Teacher: Mrs. B.J. Terhune
Primary Subject Area: Science
Outside Subject Area: Language Arts
Class Level: Regular
Grade Level: 4th grade

Title: Making Waves: Franklin County Considers New Artificial Reef

Description of Student Roles and Problem Situation:
Students will be organized into three groups: marine biologists, environmentalists, and commercial and sport fishermen. These groups will report to residents of Franklin County and the Franklin County Commission to determine the merits of a joint application between the Organization for Artificial Reefs (OAR) and Franklin County to create an offshore artificial reef.

Adaptation for a student from a non-Western culture:
• In a one-on-one conversation, I will determine the learner’s prior knowledge of the subject area through direct questioning. Information solicited will include knowledge of coastal environments, natural and man-made reefs, marine ecosystems, the fishing and diving industries, and economic development among tourism areas, particularly that affected by fishing and diving.

• When circulating among groups, I will observe to see if the non-Western student is participating in group discussions and offering opinion or suggestions. If not, I will actively solicit input from the student.

• I will model acceptance of differences and show respect for all opinions.

Adaptation for an ESOL student:
• I can provide translations of the Meet the Problem documents and other resources in the student’s native language.
• I can direct the student to use website translation tools, including Babelfish.com, WorldLingo.com, and AppliedLanguage.com.
• I can allow the use of native-language dictionaries, and assist with their acquisition if needed.
• I can allow the student to present his or her oral presentation in the student’s native language, using a translator to assess the presentation.
Title, Learner Characteristics, Sunshine State Standards

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Learner Characteristics of Elementary Grade (4th) Students (age 9-10):

1. **Physical:** Although small in magnitude, gender differences in motor-skill performance are apparent.
   **Justification:** Students at this age should be able to sit quietly for extended periods and concentrate on the intellectual task at hand (p. 79). In the proposed PBL, students will be required to research information and work on all aspects of the PBL – both independently and within their group – without disturbing their peers.

2. **Social:** The peer group becomes powerful and begins to replace adults as the major source of behavior standards and recognition of achievement.
   **Justification:** By grades 4 and 5, children are more interested in getting along with one another without adult supervision (p. 79). Students will work on the PBL in groups and will look within each group to set their own standards and requirements for their activities. The group as a whole will be able to work more cooperatively at this age. Piaget’s theory of cognitive development suggests providing plenty of opportunities for children to learn from one another, and this will occur during the PBL.

3. **Emotional:** Children develop a more global, integrated, and complex self-image.
   **Justification:** A child’s sense of self can be influenced by such significant others as teachers and friends and by how competent the child feels in areas where success is important (p. 81). In the PBL, every student in each group will have the opportunity to exhibit his/her competence and show success, thus contributing to a sense of self-worth. This uses Erikson’s theory of Psychosocial Development among elementary-grade children.

4. **Cognitive:** The elementary grade child can think logically, although such thinking is constrained and inconsistent.
   **Justification:** Most children of this age are “concrete operational” thinkers, and general and abstract ideas are often difficult concepts to master (pp. 81-82). This PBL lesson will apply specific, concrete information that students will be required to examine before determining the impact its use.

5. **Cognitive:** On tasks that call for simple memory skills, elementary grade children often perform about as well as adolescents or adults. But on tasks that require more complex memory skills, their performance is more limited.
   **Justification:** Theoretical learning involves using psychological tools to learn scientific concepts (p. 48). According to Vygotsky, this type of learning is possible, even among middle elementary-age students, if well-designed instruction is aimed slightly ahead of what children know and can do at the present time, thus creating their “zone of proximal development” (p. 49). This PBL will “set the bar a little higher” than what students are used to; however, by using their own logical cognitive skills as well as putting to use their social learning skills as a group, students will be able to complete the more complex task of determining the pros and cons of artificial reefs.
Primary Sunshine State Standards:
1.) **Subject: Science**
   Grade: 4th
   Body of Knowledge: Life Science
   BIG IDEA: Interdependence
   B. Both human activities and natural events can have major impacts on the environment.

   **Benchmark SC.4.L.17.4** Recognize ways plants and animals, including humans, can impact the environment.

2.) **Subject: Science**
   Grade: 4th
   Body of Knowledge: Nature of Science
   BIG IDEA: The Practice of Science
   A. Scientific inquiry is a multifaceted activity. The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.
   D. Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations.

   **Benchmark SC.4.N.1.1** Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

Outside Subject Sunshine State Standards from Language Arts:
1.) **Subject: Reading/Language Arts**
   Grade: 4th
   Strand: Writing Applications
   Standard 3: Persuasive: The student develops and demonstrates persuasive writing that is used for the purpose of influencing the reader.

   **Benchmark LA.4.4.3.1** The student will write persuasive text (e.g., essay, written communication) that establishes and develops a controlling idea, supporting arguments for the validity of the proposed idea with detailed evidence.

2.) **Subject: Reading/Language Arts**
   Grade: 4th
   Strand: Communication
   Standard 2: Listening and Speaking: The student effectively applies listening and speaking strategies.

   **Benchmark LA.4.5.2.5** The student will make formal and informal oral presentations for a variety of purposes, audiences, and occasions, demonstrating appropriate language choices, body language, eye contact, gestures, and appropriate use of available technologies.
Learning Outcomes, Student Role & Problem Situation, Meet the Problem Method

Learning Outcomes:

1.) **Benchmark SC.4.L.17.4** Recognize ways plants and animals, including humans, can impact the environment.

   **LO #1:** Using “Meet the Problem” documents and other research done via the Internet, each student in the team will distinguish three to five positive and three to five negative impacts that artificial reefs have on the immediate environment and surrounding area, scoring at least 18 out of 25 on a rubric. (*Analysis*)

2.) **Benchmark SC.4.N.1.1** Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

   **LO #2:** Using a “Know/Need to Know” chart, “Meet the Problem” documents and other outside research conducted via the Internet, each student in the team will categorize known facts regarding artificial reefs from unknown questions to create his/her Know/Need to Know chart. The student will distinguish at least 7 known facts and 10 unknown questions with 80% accuracy. (*Analysis*)

3.) **Benchmark LA.4.4.3.1** The student will write persuasive text (e.g., essay, written communication) that establishes and develops a controlling idea, supporting arguments for the validity of the proposed idea with detailed evidence.

   **LO #3:** Using provided documentation and outside research, each student in the team will compose a letter to the Franklin County Commission stating his/her position on the proposed artificial reef, scoring at least a 35 out of 50 on the rubric. (*Synthesis*)

4.) **Benchmark LA.4.5.2.5** The student will make formal and informal oral presentations for a variety of purposes, audiences, and occasions, demonstrating appropriate language choices, body language, eye contact, gestures, and appropriate use of available technologies.

   **LO #4:** Using his or her letter to the Franklin County Commission as a guide, each student in the team will prepare and deliver an oral presentation defending his or her stance on the proposed reef, scoring at least a 35 out of 50 on the rubric. (*Evaluation*)

Description of Student Roles and Problem Situation:
Students will be organized into three groups: marine biologists, environmentalists, and commercial and sport fishermen. These groups will report to residents of Franklin County and the Franklin County Commission to determine the merits of a joint application between the Organization for Artificial Reefs (OAR) and Franklin County to create an offshore artificial reef.

Meet the Problem Documents:
Students will receive a memo (see below) from the Organization for Artificial Reefs (OAR) – a private, nonprofit group of artificial reef advocates based in Tallahassee – seeking approval of and funding for a joint application for an artificial reef off the coast of Apalachicola in Franklin County, as well as three news articles (see below) related to the creation and implications of artificial reefs off the shores of Florida.
We are asking Franklin County to join our upcoming application to the Florida Department of Environmental Protection and U.S. Army Corps of Engineers for an artificial reef off the coast of Apalachicola. This reef will serve as critical habitat for marine life and will help replenish the area fisheries. Numerous studies have shown artificial reefs are effective in aiding depleted fisheries and providing an economic benefit to local communities depending on commercial and recreational fishing. The recent Deepwater Horizon oil spill and the unknown environmental impact to the Gulf Coast fishery only add to the urgent need for artificial reefs in our area. Much of Franklin County’s economy — from commercial fishing boats to charter captains serving tourists — depends on a thriving habitat for marine life.

Our organization is a nonprofit, 501(c)3 group that has been in existence since 1986. We have been instrumental in building more than 25 artificial reefs in Florida and Gulf coast waters. We have a strong track record of proven results, and we have developed longstanding partnerships with many officials along the Forgotten Coast.

Historically, OAR has relied on the annual Big Bend Saltwater Classic fishing tournament to raise money for the deployment of artificial reefs. This year’s 22nd tournament, scheduled for June 18-20, may be impacted by the devastating oil spill in the Gulf. The current National Oceanic and Atmospheric Administration (NOAA) closure boundary is currently well offshore of Florida. All state of Florida waters remain open to commercial and recreational fishing at this time, but the fishing tournament executives are monitoring the spill to determine whether the 2010 tournament can be held.

In light of the potential loss of these funds, we are seeking $75,000 in matching funds from Franklin County to assist in the deployment of our proposed artificial reef. This reef will be placed about 40 miles off the coast directly south of the Bob Sikes Cut on St. George Island. This area has been identified by the U.S. Coast Guard and Florida Fish and Wildlife Commission as an ideal spot for the introduction of artificial reefs. But we need your financial assistance to help defray the cost of construction, labor, and transportation in establishing this reef.

We have a deadline of July 1 to make this application; therefore, we are requesting your response by June 15. We would be happy to make a presentation at your next county commission meeting and answer any questions you may have.
Are artificial reefs good for the environment?

Proponents say they replenish the ecosystem. Some scientists aren't so sure.

By Jeneen Interlandi | Newsweek Web Exclusive
http://www.newsweek.com/id/142534
Jun 20, 2008 | Updated: 8:49 p.m. ET Jun 20, 2008

It sounds like a great idea. Take a retired oil rig, Navy ship or fleet of subway cars that would otherwise add to our nation's swelling heap of trash and drop it off the coast of just about anywhere. Plants and invertebrates will colonize the hulking structure. Fish will migrate there and reproduce. And before long, the replenished ecosystem will fuel an economic boon of recreational fishing and diving.

While the concept isn't new, more artificial reefs are being lowered into the ocean now than ever before. Six hundred old subway cars off the coast of Maryland; 125,000 tons of volcanic rock into the ocean near Southern California, and a 524-foot vessel off the Florida Keys are among hundreds of projects slated for this year and next. But as artificial-reef initiatives grow to include more coastal regions and a wider array of aged infrastructure, some scientists worry that the commercial interests of fishing, diving and trash disposal are driving efforts that should be environmental. If that's the case, they warn, thriving reefs may ultimately give way to an underwater junkyard. "Unfortunately it's one of these things where people take a very superficial view--drop something in the water and a bunch of fish come and that's wonderful," says Jim Bohnsack, a fisheries biologist with the National Oceanic and Atmospheric Administration. "The reality is not so simple."

Fish ecologists refer to it as the attraction-production debate, and even proponents of artificial reefing admit it's a tricky issue. Do man-made reefs replenish ecosystems that have been decimated by pollution, overfishing and global warming? Or do they merely lure existing populations away from natural habitats, concentrating them in unnatural ways and making them more vulnerable to overfishing? "In a lot of cases, that question has been answered," says Bohnsack. "But proponents of reefing aren't too happy with the answer, so they ignore it." Research shows that artificial reefs only enhance fish populations when habitat is the limiting factor. In many cases, it isn't. Overfishing is the bigger culprit, and because they are popular fishing locales, Bohnsack and his colleagues say, artificial reefs only make that problem worse.

Not everyone agrees. By designing reefs to attract transient species, like Black Sea bass, which flit in and out of the reefs, as opposed to species like grouper that prefer to stay in one place, and by implementing fishing restrictions, reef coordinators say they can guard against the overfishing of vulnerable species. "We believe the attraction-production issue is eminently manageable," says Martin Gary, a fisheries ecologist with the Maryland Department of Natural Resources.

Even so, there's the question of safety and durability. The federal government is still cleaning up an ill-fated 1970s attempt at artificial reefing that employed more than 2 million tires fastened together with flimsy metal clips off the coast of southern Florida. The tires came loose from one another during a rash of tropical storms. Since then, they have been rolling around the ocean floor, destroying natural reefs, polluting the water and occasionally washing up on shore. Wooden ships in Florida and junk cars in Alabama have met similar fates.

While Navy vessels and oil rigs have fared better, subway cars have a projected underwater lifespan of just 30 years. Until recently, most states had rejected the idea of dropping them in the water, based on studies that showed they would not be sturdy enough. But after prodding by the New York City Transit Authority, Maryland, Delaware and New Jersey have teamed up to sink hundreds of them in 2008 and 2009. What happens to all those reefs when the cars degrade and collapse? No one can say for sure. "Our top priority so far has been to raise the funds to do this," says Gary. "We are just beginning to put a monitoring plan in place."

Gary acknowledges that there are more durable materials available, but he says subway cars attract tourist dollars. In Maryland alone, recreational fishing and diving contribute more than $1 billion to the annual economy, and a number
of fatal diving accidents in ship reefs have not dissuaded tourists eager to dive the subways. On top of that, the need to dispose of these things provides an added incentive: by dumping its retired cars into the ocean, the New York City Transit authority will save an estimated $13 million in disposal costs.

That rationale has frustrated some experts. "The artificial reefs have been sold by a number of specific interests that benefit from them," says Jack Sobel, director of conservation science and policy at the Ocean Conservancy. "The oil industry in the Gulf of Mexico, the sports-fishing and recreational-diving industries up and down both coasts, and the people who need to dispose of old cars, bridges and boats, all make out better than the fish and sea anemones do."

Ultimately, artificial reefs are no replacement for natural ecosystems, says Sobel. "We'd be getting much more bang for our buck by focusing on the things that we know work." That is, by establishing more marine reserves, which have been proven to restore overfished populations, even if they don't spur the same economic gains that artificial reefs do.

Artificial Reef Deployment


Reef-building corals are the source of primary production in reef communities through symbiosis with unicellular algae (zooxanthellae). Biologically active compounds, produced by reef-dwelling organisms, possess antimicrobial and antiviral activity. These compounds may be important sources for natural product-based drugs and medicines. Tourists attracted to the beauty of coral reefs can be a significant source of revenue for communities in those areas. Unfortunately, as our understanding of coral reefs increases, it becomes apparent that the effects of human population on these communities may be increasing as well. Creating and deploying artificial reefs is one effective way groups like the Organization for Artificial Reefs, Inc. (OAR), are taking steps to help alleviate damage caused by humans.

The Organization for Artificial Reefs is a diverse group of volunteers dedicated to conserving and enhancing the marine environment of Florida's Big Bend coast and beyond. The organization, founded in 1986, is based in Tallahassee, Florida. OAR's growing membership of nearly 300 makes it Florida's largest private, non-profit organization involved in the development of manmade marine habitat. A growing list of accomplishments also makes OAR one of the most successful of these groups.

What is an artificial reef?
An artificial reef is any structure placed by man in the marine environment. Properly prepared and strategically located, they attract marine life of all kinds.

Who, or what, is OAR?
The Organization for Artificial Reefs, Inc. (OAR) is a private, 501(c)(3) nonprofit group of marine enthusiasts and artificial reef advocates, based in Tallahassee. OAR serves the recreational saltwater fishing community of Florida's Big Bend Gulf Coast by promoting the professional development of public artificial reefs.

OAR is committed to responsibly designing and deploying artificial reefs as a means of protecting and enhancing a variety of marine life for the sake of both biodiversity and for promoting the enjoyment of the saltwater environment by the sport fishing and sport diving communities. Primarily relying on volunteers, OAR is made up of a dues-paying membership base that is called upon to carry out various duties. A non-paid coordinator and an 11-member, non-paid board of directors, which holds monthly meetings open to all members, govern the organization. OAR strives to operate at every level as a professional organization with highly cultivated ties to key organizations and leaders in federal, state and local governments.

How was OAR started? By an individual, a group or due to legislation?
OAR was started in 1986 by a group of local marine enthusiasts who saw the need to create much needed habitat in the Northern Gulf for the purpose of reducing the stresses placed on natural habitat, and to create more recreational fishing and diving opportunities for both residents and tourists.
How do you obtain the money to operate and produce these reefs?
For operating funds, OAR relies on a variety of sources, including membership fees, proceeds from the sale of internally produced products, private tax-deductible donations, and government grants. Also, OAR’s primary annual fundraiser is the [http://www.saltwaterclassic.com](http://www.saltwaterclassic.com). Established in 1989, our tournament has grown into the largest saltwater fishing tournament operating on the northeast Gulf Coast, with weigh stations in Panama, Carrabelle and Mexico Beach.

How do you determine the location for a new reef?
OAR determines suitable locations for new artificial reef construction by utilizing the organization’s volunteer Research Dive Team (RDT). This group of specially trained divers is skilled in conducting the types of underwater work essential to the creation of artificial reefs. The RDT dives and evaluates possible locations looking for suitable bottom conditions. Bottom conditions play a very important role in the development of new reefs. Suitability for a new reef site is determined by the RDT probing the sea bottom and noting the depths of the underlying substrate to bedrock, as well as the absence of significant marine habitat such as sea grasses, hard or soft corals, exposed and encrusted limestone, other than sand and granular sediments.

How long does it take, from the planning of a location, to actually dropping the material into the water?
Typically, it takes OAR around one year to create a new artificial reef. The site must first be evaluated, scientific data must be collected by the RDT and submitted with the assistance of a local government to the Army Corps of Engineers (ACOE) for the purpose of obtaining the permit before construction can take place. The permitting process, on average, takes OAR approximately 6 months. Once the permit has been obtained, OAR determines the funding sources available to create the reef, and then subcontracts the actual deployment of the reef.

What methods are used to deploy the materials?
Deployment methods vary from reef to reef. The methods are determined by the materials being deployed and the navigational clearance required as part of the ACOE permit.

Who deploys the materials?
OAR currently subcontracts out all of its reef-deploying activities. OAR, with assistance of local governments, sends out requests for bids to various reef builders in the area. Typically, the lowest bid is awarded the contract to deploy.

Is there a particular guideline you follow for the layout of the materials on the ocean floor?
OAR creates reefs that are complex in both structure and deployment pattern. Materials are selected in an effort to create a truly balanced reef that provides a complex habitat providing shelter for a wide range of marine fish and invertebrates. The reef spacing and distribution have been designed to maximize this potential. Following the belief that an underwater structure provides a safe shelter for marine species, each group of materials is spaced roughly twenty feet apart from the center of the reef in an effort to provide an adequate foraging zone.

What are the best materials suited for artificial reefs?
There are a wide range of materials that can be used to create an artificial reef. However, there are strict guidelines as to what materials can be used. Currently, the only permissible materials for deployment are either steel (vessels and scrap) or concrete (bridge rubble, culverts, prefabricated modules).

What are some styles of prefabricated habitats?
OAR has deployed reefs consisting of various prefabricated modules. Most recently, OAR deployed reefs constructed solely of modules produced by Artificial Reefs, Inc. of Gulf Breeze, FL, called Fish Havens. These modules have a vertical relief of approximately 8 feet and with a base of 10 feet on each of the modules, 3 sides. These modules are specially treated during construction to allow for rapid growth. Other modules such as reef balls, produced by the Reef Ball Foundation ([www.reefball.org](http://www.reefball.org)), and Lindberg Cubes designed by Dr. William Lindberg from the University of Florida, have also been used.

How many reefs has OAR built to date?
Approximately 22 reefs have been built to date, with the St. George Island Bridge Reef being the largest one time deployment in the State of Florida.

How long does it take for fish to inhabit a newly built reef?
Some fish move into a new reef within hours of deployment. Most of these are ornamental fish. Sport fish such as grouper, snapper and pelagics, usually start moving in within days, sometimes weeks, of deployment. It’s hard to tell for sure, because the reef is typically not monitored until weeks or months after the actual deployment date.
What is the largest reef that OAR has deployed?
The largest to date is the St. George Island Bridge Reef (2004). This reef consists of bridge rubble from the old causeway connecting St. George Island and East Point, Florida.

How can the public obtain the locations of the various artificial reefs in their area?
The locations of all artificial reefs deployed in the State of Florida can be located on the Florida Wildlife Conservation Commission's Marine Fisheries Web site:
http://marinefisheries.org/ar/index.htm

How much do your reefs impact the sport and recreational fishing economy?
Recent studies conducted in the Florida Panhandle have shown that for every $1 spent on artificial reefs, the conservative overall socio-economic benefit of the artificial reef system, throughout its estimated functioning life, was estimated at $138.

Are there other organizations like OAR in Florida?
There are other groups throughout the state that operate similarly to OAR. However, several of these groups are part of large coastal counties and municipalities that have their own artificial reef programs and budgets.

Can anyone get involved with the OAR? If so, who should be contacted?
Anyone and everyone is invited to become a member of OAR. For more information about OAR and how to become a member, or to make a tax-deductible donation, please visit the Web site at http://oarreefs.org/ or contact us at the OAR office at 850.656.2114.

Organization for Artificial Reefs Deploys Two New Reefs
July 16, 2007
http://www.saltwaterclassic.com/MemorialReef.htm

On July 14, 2007, the Organization for Artificial Reefs (OAR) deployed two new memorial artificial reefs in the Gulf of Mexico offshore Carrabelle, Florida. The reefs consist of concrete pipes and culverts dropped in two locations, and will be named in the memory of Nick Cureton and Dave Iacampo.

Purchased with proceeds from the Big Bend Saltwater Classic (BBSC) fishing tournament and donations in the name of Nicholas Cureton, the new reefs will increase recreational opportunities for both fishermen and divers.

The Nicholas Cureton Memorial Reef and the Dave Iacampo Memorial Reef are located approximately 15 nautical miles southeast of Carrabelle in 45 to 55 feet of water. The coordinates of the two reefs are N 29 39.808 W84 29.956 and N 29 39.904 W84 29.994.

These two memorial reefs mark the third and fourth reef deployments for OAR this year. The previous two reefs were 25 ReefMaker modules deployed in Bay County and a 100’ barge deployed in Gulf County off Mexico Beach.

OAR is a private, 501(c)(3) nonprofit group of marine enthusiasts and artificial reef advocates based in Tallahassee, FL. OAR serves the recreational saltwater fishing community of Florida’s Big Bend Gulf Coast by promoting the professional development of public artificial reefs. For more information about memorial reefs, visit OAR online at www.oar-reefs.org.

The BBSC is a Florida non-profit corporation and maintains 501(c)(3) status with the Internal Revenue Service. Each year, the proceeds from the tournament are distributed to
organizations that plan, permit, deploy and monitor artificial reefs in the Gulf of Mexico, along a stretch of approximately one hundred fifty miles of coastline in the “Big Bend” region of Florida. Visit us online at www.saltwaterclassic.com.
Problem Statement, Know/Need to Know Boards, Possible Resources

Problem Statement:
How can we, as environmentalists, determine what recommendation to make to the Franklin County Commission to decide the merits of an offshore artificial reef in such a way that:

- Maintains the natural beauty of Franklin County
- Enhances the marine ecosystem of the Forgotten Coast
- Positively impacts the economic environment of Franklin County
- Meets the June 15 deadline that the Organization for Artificial Reefs, Inc. (OAR) is requesting
- Limits county expenses to $75,000

Know/Need to Know Sample Board:

<table>
<thead>
<tr>
<th>KNOW</th>
<th>NEED TO KNOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>• An artificial reef is any structure placed by man in the marine environment</td>
<td>• What will be used to construct the reef?</td>
</tr>
<tr>
<td>• Proposed reef is off the coast of Apalachicola, 40 miles south of Bob Sikes Cut on St. George Island</td>
<td>• Who/what company is providing the construction materials?</td>
</tr>
<tr>
<td>• Proposed area identified by U.S. Coast Guard and Fish &amp; Wildlife as “ideal” spot for artificial reef</td>
<td>• Are the materials new or used?</td>
</tr>
<tr>
<td>• Organization for Artificial Reefs, Inc. (OAR) in existence since 1986 and serves the saltwater fishing community of Florida’s Big Bend and Gulf Coast</td>
<td>• What method will be used to deploy the materials?</td>
</tr>
<tr>
<td>• OAR has built more than 20 reefs in Florida waters</td>
<td>• How soon after deployment will the reef be monitored?</td>
</tr>
<tr>
<td>• More artificial reefs are being created than ever before, including reefs slated for creation in 2008-09 in Maryland, Southern California, and the Florida Keys</td>
<td>• How will the reef be monitored?</td>
</tr>
<tr>
<td>• Many artificial reefs are built with “retired” materials, including oil rigs, ships, and construction debris that might otherwise be described as “trash” and disposed of in landfills or junkyards</td>
<td>• What is the monitored status of the St. George Island Bridge Reef deployed by OAR in 2004?</td>
</tr>
<tr>
<td>• Research shows that artificial reefs enhance fish populations when habit is the limiting factor of such fish</td>
<td>• What is the monitored status of the two most-recent OAR reefs deployed off Carrabelle in 2007?</td>
</tr>
<tr>
<td>• Reefs constructed of “trash” (tires in South Florida, wooden ships in Florida and Alabama) have previously polluted the water and destroyed natural reefs</td>
<td>• What types of fish are likely to be attracted to the reef – transient or stationery species?</td>
</tr>
<tr>
<td>• “Disposal” of material debris, such as ships, subway cars, and bridges, into the water saves money compared to disposing of such materials on land</td>
<td>• How will/has the Deepwater Horizon oil spill affect(ed) Franklin County fisheries?</td>
</tr>
<tr>
<td>• Fishing and diving contributes to economy of coastal communities</td>
<td>• What economic impact does recreational fishing have on Franklin County?</td>
</tr>
<tr>
<td>• Typically takes 1 year to create new artificial reef: evaluation and permitting takes 6 months; funding and deployment another 6 months</td>
<td>• What economic impact does commercial fishing have on Franklin County?</td>
</tr>
<tr>
<td>• Only permissible materials available for construction are steel or concrete</td>
<td>• Will fishing restrictions be implemented at the new reef, and if so, what kind?</td>
</tr>
<tr>
<td>• The St. George Island Bridge Reef is the largest one-time artificial reef deployment by OAR in Florida (2004)</td>
<td>• What is the life expectancy of the reef?</td>
</tr>
<tr>
<td>• Studies in the Florida Panhandle have shown that for every $1 spent on artificial reefs, the conservative overall socio-economic benefit of the artificial reef system, throughout its estimated functioning life, was estimated at $138.</td>
<td>• What happens if/when the artificial reef degrades or collapses?</td>
</tr>
</tbody>
</table>
Possible Resources:

Internet:
1. The Organization for Artificial Reefs, Inc: http://oarreefs.org/
3. Florida State Coastal & Marine Laboratory: http://www.marinelab.fsu.edu/

Books (print):
5. Islands in the Sand: An Introduction to Artificial Reefs in the USA. Charlie Hudson Booklocker.com, Inc., 2009

Research articles (print):

Newspaper articles (print):

Video (non-print):

Human Sources (non-print):

a. William Seaman, associate director, Florida Sea Grant College Program; professor, Department of Fisheries and Aquatic Sciences, University of Florida, (352) 392-9617; seaman@ufl.edu
14. Helen Spohrer, Chairman Franklin County Tourism Development Council, 850-653 8678; hspohrer@stgeorgeisland.com
Capstone Performance

Capstone Performance Description:
The capstone performance for the problem contains 2 parts: an individual report, in the form of a letter to the Franklin County Commission, based on individual research, which will compare and contrast the positives and negatives of the proposed artificial reef; and a group presentation to the Franklin County Commission, in which each student presents one justification for his/her team’s overall position on the proposed artificial reef. Each student will be assessed on both of these parts by two separate rubrics – a written rubric and an oral presentation rubric.

In the letter portion of the capstone (LO#3), each student, using his/her own research as a basis, will compare and contrast the advantages and disadvantages of a proposed artificial reef, providing at least 4 documented justifications for each position as well as clearly stating his/her own “best” position, indicating research that outweighs one position over the other. Such justifications will include the impact(s) that the presence or absence of an artificial reef would have on the immediate environment and surrounding area (LO#1).

The three groups (6 students each, acting as either marine biologists, environmentalists, or commercial and sport fishermen) will read over each others’ letters and decide on or formulate the team’s overall “best” position on the proposed artificial reef and will include one unique justification per student for this position.

In the oral presentation (LO#4), each student, acting as a member of his/her assigned team, will present the following to the “Franklin County Commission”:

1. His/her “best” approach from the two positions prepared for the letter portion of the capstone, citing one or two justifications for this individual position.
2. The team’s “best” agreed-upon overall position (based on research done during the letter preparations and then shared with the group as a whole) and include one unique justification for the overall best position, so that in total 6 unique justifications (one from each student) are presented for the team’s overall position regarding the proposed artificial reef.
3. Each student will be given 3-5 minutes to make his/her presentation.

At least one member of the Franklin County Commission will be present for the oral presentations, with the remaining 4 members of the Commission (if the real commissioners are not available) played by teachers, school administrators, and/or parents. The 5 “Commission” members will be seated at a long table at the left front of the stage in the school auditorium, angled slightly toward the back of the stage. The 3 teams of students will be seated in their respective groups at tables at the back of the stage facing the audience, and when giving individual presentations, will face the Commissioners as well as the audience. The other 4th-grade class will act as the “audience” of the Commission meeting and will be seated in the audience section of the auditorium. (See Room Arrangement below)

Students will be presented with the PBL toward the end of Week 1 of the lesson (a Thursday). The following day, students will be grouped into three teams and will be given class time to construct a Know/Need to Know chart (LO#2). At the beginning of Week 2, students will be given a full week (5 school days) to research and write their individual letters. At the beginning of Week 3, students will meet as a team to review each others’ letters and decide on the team’s overall “best” position. Students will take 1 day working together to compile the team’s agreed-upon position (either pro or con) with one unique justification from each student for the stated position. Students then will take 2 days to prepare their oral presentations, based on their individual letters and the group’s position and justifications. At the end of Week 3 (Day 12), students will present their oral presentations in a 1½-hour (30 minutes for each of the three groups) block. An additional 30 minutes will be allotted for introduction of the problem (opening of the “Commission” meeting) as well as questioning of the individual group members by “Commission” members or by the audience following their presentations. At the end of the presentations, the Commission will vote on its choice for the best position for the County regarding a proposed artificial reef.
Students will conduct their own research and determine their own position regarding a potential artificial reef of the coast of Franklin County (autonomy portion of the capstone). Students also will engage in metacognition during the capstone performance while examining each proposed solution presented to the group before determining the "best" one. This would encompass the *knowledge-of-strategy variable*. 
Room Arrangement:

- Franklin County Commissioners
- Presenters
- Marine Biologists
- Environmentalists
- Fishermen

Audience
Rubrics for Assessing the Capstone Performance

Rubric for Written Letter Portion of Capstone:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Superior</th>
<th>Adequate</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content Accuracy</strong></td>
<td>All justifications for both positions stated within the letter, AND justification for the “best” position, are cited with research-based documentation</td>
<td>No more than 1 justification for either position lacks research-based documentation and citing within the letter, AND the justification for the “best” position is cited with research-based documentation</td>
<td>2 or more justifications lack research-based documentation OR the “best” position lacks research-based documentation within the letter</td>
</tr>
<tr>
<td><strong>Alignment to Problem Statement</strong></td>
<td>Each position aligns with all conditions in the problem statement</td>
<td>One solution aligns with all conditions; the other aligns with all but one condition</td>
<td>Neither solution aligns with all conditions</td>
</tr>
<tr>
<td><strong>Required Components</strong></td>
<td>Letter contains a) The group’s identification b) The problem statement c) Two positions (advantages and disadvantages) regarding the reef proposal d) At least four justifications for EACH position e) The student's own “best” position f) Cited research indicating why position is best</td>
<td>Letter contains a) The group’s identification b) Two positions (advantages and disadvantages) regarding the reef proposal c) At least four justifications for EACH position d) The student’s own “best” position</td>
<td>Letter contains less information than listed in the “Adequate” category.</td>
</tr>
<tr>
<td><strong>Mechanics</strong></td>
<td>Letter contains no grammatical errors (spelling, capitalization, punctuation, subject/verb agreement)</td>
<td>Letter contains 2-3 grammatical errors.</td>
<td>Letter contains more than 3 grammatical errors.</td>
</tr>
</tbody>
</table>

**Scoring Guide**

A  45-50
B  35-44
C  27-34
D  20-26
F  Less than 20
## Rubric for Oral Presentation Portion of Capstone:

### Oral Presentation Rubric

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Superior</th>
<th>Adequate</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 points</td>
<td>15 points</td>
<td>10 points</td>
</tr>
<tr>
<td><strong>Delivery Method</strong></td>
<td>a) Keeps eye contact with “Commission” members 90% or more of the time</td>
<td>a) Keeps eye contact with “Commission” members more than 75% of the time (but less than 85%)</td>
<td>a) Keeps eye contact with “Commission” members less than 75% of the time</td>
</tr>
<tr>
<td></td>
<td>b) If using notes, refers to notes no more than 3 times</td>
<td>b) Refers to notes 3-5 times</td>
<td>b) Student refers to notes more than 5 times</td>
</tr>
<tr>
<td></td>
<td>c) If using notes, refers only briefly (for 1-2 seconds at a time)</td>
<td>c) References to notes create pauses no more than 3-5 seconds long in presentation before returning attention to “Commission”</td>
<td>c) References to notes create pauses more than 5 seconds long in presentation before returning attention to “Commission”</td>
</tr>
<tr>
<td></td>
<td>d) Speaks “with expression” for at least 90% of the presentation (changing volume and tone as appropriate for the message)</td>
<td>d) Speaks “with expression” for at least 75% of the presentation (changing volume and tone as appropriate for the message)</td>
<td>d) Speaks “with expression” for less than 75% of the presentation (changing volume and tone as appropriate for the message)</td>
</tr>
<tr>
<td></td>
<td>e) Stands straight and tall at least 90% of the time and has 2 or fewer non-purposeful movements</td>
<td>e) Stands straight and tall at least 75% of the time and has 3-4 non-purposeful movements</td>
<td>e) Stands straight and tall less than 75% of the time and/or has more than 4 non-purposeful movements</td>
</tr>
<tr>
<td></td>
<td>f) Volume (using a microphone) is loud enough to be heard and clearly understood by audience 95% of the time</td>
<td>f) Volume (using a microphone) is loud enough to be heard and clearly understood by audience between 80 and 95% of the time</td>
<td>f) Volume (using a microphone) is heard and understood by audience less than 80% of the time</td>
</tr>
<tr>
<td></td>
<td>15 points</td>
<td>10 points</td>
<td>5 points</td>
</tr>
<tr>
<td><strong>Delivery Content</strong></td>
<td>b) Presents his/her “best” position regarding proposed artificial reef</td>
<td>a) Presents his/her “best” position regarding proposed artificial reef</td>
<td>Delivery content contains less information than listed in the “Adequate” category.</td>
</tr>
<tr>
<td></td>
<td>c) Cites 2 justifications for this position</td>
<td>b) Cites 1 justification for this position</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) States group’s overall agreed-upon “best” position</td>
<td>c) States group’s overall agreed-upon “best” position</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Cites 1 unique</td>
<td>d) Cites 1 justification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 points</td>
<td>3 points</td>
<td>1 point</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Timing of delivery</td>
<td>Student’s presentation is 4-5 minutes in length</td>
<td>Student’s presentation is 2-3 minutes in length</td>
<td>Student’s presentation is less than 2 minutes in length</td>
</tr>
<tr>
<td>Comprehension of Problem and Accuracy</td>
<td>Student answers question from “Commissioner” or audience member, justifying answer with at least 2 documented research-based facts</td>
<td>Student answers question from “Commissioner” or audience member, justifying answer with 1 documented research-based fact</td>
<td>Student fails to answer question or could not justify answer with documented research-based fact</td>
</tr>
</tbody>
</table>

**Scoring Guide**

A  45-50  
B  35-44  
C  27-34  
D  20-26  
F  Less than 20
Problem Statement (reiterated):
How can we, as environmentalists, determine what recommendation to make to the Franklin County Commission to decide the merits of an offshore artificial reef in such a way that:

- Maintains the natural beauty of Franklin County
- Enhances the marine ecosystem of the Forgotten Coast
- Positively impacts the economic environment of Franklin County
- Meets the June 15 deadline that the Organization for Artificial Reefs, Inc. (OAR) is requesting
- Limits county expenses to $75,000
Two Alternative Solutions and “Best” Solution Analysis

Solution One:

The environmentalists do NOT recommend that Franklin County engage in the creation of an artificial reef off the coast of St. George Island. They provide accurate, research-based documentation about the number of artificial reefs created by the Organization for Artificial Reefs (OAR) in Florida waters, specifically looking at the St. George Island Bridge Reef deployed by OAR in 2004 and the two most-recent OAR reefs deployed off Carrabelle in 2007. They also provide accurate, research-based documentation about how an artificial reef would impact the natural beauty of Franklin County, the marine ecosystem of the Forgotten Coast, and the economic environment of Franklin County by comparing how artificial reefs in other locations have impacted these factors in other coastal Florida communities.

<table>
<thead>
<tr>
<th>Pro</th>
<th>Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for environmental waste or contamination within the water is eliminated</td>
<td>Additional habitat for marine creatures and a healthier, more diverse ecological environment would not be created</td>
</tr>
<tr>
<td>Potential for damage to existing marine ecosystem while artificial reef is under construction is eliminated</td>
<td>Existing ecosystem is left without additional support structures, placing “user-pressure” on existing reefs and other marine areas</td>
</tr>
<tr>
<td>Amount of money Franklin County spends during fiscally unstable economy is limited or reduced</td>
<td>Potential increased revenue for Franklin County from tourists, fishing and diving enthusiasts to the area is lost</td>
</tr>
<tr>
<td>Potential for displacement of naturally occurring species and habitats is eliminated</td>
<td>Loss of new habitat or spawning ground for marine fish and other sea creatures</td>
</tr>
</tbody>
</table>

Consequences:

1. Franklin County would maintain its natural beauty by ensuring that no environmental waste or potential contamination is introduced into its coastline and offshore areas and that no harm is done to its existing marine ecosystem.
2. Franklin County would lose any potential increase in tourism revenue from sport fishermen or divers, who are drawn to the new reef.

Solution Two:

The environmentalists DO recommend that Franklin County engage in the creation of an artificial reef off the coast of St. George Island. They provide accurate, research-based documentation about the number of artificial reefs created by the Organization for Artificial Reefs (OAR) in Florida waters, specifically looking at the St. George Island Bridge Reef deployed by OAR in 2004 and the two most-recent OAR reefs deployed off Carrabelle in 2007. They also provide accurate, research-based documentation about how an artificial reef would impact the natural beauty of Franklin County, the marine ecosystem of the Forgotten Coast, and the economic environment of Franklin County by comparing how artificial reefs in other locations have impacted these factors in other coastal Florida communities.

<table>
<thead>
<tr>
<th>Pro</th>
<th>Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased biodiversity within marine ecosystem and increased habitat for marine creatures, particularly commercial and sport fish, is created</td>
<td>Certain recreational fish resources might be enhanced at the expense of other species or habitats, creating a negative balance</td>
</tr>
<tr>
<td>Potential revenue for the county from fishing and diving enthusiasts drawn to the new reef</td>
<td>Franklin County must spend money to “make” money</td>
</tr>
<tr>
<td>Increased habitat creates a healthy ocean, which can rebuild fish populations and help create a</td>
<td>Large concentrations of fish in one area may lead to overfishing</td>
</tr>
</tbody>
</table>
sustainable fishing industry  

Existing ecosystem is given additional support structures, relieving "user-pressure" on existing reefs and other marine areas.  

Existing marine ecosystem could be damaged while artificial reef is under construction.

Consequences:
1. The marine ecosystem of the Forgotten Coast is enhanced, including an increase in the biodiversity and habitat for the area's marine life, thus enhancing the natural beauty of Franklin County.
2. Franklin County likely would see increased tourism revenue from sport fishermen or divers, who are drawn to the new reef, and local commercial fishermen would have additional fishing grounds, also contributing to the economic environment of the county.

Justification:

Best solution: Solution Two.

Over the past several decades, increased development along our coastal areas, particularly along St. George Island, has greatly reduced the nursery habitats for fish and other marine life. The loss of these habitats, along with increased use of coastal resources, has led to a decline in the overall marine life population in certain areas. This is why artificial reefs are so important. They provide food, shelter, protection, and spawning areas for hundreds of species of fish, shellfish, and other marine creatures.

But artificial reefs are not just for fish. In their 2000 report, Evaluating Artificial Reefs and Related Aquatic Habitats, J.W. Milon, S. Holland, and D. Whitemarsh suggest that "a reef that is not useful to people is not a successful reef." A new artificial reef off the coast of Franklin County would provide alternate areas for divers and commercial and sport fisherman to use, reducing the "user-pressures" on other reefs and marine environments in the area. Usage of such an artificial reef could add millions in tourism dollars and in wages and salaries of workers who use the reef, including fishing guides or reef monitors, each year. Recent studies conducted by the University of Florida’s Institute for Food and Agricultural Sciences estimated $414 million in annual expenditures associated with artificial reef use in 5 northwest Florida counties bordering Franklin County, suggesting Franklin County would see similar economic benefits.

Finally, the concerns of environmental waste, contamination, or destruction of existing marine habitat by the deployment of an artificial reef are negated by thorough and mandatory surveys conducted in advance of reef development. The U.S. Army Corps of Engineers (ACOE) is the permitting authority for reefs in federal waters, and both the ACOE and the Florida Department of Environmental Protection (FDEP) are in charge of permitting in state waters. This rigorous permitting process can take anywhere from six months to a year to complete, and it ensures there is no "sensitive habitat," such as live, hard-bottom or submerged aquatic vegetation, present that could be harmed by new reef materials. After failed reefs made from poor materials such as used tires or old automobiles, allowable reef-building materials now focus only on heavy, stable, durable and non-polluting materials. FDEP states it will “allow only clean concrete or rock, clean steel boat hulls, other clean, heavy-gauge steel products with a thickness of a quarter of an inch or greater and prefabricated structures that are a mixture of clean concrete and heavy gauge steel.”

Although some may argue that spending any money on the creation of an additional artificial reef in Franklin County, where more than 40 reefs already exist – particularly during the current economic downtown and the financial struggles within the county – studies show that these reefs are beneficial to local economies. Studies of nearby areas report extremely positive benefit-to-cost ratios, suggesting Franklin County would see similar economic benefits. For example, a 2009 report conducted by the University of Florida cited the benefit-to-cost ratio of artificial reefs in a 5-county northwest Florida region near Franklin County was estimated to be 131, a value indicating an extremely high, positive return compared to the cost of developing and implementing the artificial reef programs in those five counties. A benefit-to-cost ratio of greater than 1.0 suggests that benefits associated with artificial reefs exceed the costs, thereby yielding positive overall economic benefits. “Overall, artificial reefs are a source of economic value that may justify additional deployments, even after taking into account the opportunity costs associated with scarce public funds,” according to the UF report.
Debriefing Plan and Coaching Questions

All three student teams – marine biologists, environmentalists, and commercial and sport fishermen – will make presentations regarding the potential merits of an artificial reef to the “Franklin County Commission” in the presence of all other teams as well as in the presence of “audience members” of the other 4th-grade class. In this way, every student involved in the PBL will hear all possible solutions. Each presentation ultimately will offer a “best” solution, incorporating unique justifications, as to whether the county should approve of and fund a joint application for an artificial reef off the coast of Apalachicola in Franklin County. Each student will have an equal speaking part in his or her team’s presentation.

The teacher, all members of the “Franklin County Commission, all "audience members” of the other 4th-grade class, and students within this class (when their own team is not presenting) will use the Rating Scale described below for the “best” solution given in each team’s presentation. Students will not rate their own team presentations. After all of the students have given their presentations, the Rating Scales will be completed, collected, and then tallied by the teacher, who will share them with the whole class on the day following the presentations. The team with the solution that has the highest rating will be chosen as the “best” and therefore will be the ultimate position taken by the “Commission.” Team members will receive a predetermined incentive for having the “best” solution.

Instructions for filling out the Rating Scale:

1. Take brief notes on 3 Pros and 3 Cons of the main solution presented by each team.
2. Use the Pro/Con Rating Scales at the bottom of the page to assign a score between 1 and 5 to each Pro and Con.
3. Tally the Pro Total Score and Con Total Score for each team.
4. Use the last column on the right to subtract the Con Total Score from the Pro Total Score and give the Overall Rating.

The team solution with the highest numerical Overall Rating will be chosen as the “best” solution and ultimately will be that selected by the “Franklin County Commission.”

<table>
<thead>
<tr>
<th>Group #</th>
<th>Pro Total Score</th>
<th>Brief Notes on 3 Pros of Main Solution (give score for each Pro using scale below)</th>
<th>Con Total Score</th>
<th>Brief Notes on 3 Cons of Main Solution (give score for each Con using scale below)</th>
<th>Overall Rating: Pro Total Score - Con Total Score*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pro Rating Scale:
1 This is a good basic idea but it needs a lot of revision to be a strong solution.
3 This could work but I am cautious to give my full confidence, it has at least one factor that could be a problem.
5 This is the best idea I have ever heard! It will definitely solve the problem!

Con Rating Scale:
1 This would not help solve the problem as it is presented, but it has an easy fix.
3 This would not help solve the problem and needs major revision.
5 This is a killer – it will definitely not solve the problem and there are many major flaws.
Five Essential Concepts:

Each “best” solution must use accurate information that can be supported by research. Specifically, these must include:
1. The current status of the Forgotten Coast’s marine ecosystem and how an artificial reef would impact that ecosystem, including species of fish and other marine creatures likely to be attracted to the reef.
2. How an artificial reef would impact the economic environment of Franklin County, including an accurate estimated benefit-to-cost ratio.
3. How an artificial reef would impact the diving and the commercial and sport-fishing industries of Franklin County.
4. How the use of existing reefs and other marine areas on the Forgotten Coast would be impacted by a new artificial reef.
5. What material(s) will be used to construct the artificial reef and how will it be deployed.

Coaching Questions:

Key to question type:  C = cognitive; M = metacognitive; E = epistemic

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meet the Problem</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>What is the student role in this problem?</td>
</tr>
<tr>
<td>M</td>
<td>What do you already know about artificial reefs?</td>
</tr>
<tr>
<td>E</td>
<td>How realistic is this problem?</td>
</tr>
<tr>
<td>Know/Need to Know Board</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Is the creation and deployment of artificial reefs increasing or decreasing?</td>
</tr>
<tr>
<td>M</td>
<td>Where would you go to find out if other regions in the United States are dealing with this same problem?</td>
</tr>
<tr>
<td>E</td>
<td>Is it necessary to find the answers to all the “need to know” questions?</td>
</tr>
<tr>
<td>Problem Statement</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>What resources might you need to solve this problem?</td>
</tr>
<tr>
<td>M</td>
<td>Are you comfortable with the problem statement your group has written, or would you change something?</td>
</tr>
<tr>
<td>E</td>
<td>Have you considered the needs or interests of all the stakeholders in this problem?</td>
</tr>
<tr>
<td>Research</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>How might you find information on artificial reefs in Florida?</td>
</tr>
<tr>
<td>M</td>
<td>How did you decide to divide the group work among all the members of the group and why?</td>
</tr>
<tr>
<td>E</td>
<td>What different types of resources can be helpful in solving problems?</td>
</tr>
<tr>
<td>Generating Possible Solutions</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>What research-based evidence do you have to back up this solution?</td>
</tr>
<tr>
<td>M</td>
<td>Why do you feel that Solution 2 is better than Solution 1? Explain your reasoning.</td>
</tr>
<tr>
<td>E</td>
<td>Who will be unhappy about this solution?</td>
</tr>
</tbody>
</table>