COASTAL CLASH

GRADE LEVEL 9-12

SUBJECTS Biology, Earth Science

STANDARDS California Department of Education

http://www.cde.ca.gov/ci/

Earth Science Grades 9-12
- Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
- Students know the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.

Biology Grades 9-12
- Stability in an ecosystem is a balance between competing effects
- Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction on nonnative species, or changes in population size

Investigation and Experimentation Grades 9-12
- Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations.
- Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data.
- Identify possible reasons for inconsistent results, such as sources of errors or uncontrolled conditions.
- Formulate explanations by using logic and evidence.
- Recognize the usefulness and limitations of models and theories as scientific representations of reality.
- Distinguish between hypothesis and theory as scientific terms.
- Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings.

OVERVIEW

Decisions affecting undeveloped ocean front land are becoming critical as economic pressures collide with public interests. Decisions that will determine the ecological character of our coastal shorelines will also influence human access to the coastal regions, as well as economic, legal, political, and aesthetic aspects of our future. Knowledge of the oceans

physical and biological processes is vital in selecting the best choices. In these activities students are given an opportunity to interact with the aspects of physical oceanography that affect development of our ocean fronts.

OVERVIE OF THE ACTIVITIES

The following activities are selected to assist students to acquire and organize understanding of new concepts, utilizing critical thinking and problem solving skills. Students will be asked to read, write, research, produce graphic work, present, analyze, interpret, and summarize.

1.) Energy must be provided to move water. Movement of water determines the ability of water to transport materials.
2.) Sand Movement Cycle: Sources of sand movement along the shore and the removal of beaches into trenches
3.) What happens when human activity interferes with the normal sand cycle?
4.) Why does the beach pattern change as it does between summer and winter? How does an El Nino year affect the pattern?

A NOTE TO TEACHERS: HOW TO USE THIS GUIDE

The activities and lesson plans for the film "California Clash" target students at the high school level and align with the California State Standards for Science. The lessons are designed to last for multiple days as a short unit and although they build on each other as a sequence, they are also designed to be used individually as pull-outs for those that do not have the curricular time to devote to the whole short unit. All lessons aim to incorporate educational content and themes from the broadcast film which can be integrated into your existing content curriculum. Although the unit lesson plans are geared toward a specific grade range, the unit lesson plans can be adapted to fit the needs of your grade or students' levels. All lesson plans include the following details for your convenience:

- Title
- Skill Area/Purpose
- Materials
- Estimated Time Allotment
- Procedure (with step by step instructions of implementation)

It is recommended that you review the lesson plan first before implementing it in your classrooms to make any necessary adjustments to fit your own and students' needs.

LESSON PLAN ONE

Title	The Amount of Kinetic Energy of Water Determines the Ability of Water to Transport Materials
Skill Area/Purpose	Students will learn that the process of beach movement is dependant on understanding the relationship between moving water and its ability to carry substrate particles

Students will learn that wind provides the energy for wave formation

Students will learn that the angle of the incoming wave determines the movement of sand particles in the beach front

Students will process new information, answer questions with a partner, perform a lab activity, and conduct a lab report

Materials

Sample textbook source, *Earth Science*, by the Heath Publishing Company, Chapter 10 entitled "Running Water," page 170

"Oceanography: Dunes and Beaches"
http://www.poemsinc.org/oceano/beach/htm
POEMS- Renewable Ocean Energy; Practical Ocean Energy Management Systems, Inc.

"Erosion and Deposition" by Dr. Michael Pidwirny
http://www.physicalgeography.net/fundamentals/10w.html
Department of Geography, Okanagan University College, 1999-2004.

"Waves, Near Shore Currents, and Tides"
http://www.coastalchange.ucsd.edu/st3_basics/waves/html
Coastal Morphology Group-Scripps Institution of Oceanography; Regents of the University of California and the Kavli Institute, 2002-2003.

Time

3 days

Procedure

Part I

Step 1: Each student reads the source materials. In pairs, have students work together to write down and answer the following questions:

1) How do particles of sand gain enough energy to move in a stream bed or along a shore?
2) Why do some rivers or beaches transport large sand and pebbles but others only carry fine sand or mud?
3) Which size of particles in the sediment load are dropped first if the water slows down? What size of particles is carried by the slowest water?
4) Predict what would happen if a fast moving river empties its deposits into an ocean beach with a moderate current flowing along the coast.

Teacher Note: Sample Answers

1) Kinetic energy from the moving water is transferred to the sand particles. Water moves downhill under the effects of gravity.

2) If the water is moving slowly it only has enough kinetic energy to carry very small particles. Fast moving water can carry larger particles, pebbles, or stones.

3) If the speed of the water slows down, its kinetic energy drops, and large particles are dropped first. Slow moving water can only carry silt or clay particles.

4) If the fast river water joins a slower moving ocean it must drop those particles too heavy to carry.

Step 2: Facilitate class discussion to discuss and expand the answers.

Part II: Lab

Teacher Note: As with all labs it is recommended that the teacher perform the test in advance to better explain details to students. The size of the nail hole in the can may need to be adjusted to match the particular blend of small, medium, and large sand grains used.

Materials
- 8.5 x 11 inch manila folder
- clear tape
- sand containing a mixture of sizes
- tablespoon
- soda can for water source
- nail to perforate can
- 400 ml beaker to serve as catch basin

Procedure

Step 1: Open the manila folder and fold longwise 2 times(the folder file is now 4 layers thick).
Step 2: Bend and fold up 1 cm walls on both sides of a trough.
Step 3: Fold up a 1 cm tab of file material at the upper end (to prevent back flow). Secure with tape.
Step 4: Mark point "A" 3 cm from the "upper" end and point "B" 8 cm from the "upper" end.
Step 5: Prepare the water supply: an aluminum soda can with a 2-3 mm diameter hole near the bottom of the can.
Step 6: Raise the point "A" end of the trough 1 cm above the table top. Place the catch basin at the far end to catch the water.
Step 7: Add one "level" teaspoon of mixed sediment at point "B."
Step 8: Fill the soda can with water and allow to drain, pointing the stream of water upstream against the splash guard.
Step 9: For each trial, sketch the overall pattern of transport. Be sure to note what kind of particles are deposited along the flow path. On a scale of 0-5, record how much sediment is carried to the catch basin.
Step 10: Repeat the process raising the point "A" end 2 and 3 cm. Record the results on separate sheets of paper. Be sure to label your findings.

Step 11: Questions for Analysis

1) What can explain why water in a river sometimes moves faster than at other times?
2) Why was it important to control the rate of water entering the trough?
3) What was the effect on the sediment in your experiments of increasing the "slope" of the river?
4) If you see a beach with only cobblestones and no sand, what can you predict about the ocean currents that flow parallel to the beach?

Teacher Note: Sample Answers

1) The steeper the slope of descent, the faster the water moves.
2) *Changing the rate of water addition would change the speed of the water.*
3) *The moving water could now carry larger fragments.*
4) *The water is moving fast enough to carry away all smaller fragments except cobblestones.*

Part III

Materials
- Labeled reference map from textbook or Internet

Sample textbook, *Earth Science*, by the Heath Publishing Company, section entitled "Shoreline Currents," page 218

"Coastal Dynamics" by Michael Rosenmeier
http://www.clas.ufl.edu/users/mrosenme/Oceanography/Lectures/coastal_dynamics.htm
University of Florida, Oceanography.

"Transport of Sediment by Waves and Currents" by Stephen A. Nelson in *Coastal Erosion and Sediment Transport*, Earth Science, Australia
http://www.earthsci.org/geopro/ocean/ocean.html

Procedure

Step 1: Get into groups of four and answer the following questions using the reference map:

1) Locate and label the following: the California coast, Alaska, Hawaii, China, Australia, and Baja California.
2) During both the summer and winter seasons our most common prevailing wind comes from the northwest. What direction will the wave system from this iwnd produce? Draw with a number of small arrows the direction of the prevailing wind. Show with a series of parallel lines the direction of the wave system as it approaches the California coast.
3) Heavy storms develop strong waves in different parts of the Pacific Ocean. Surprisingly, a system of waves can travel vast distances from the place of origin to a break on the Pacific shore. Where storms develop will determine the direction of the waves striking the Coast of California. Show with arrows the direction of the wave systems when the storm is located a) north and east of Australia, b) off the shore of Japan, c) off the coast of Alaska.

Step 2: Follow Up Questions

1) Windblown sand will be more likely to move south than north. Explain why.
2) The angle of the waves will also move sand more to the south than to the north. Explain why.
3) Would a wave system from Australia help or cancel the force of the "along shore current?"
4) Do you think the movement of sand in the "along shore current" is constant? What could make it speed up? What could make it slow down?

LESSON PLAN TWO

Title	Sand Cycle: Formation, movement, and removal of sand from beach Systems
Skill Area/Purpose	Students will learn that most beach sand is formed in erosion as Rocks undergo decomposition in stream action and by wave action of cliffs Students will learn that wind and offshore currents move sand along the beach Students will learn that sand is removed when an offshore trench is encountered and the sand is diverted from the beach system.
Materials	butcher paper cut into 24' x 24' sheets

color felt pens
map of the California Coast from San Francisco Bay to Monterey
http://www.flag.wr.usgs.gov/USGSFlag/Data/maps/California
The U.S. Geological Survey
"Geologic Work of Streams" by Michael Ritter in *The Physical Environment,* University of Wisconsin-Stevens Point.
http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/
http://coastalchange.ucsd.edu
Look for categories of "Cliffs and Platforms," "Sediment Budget," and "Littoral Cells."

Time 3-4 days

Procedure

Step 1: Have students work in pairs. Students will be creating their own map of the California coast which will include explanations of the natural processes of shore movement and beach development.

Step 2: Have students draw onto their maps (using different color pens) the following:

- an enlarged version of the map of the mid-California coast line
- sample locations on the map that represent sources of sand
- the direction of the prevailing winds (use a system of small arrows)
- the location and direction of the along shore current
- the location of sand sinks

Step 3: As part of the poster, in your own words, write an explanation for each of these ideas:

- How is sand formed in rivers?
- How is sand formed from coastal cliffs?
- How does the along shore current form?
- In mid-California, how does the sand move from north towards the south?
- How is sand removed form beach systems?
- What happens to beaches when the moving water is made to move faster?
- What happens to beaches when the moving water is made to slow down?

LESSON PLAN THREE

Title Interfering with the normal sand cycle: the effects of breakwaters, harbors, and dams

Skill Area/Purpose Students will learn that particle movement or deposition depends On the speed of the moving water
Students will learn that any system that slows the movement of water will cause the sand load to be deposited

Students will learn that if water is made to move more rapidly the load of sand will be increased

Students will learn that if dams across rivers prevent sand from entering the ocean, beaches will be diminished and increase the erosion of ocean cliffs

Materials

Copies of letter from Yacht harbor applicant (attached)

"Large Sea Wall" by Chris Metzler, Geology and Oceanography, Mira Costa College, Oceanside, CA
http://www.miracosta.cc.ca.us/home/cmetzler/field_trip/lg-_sea_wall.html

"Breakwaters"
http://www.usna.edu/NAOE/courses/en420/bonnette/breakwater_design.html
United States Naval Academy

"Effects of Beach Modification"
http://www.cwe.queensu.ca/news/Erosion_Solutions.pdf
Center for Water and the Environment, Queen's University, Kingston, Ontario

Time

1 day

Procedure

Part I

Step 1: Review background information (refer to lesson plans 1-2). Facilitate whole class discussion and review the answers to the following questions:

- What is the relationship between water speed and sand movement?
- What conditions affect the speed of the along shore current?
- If you see a beach composed of fine sand, what can you determine about the speed of the along shore current in that location?
- If you see a beach composed of cobblestones and no sand, what kind of along shore current is involved in that location?

Step 2: Distribute the letter from the sea coast yacht club. The letter is to the California Coastal Commission requesting a permit to build a system of breakwaters to block active waves from the northwest and the southwest. A channel to the open ocean would remain facing west.

Step 3: After having read the letter, students will take on the role of an agent of the Coastal Commission and respond to the letter, notifying the applicant of the effects of their proposal.

Step 4: Students meet briefly in groups of four to discuss what needs to be included in their response. Each student will write their own individual letter. Get back into groups with each member listening to one student read aloud their letter. Each listener will write down one idea they liked the best and then give it to the reader.

Part II

Step 1: Have students get into pairs. Students are to analyze, answer, and write down their responses to the different scenarios presented. The scenarios are as follows:

a) Tumbling rocks in an active river grind down sediment as it flows, and grinds down the channel of the river. How does this result in sand being formed?
b) What happens to the amount of sand entering the ocean if a dam is built across a river? What happens to the original river sand?
c) What do you predict would happen to the beaches down the along shore current from the point where the river enters the ocean if a dam is built across the river?
d) At many locations along the California coast soft sand from stone cliffs falls into the ocean. How does the presence or absence of beaches affect the erosion of cliffs?
e) How could building river dams affect erosion of coastal cliffs? Explain.
f) In Part One you explained the effects on water energy and the ability to carry sand when a breakwater is constructed. If a breakwater is constructed, what would happen to the beaches down the direction of the along shore current?
g) What would be the effects of a breakwater on cliff erosion down the direction of the along shore current?

Step 2: Check the students' responses for understanding. Answer all clarifying questions.

DOLPHIN YACHT CLUB
HARBORTON, CALIFORNIA

Ms. Dominique Taylor, Director
Applications Department
California Coastal Commission
Administration Building
Sacramento California

Dear Ms. Taylor,

At the last board meeting of the Dolphin Yacht Club the decision was made to add solid concrete block breakwaters to extend out into the sea to block the predominate incoming wave action from the north-west, and also storm waves from the south-west. Our proposal is to create an artificial harbor to facilitate the entrance and exit of sailing boats into out yacht club facility. Our project will result in a quiet harbor free of large ocean waves. We would maintain a harbor opening 100 feet wide extending west and a bit south. Funding has been arranged through the adoption of a loan taken out by the club and financial support by the town of Harborton. The club is not wealthy, but we expect the value of our club to increase once the artificial harbor is complete. We anticipate that the only maintenance costs will be to maintain the concrete breakwater and that should be minimal.

We request that your department evaluate our project.; and if you give the “green light” please advise us how to proceed with the application process.

Thank you,

Smokey Williamson
Communicating secretary
Dolphin Yacht Club
Harborton California

“Visit beautiful Harborton; The clam chowder capital of the World”

LESSON PLAN FOUR

Title	Seasonal Changes in Beaches
Skill Area/Purpose	Students will learn that winter storms increase the energy of wave Action, resulting in movement of beach sand to sand beds offshore Students will learn that summer wave action is more gentle and offshore sand is carried inward toward the shore to form beaches Students will learn that the loss of beaches opens the possibility for wave action against cliff systems to promote the breakdown of the cliffs Students will understand that any human activity that adds to the loss of beaches, will increase cliff erosion processes Students will learn that El Nino climatic variations result in stronger winter waves, more reduction in beach sand, and more erosion of cliffs
Materials	“Sandy Beach Process” by Genny Anderson, 2003. http://www.biosbcc.net/ocean/marinessci/03ecology/ “Living With Coastal Change, Coastal Basics” http://coastalchange.ucsd.edu Coastal Morphology Group- Scripps Institute of Oceanography, Regents of the University of California and the Kavli Institute, 2002-2003. “El Nino Sea-Level Rise Wreaks Havoc in California’s San Francisco Bay Region” http://www.geopubs.wr.usgs.gov/fact-sheet/fs175-99/ U.S. Geological Survey
Time	2 days

Procedure

Step 1: Prepare students with background information by presenting the relationship between wav action, energy of moving water, and the movement of sand. Relate this information to summer and winter wave differences. Emphasize that this effect is separate to along shore currents.

Step 2: Have students write a “quickwrite” to explain the reasons why the beaches are different in summer and winter.

Step 3: Prepare students for a jigsaw research project. Follow these instructions for the jigsaw:

- Divide the class into groups of 4 people each designated by letter A-B-C-D

- Within the letter group number the four members 1-2-3-4
- Each person must record their respective letter and number.
- All of the "1" members of the group move to form a new research group. Repeat with the "2" through "4" groups until all groups are formed.

Step 4: Each group will research and brainstorm key information on one aspect of the study and will return to their letter grade group. Each person in the "letter" group becomes an "expert" in a different topic. The four topic groups are

A) How do the winter storm waves affect the beach sand movement?
B) Why do summer time beaches form as they do?
C) What natural and artificial conditions cause coastal cliffs to be eroded by wave action?
D) Summarize El Nino conditions and how they affect the beaches and cliffs.

Step 5: Each student should prepare for a five minute presentation. After the number groups are prepared, re-from the letter groups. Each member of the number group is required to take notes on the presentations. Students are to listen carefully for the key ideas that explain the topic questions for each group.

Step 6: During the presentation students are to write down key words and ideas as the presenter speaks about his or her topic. At the end of the presentations, each students is to rewrite presentation notes into a final draft. Reconstruct all key ideas presented. Collect both the rough notes and final notes.