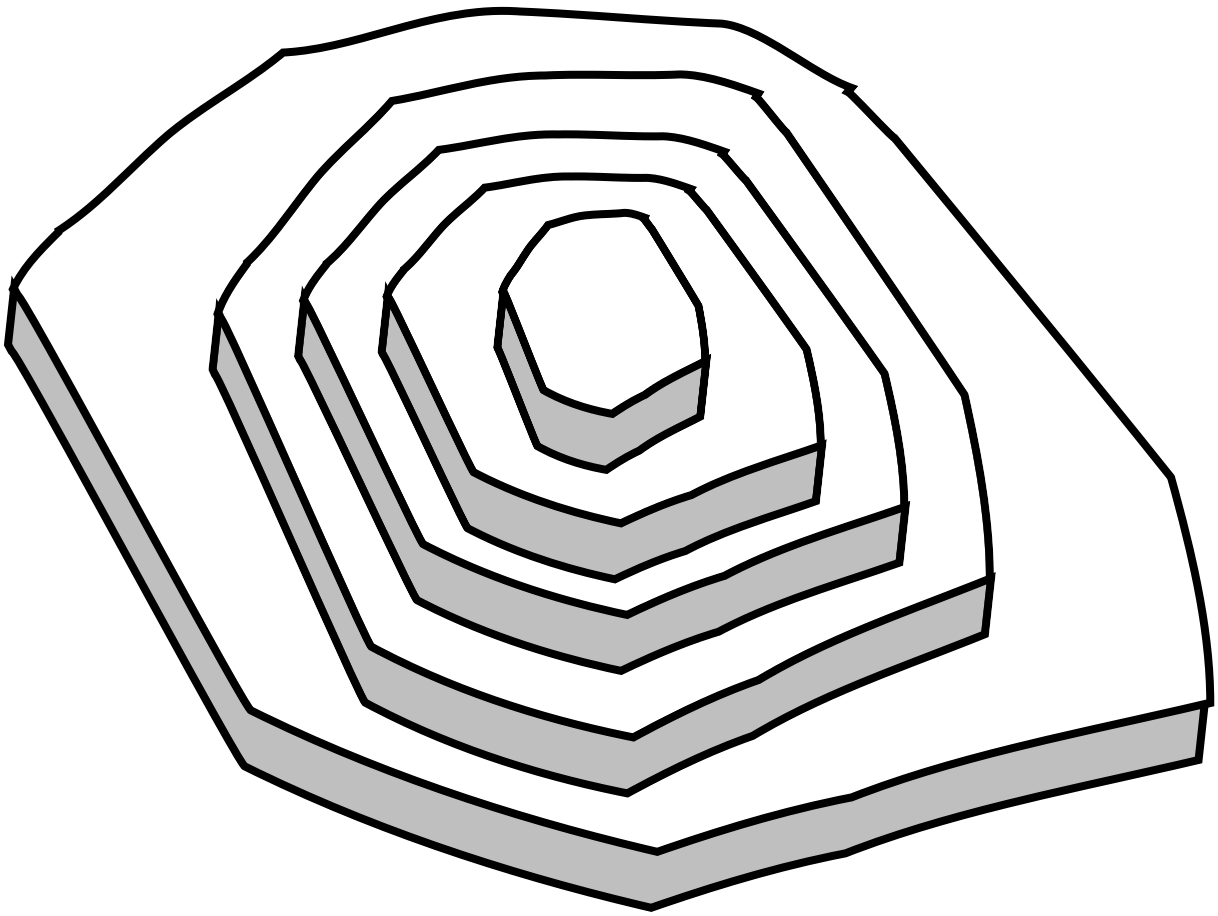

2000
1500
1000
500
Cut foamcore with craft knife
Cutout from map copy
1/4 inch thick foamcore

Figure 4:



Foamcore contour cut-outs stacked to form model