A Review of Successful Practices in Environmental Education to apply in the design of a Marine Science Curriculum

by

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Executive Summary:

There are people today who consider themselves conservationists, or at least care about the environment. However, these same people may fail to understand how their actions are actually linked to environmental problems. This lack of connection is a growing concern, but also one of growing interest. The opportunity to help people understand how their consumption and their actions will impact the planets ecosystems, is an educational platform which needs to be reviewed and expanded.

Experiential education, citizen science and voluntourism, are examples of people's desire to learn while seeking more of a connection to nature, with all these learning platforms being categorized as Environmental Education. Continued research shows that those who connect with nature are more involved with conservation efforts (37), as well as make changes in their own lives (38). You conserve what you know and care about, and a proven method for this connection is through hands-on involvement (39).

SAILwind Expeditions is a research, science and educational based non-profit which has been designed to help connect people with nature, with a goal of behavioral change to increase environmental stewardship. This educational entity provides students, scientists and visitors the opportunity to learn about marine and coastal ecosystems, while being guided to see the link between their own actions and the impact to the natural world. Seeing an entangled humpback whale with a fishing net used for shrimping, can be a strong image when viewing the option of a shrimp taco on the dinner menu. Or collecting 200 plastic pieces off a beach can make someone more conscious about making sure to ask for no straw in their next drink. It's this connection, from a personal experience, which can lead to a change in personal behaviors and actions.

This Masters project began with a review of environmental education history to establish a basis from which interest in education around the natural world originated. Next, educational themes and successful practices were reviewed to understand what are current trends in environmental education. The themes that kept surfacing in this review were; understanding the objectives and goals of the organization and the learner, presenting the educational material in personally relevant and meaningful way to those learning, engaging the learners to be more active, understanding what change in attitude and/or action may happen, and making sure program complexity fits the audience.

 A look into evaluation methods and challenges for both those on the learning side and those providing the education, can show the strong points and the gaps in current educational methods. Included are examples of educational curriculum to put some real-world clarity on current environmental concerns. The review of current and past environmental education programs, helped in the design of a couple of curriculum models. This educational curriculum is planned to be used by the educational organization SAILwind, to assist meeting their interests of connecting people with nature, with their goal of behavioral change to increase environmental stewardship.

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Chapter 1

Introduction:

Connecting people to natural systems has become an important way of addressing current environmental issues (27). The need for conservation and protection of these natural systems will have a much greater chance of success if environmental education for students is designed to help link human actions to environmental impacts (28). This can be a challenge for educators when environmental issues are not directly related to a student's lifestyle or understood. For example, sea level rise may not be well understood in North Dakota, a landlocked U.S. state. However, this does not mean the actions or the consumption from "upstream" has no effect on coastal regions, which in turn can affect that landlocked person. For example, pollution running downstream may deplete a fish stock that a person from North Dakota likes to eat, making that fish more expensive or not available at all. How to connect environmental issues to anyone that may have little or no understanding of an issue is a challenge for environmental educators (28).

This MP will provide a short review of environmental education - the past, current themes and methods, and ideas for the future. This review will also assist in helping the client, SAILwind (an educational organization which focuses on coastal ecology and environmental issues) by developing an understanding of how environmental education developed and what is currently happening in several selected learning institutions and organizations. Obtaining the background for environmental education, helps in providing appropriate and accurate curriculum for the educational organization SAILwind, to assist them with their goals of protection and conservation.

SAILwind is a highly interactive, educational non-profit, using science, adventure, and fun to help people learn about natural systems and to connect their individual actions and habits with impacts on the natural world. This is accomplished through "play with a purpose", a tagline of the organization. Sailing and kayak trips, stream bed exploration and coastal excursions all are part of the platform using a nature based experience to learn about an ecosystem and to see

how humans affect these natural systems. SAILwind needs more curriculum designed around school aged kids to help expand their educational efforts and this MP includes three educational models/programs to be used for school kids in SAILwind's educational and conservation efforts.

Objectives:

This Masters Project reviewed some history of environmental education, examples of educational methodologies and programs under both formal and non-formal structures, and reviewed current environmental education themes. The goal was to find successful educational themes and practices that would benefit new curriculum to be developed for SAILwind. Evaluation methods and assessing challenges in teaching environmental education were also reviewed to assist SAILwind in providing curriculum.

Chapter 2
Environmental Education

History:

Environmental Education has had many names over the past 100+ years including outdoor education, environmental studies, and the study of the environment (used in 1968 by UNESCO's International Bureau of Education). The term environmental education can be traced back to 1905 to the "Father of American Horticulture", Liberty Hyde Bailey, the first President of the Society for Horticultural Science[1], who considered employing the label "environmental education" into his studies (1, 2). The term resurfaced again in the 1960s with numerous individuals starting to use it more regularly: in Britain, at a conservation and education conference held at the University of Keele in 1965, in an article by Swan in 1969, and by Schoenfield, who founded the Journal of Environmental Education in 1969 and claimed to use the term in 1966 (1). In 1969 it was William B Stapp who described the concept of Environmental Education in Schoenfield's journal of Environmental Education, which set a baseline definition of Environmental Education as: "Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution" (3).

Since the 1960s, many renowned organizations and governmental bodies worldwide have started to use the term environmental education. For a concept or term to take hold, especially across numerous countries, organizations and cultures, it helps to have a recognized definition. Therefore, exploring where the term "environmental education" came from and noting some influential organizations that used the term, helps to show how the term became common practice.   To expand on the use of the term environmental education and why there has become such a need, the following internationally recognized organizations show a progression and use of environmental education.

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[1] re- named the American Society for Horticultural Science in 1916

The United Nations Belgrade Charter, produced at the International Environmental Workshop in 1976, stated that the goal of "…environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones" (4).   This goal from the internationally represented United Nations, is an example of the worlds interest in environmental education and hence conservation and protection of the natural world. The charter includes the awareness of economic growth and the concern this growth may have on the planet and peoples living conditions (4).

In 1977, the United Nations Education, Scientific and Cultural Organization (5) organized an intergovernmental conference on environmental education, the world's first, in Tbilisi, Georgia (USSR). The outcome was the Tbilisi Declaration and it constituted a framework, principles, and guidelines for environmental education at all levels (local, national, regional, and international) and for all age groups both inside and outside the formal school system (5). The Tbilisi Declaration also lists certain actions to incorporate in environmental education to achieve such goals. These actions include a holistic and interdisciplinary approach combined with research and innovation, which is available and shared by all (41). Inclusion of such actions into environmental education may help people acknowledge the connectedness between the man-made and natural environment, while learning about skills and tools to improve environmental conservation (41). This declaration puts actionable items to environmental education and encourages a variety of teaching methods in formal and non-formal structures.

The World conference on education for all - meeting basic learning needs - in 1990 for the UN's declared International year of literacy, shows another concentration on the worldwide movement towards environmental education. With principle agencies such as the World Bank, UNESCO, UNDP and UNICEF involved and over 100 countries sending more than 1500 representatives, provided an internationally represented collection of people and countries interested in environmental issues and the education designed to help with conservation (47). In Hungerford and Volk (1990), they reference the importance of this conference for

stewardship of the environment, with the need of environmental education to help change the way people act and behave (6). The conference adopted six educational goals, with the majority of them focusing on youth and female education, but also highlighted the importance of education to "...help ensure a safer, healthier, more prosperous and environmentally sound world..." (page 2) (47). This inclusion of, the need for the understanding and protection of the natural world at a conference that was more about general education, helps to show how these diverse countries were also connecting the importance of education and the environment.

The Centers for Ocean Sciences Education Excellence (COSEE) was formed in 2000 with a goal to improve education of ocean sciences. They provide the National Science Foundation (NSF) a platform to bring scientists into ocean-based education, helping to connect current research with those educating students and the general public. This platform addresses what information should be learned to be considered ocean literate, encourages workplace diversity, recommends evaluation plans both nationally and regionally, and seeks to include ocean sciences into National Science Education Standards (8).

An Ocean Blueprint (for the 21st Century) by the U.S. Commission on Ocean Policy in 2004 was another move towards the need for environmental education. This commission of 16 people, appointed by the U.S. President and from a diverse background of experiences, unanimously supported this plan.   This document provides a more modern approach to ocean conservation by realizing the ocean is an asset that also poses management challenges. They review environmental history to help explain the path to environmental education today, they offer management and educational opportunities to support the findings, and the group realizes science is vital to future ocean and coastal management decisions. The key section related to this MP is where the report dedicates Part III to the importance of education and public awareness, in this case around ocean stewardship. This educational aspect of the policy is designed to promote and encourage various educational opportunities to all, through scientific based research, to help U.S. citizens become knowledgeable about coastal issues for improved coastal management (7). The commission believes that knowledge and connection (gained

from public education) forms environmental stewards, who value our coasts and oceans and help support policies which protect these resources.

Environmental Education:

Is there a structure or process used to teach environmental education that is most beneficial? Best answer - it depends – which is why it's so hard to educate via one method, allowing for (almost requiring) many forms, styles, learning formats, age groups, organizations, locations and methodologies. To help decipher this, first a review of these educational structures (formal and non-formal) will help understand these formats for current education. Next, a look into why some programs are more successful, will help glean good themes and practices to help form SAILwind's curriculum. Followed by, understanding the need for why and how educational models can be evaluated, will add to assuring a successful program, while also exploring the challenges in delivering educational curriculum.

Formal and non-formal:

Educational structures, especially in environmental education, can vary greatly with complex programs and numerous teaching methods, but they tend to fall into two distinct categories: formal and non-formal structures. Mocker and Spear (1982) provide details (almost definitions) of these two educational structures.

In *Formal Learning,* Mocker and Spear (1982) believe an institution controls both the objectives and the means of learning (9) and is typically considered to be education that happens in a traditional school/classroom setting (18). Testing or evaluation along with some sort of completion certification/degree and a structured timeframe, are all normally part of a formal educational process. This formal learning structure typically puts all students taking a course or class on the same level (similar age and same evaluation criteria) and allows for repeatable classes over different semesters or years.

Mocker and Spear (1982) described **Non-formal Learning** as, the learners control the objectives but not the means (9). The student typically has an objective, what they would like to learn about, they just need help on "the means", how they will receive that information. Non-formal education can happen in numerous methods, venues and age groups and this education structure is being used more often in environmental education today (40). Workshops and seminars, environmental groups and clubs, even religious organizations are all options for providing a non-formal structure to environmental education. This structure makes sense when many traditional schools that fall into the stricter and more structured requirements of formal education, may not be able to provide the hands-on experiential aspect and variety of teaching methods so important to helping learners connect with the subject. After school clubs, non-profits, lecture series, conferences and community based organizations tend to attract people of similar interests and even backgrounds, allowing for education to be more specific in targeting the interests of those learning. In non-formal education it also can be easier to design an environmental educational program to fit those attending, since similar people are more likely to take a particular class or participate in a program, because it's on a subject of their interests. Lectures or other presentations can also fall under non-formal education. When someone chooses to attend a particular lecture on a topic of interest to them, even though the lecture may be in a formal setting, this speaking event would be categorized as non-formal, due to the learner choosing to attend and is therefore controlling the educational subject (10).

Themes of Successful Programs:

For program success, a solid foundation of good practices and methods needs to take place (6). These practices and/or methods can differ for formal and non-formal structures, but they may also have many of the same attributes. Four themes became relevant through review of environmental education and to incorporate in successful educational programs: 1) the *objectives and goals* of the educational institution, 2) presenting information to be *personally relevant and meaningful* while *engaging learners*, 3) what personal *change* happened because of the education, and 4) the *program's complexity*.

Heimlich (1993) discusses the importance of **objectives and goals** for the success of an educational program. Having a clear and precise understanding of why an environmental educational program is being implemented (the objectives and goals), is important to know during the program design and provides a better chance at program success (10). For example, CHANGE (Curriculum in High Altitude Environments for Teaching Global Climate Change Education) (11) an environmental educational program looked to focus their objectives and goals on students and climate change. CHANGE's objective and goal is to help students understand some science around climate change and then how to make informed decisions with this science based information (11). CHANGE accomplishes this by combining in classroom lessons with field trips on a local mountain to collect scientific data and record observations. The students then process and analyze the results back in their classroom. CHANGE believes success of their goals and objectives have been accomplished, since program evaluation has shown the students became more knowledgeable on important aspects of climate literacy, to help them make informed decisions (11).

Presenting information in a **personally relevant and meaningful** way for learners, and the design of activities or educational interventions to **engage learners,** are vital to the success of any environmental educational program, according to The North American Association for Environmental Education (NAAEE) (2004, 2010). An educational model needs to connect to a person's lifestyle, interests, feelings, health or even income, or the program objectives may not engage the learner (12). *Experiential learning* is another term used in engaging learners, and having an educational model which allows and encourages the students to be active in participation, has shown programs to be more successful (13). A program in coastal California looked at local adaptation and how the students viewed their own coastline in regards to sea level rise, after climate change education (14). This study used pre and post course surveys to understand how students related climate change to their personal surroundings. The findings showed after a class on climate change, the students "expressed stronger system and action knowledge" (14). By using the student's own neighborhood, this helped them to connect the teachings to something the students can relate to personally. Engaging learners through

student-centered, inquiry-based, experiential practices, is an effective and beneficial method for program success in environmental education (16, 17).

According to Thomson et al (2010), *change* is a good measure for success. "Change is a key word here – what is the 'change' that results from a particular program? Is it an increase in something, such as knowledge? Or a decrease in something, such as environmentally detrimental behavior?" (18). For example, in the case of an environmental educational program that shows the harm single use plastics/products can cause to the environment, a habitual change, like to always ask for no straw or never take a single use coffee cup, is a great evaluator of a successful educational program. Thomson et al (2010) states, "Actions can be as simple as making and maintaining a community notice board of environmental events, or as complex as developing and implementing a plan for walking school buses". A person who changes something in their thoughts, actions, work or lifestyle, because of something they were educated about, can show success in a program (31).

Program complexity can also play a vital role in success and is important to include in the program development stage. The design of educational models to fit the audience, by making sure the topic and level (complexity) of curriculum is appropriate for the learner, can help the organization achieve success (32). Here is a simple example - having a program which works well for high school aged students, may not be appropriate for adults or younger students. This does not mean the subject or even the objective outcome needs to change much, just the method or design of presenting the education may need to be adjusted.

Incorporating these four themes: the *objectives and goals* of the educational institution, presenting information to be *personally relevant and meaningful* while *engaging learners*, what personal *change* happened because of the education, and the *program's complexity*, are good steps to consider to help with program success. There is also a need to understand who is viewing a program as successful and how the design, combined with these four themes, can show success differently depending on one's viewpoint.

The success of a program can be viewed from many different people (and/or organizations/businesses/governments) and depending what vantage point, may be considered successful or not. A teacher, an institution, the student, the community, a government and even other educational entities, could yield vastly different views of "the success" of an educational program (18).

Success in a formal setting to the school or institution may judge a program on how well the teacher presents, with the baseline of what grades the students receive.   If too many students don't do well, that could indicate failure of the teacher, the program, or the institution not connecting the program to the students. In non-formal structures, the organizations mission and goals typically stipulate what is to be reviewed for success. Success for these organizations is determined by what their board (and their funders) are looking to accomplish, normally via a mission statement and/or a set of goals. This accomplishment could be very simple like just providing an opportunity for inner city kids to go to the beach, or as detailed as participants learn X, change Y and impact Z.

There are other structured programs that can be followed for environmental educational success that combines some of these same themes. One good model to review in educational success is from the Biological Sciences Curriculum Study (BSCS). In 1987 BSCS developed the 5E Instructional Model to help progress curriculum in their Science for Life and Living program. As of 2006, over 235,000 lesson plans have used this educational model (16). This 5E model uses the similar practices of engagement and exploration (participation) and then adds explanation, elaboration and evaluation. The following box highlights the BSCS model.

What the BSCS 5E Instructional Model is/does:

- The five phases of the **BSCS 5E Instructional Model** are designed to facilitate the process of conceptual change.
- The use of this model brings coherence to different teaching strategies, provides connections among educational activities, and helps science teachers make decisions about interactions with students.
- Each phase of the model and a short phrase to indicate its purpose from a student perspective are:
  - Engagement - students' prior knowledge accessed and interest engaged in the phenomenon
  - Exploration - students participate in an activity that facilitates conceptual change
  - Explanation - students generate an explanation of the phenomenon
  - Elaboration - students' understanding of the phenomenon challenged and deepened through new experiences
  - Evaluation - students assess their understanding of the phenomenon

https://bscs.org/bscs-5e-instructional-model/

Karpudewan et al (2015) used the 5E instructional model to look at student's aptitude around climate change. This paper explored how children retained knowledge about global warming, changed their mindset about the environment and connect the new knowledge to their actions and attitude around climatic issues (19).

Evaluation:

BSCS's last "E", evaluation, is more designed for the students. However, to help assure program success, evaluation can also come from many others. The institution presenting the education, the funders supporting the institution, even outside organizations and the community, are all additional areas to consider for evaluation of a successful environmental education program.

The review of two current methods - Outcome Based and SWOT (Strengths, Weaknesses, Opportunities and Threats) - will help understand the importance of evaluation, in making sure

an environmental educational program has accomplished what it has been designed to do. SWOT is a good evaluation tool since it has been used across many spectrums such as companies across varying industries, consultants, educators and even governments (42).   This diverse reach helps to show how this evaluation tool has been tested and excepted.   Outcome-based evaluation is another good model mostly due to the questions that it can help answer: is my program efficient and effective, does it meet my goals and objectives, how can my program be improved, and what does the program produce for the participants, all help to assess an environmental program (43).

Any evaluation step benefits the students, teachers, administrators and funders. An important aspect of evaluation is also making sure whoever is paying for the program/module/curriculum is satisfied with the results (33). These funders could be private such as foundations or philanthropists, or public such as a school district (tax payers). Keeping funders informed that "their" money (whoever is paying for the education) is well spent, can help keep a program successful (34).

Outcome(s)-based Evaluation:

Other names for this evaluation method have been known as: results-based management, outcome or performance measurement, and performance mapping. Outcome-Based evaluation methods are being used in education, healthcare, in funding organizations and the non-governmental community (35). This method reviews what happens after the educational program - the results. What did the student/client change?   What benefit(s) or impact(s) does this change do, and in the case of environmental education, for the environment (18)?   Did an attitude or perception adjust, a new skill set developed, or better knowledge of a certain subject take place (20)?   To help answer these questions, outcome-based evaluation uses a logic model to structure the evaluation. Logic models have a systematic approach and requires inputs, activities, outputs and outcomes to complete the evaluation.

The box below is directly from Thomson et al, Measuring the Success of Environmental Education Programs/Plan:Net (pg 20-22) (2003). It is being listed here without change to

provide their logic model criteria for an outcome-based evaluation in the most accurate manner.

INPUTS - these are the human and physical "ingredients" - the raw materials – that you need to bring about the changes (results) you seek. This is where you identify expertise, equipment and supplies. Having a good understanding of your INPUT requirements allows you to draft a budget.

ACTIVITIES – these are what you do with those ingredients - how you combine them. Typically, projects involve tens or hundreds of definable activities. You should group them into between five and eight activity sets. Common headings for these sets include: "promotion", "group formation", "research", "networking", "advocacy", "training", "procurement" and "construction". Under headings like these, write short paragraphs describing what it is the project is DOING.

OUTPUTS – these describe the completion of an activity – what is most immediately produced by the activity. The products or services, sometimes known as 'deliverables', are most often quantitative in nature and, as such, convey the volume of work completed.

IMMEDIATE OUTCOMES (also referred to as short term outcomes) – these are the first and most immediate results of your project. You have substantial control over how these turn out. Most *immediate outcomes* relate directly to one combination of activities and their outputs, so you should have roughly as many immediate outcomes as outputs (i.e. five to eight). Like outputs, immediate outcomes can be stated using numbers, but they should also describe some qualitative change. Immediate outcomes capture "potential" you create through activities and their outputs. Often this potential is created among a defined group of people – those who directly participate in the activity such as participants of a training program. In a training scenario, the potential might come in the form of applied knowledge, more confidence, new contacts, or an implementation plan. Sometimes this potential comes in the form of a product that emerges from a set of activities such as tested training curricula for a particular group of professionals.

INTERMEDIATE OUTCOMES (also referred to as Medium Term Outcomes) – these flow from a collection of immediate outcomes and describe the unleashing of that potential. *Intermediate outcomes* usually take place in families, organizations and communities that surround the individual (or that are influenced by the product – see above). You should be able to bring these

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changes about in the life of the project. You don't have full control over these changes because they are least one step removed from the activity and, with this kind of distance, outside influences can so easily get in the way. Yet, it is very important to manage toward these outcomes because they represent the concrete changes you are trying to bring about through your work. For the sake of manageability, aim for two to three intermediate outcomes. A project's purpose or objective statement is usually equivalent to intermediate outcomes.

ULTIMATE OUTCOMES (also referred to as impact) – these usually describe "big picture" changes that your project is working toward but that you alone cannot bring about. Aim for one statement that paints a picture of this preferred future. *Ultimate outcomes* illustrate the underlying goal of your work; they answer why the work is important. The ideal ultimate outcome is one that: a) inspires people toward a certain future, AND b) to which your project can, at some point in the future, demonstrate a contribution. Think of a ship or lighthouse on the horizon. If the object is too far away it sinks below the horizon and gives no direction. Goal and/or vision statements are roughly equivalent to an ultimate outcome statement.

From: Measuring the Success of Environmental Education Programs/Plan:Net

Outcome-based evaluation uses a systematic approach to understand the effectiveness of a program (18). Since many educational programs require a (sometimes very comprehensive) post program evaluation, this evaluation method can assist with most post program reporting. Outcome-based evaluation provides indicators to those developing, implementing and funding a program, to review what is working well, where improvement can happen, and what change (outcome) took place after the education.

S.W.O.T. - Strengths, Weaknesses, Opportunities and Threats

The SWOT evaluation method is common in business and other non-educational based entities and provides for a relatively simple and straightforward approach that is understood by many, allowing for more comprehension from a variety of those evaluating (21, 22). The SWOT template when used in environmental education, allows for an evaluation to help organizations

review the benefits and challenges of the educational program (23).

SWOT is designed to:

- Increase the effectiveness by verifying and understanding the education method.
- Improve how the education is being presented.
- Confirm if the objectives of the program are being met.
- Report via data, information that can be examined by others.
  (McNeal et al 2014)

SWOT does this by asking questions and looking at each of the acronyms.

- o *Strengths:* What is going well. Where a program or curriculum accomplishes the planned objectives of a program. Examples: Solid finances, return clients, skilled staff/employees.
- o *Weaknesses*: Where an educational model falls short. What may be missing in the model for the organization to hit its goals. Examples: Finances. Organization's skill set or employee experience. Location.
- o *Opportunities*: What is being overlooked in the industry. Examples: Is anyone highlighting current themes or trends? Is the timing right? Is another similar program missing a key area, topic, culture, or age group? An interested funder, or clients (students).
- o *Threats*: Anything that could derail the program or process. Examples: Competition from other similar programs. If the timing of a program becomes impacted, like a pandemic. Changes in politics or governmental view of environmental programs.

SWOT's relatively simple approach in looking at internal (strengths and weaknesses) and external issues (opportunities and threats) which impact the program, provides for a balanced evaluation of an educational program (21). By understanding where a program is strong or successful, and where a weakness may lie by showing an area for the program to

adjust/improve, provides a solid base for improving an educational program. SWOT (and any) evaluation is an important step in assessing an educational program to help with ongoing success.

Evaluation methods and concepts are designed to benefit educational programs, with each method such as SWOT or Outcome-based, having their own guidelines and protocols to help chose an evaluation method which best suits an organization's needs. What evaluation method is best for each educational situation needs to be considered by those doing the evaluation and designing the program. Here are a few important elements to look at in any program to help assure complete evaluation. Addressing these 6 steps below will help with the design and implementation of any environmental education.

1. Decide what you want to assess.
2. Select an evaluation design to fit your program.
3. Choose methods of measurement.
4. Decide whom you will assess.
5. Determine when you will conduct the assessment.
6. Gather, analyze, and interpret the data.

    (SAMHSA-CSAP-NCAP, 2000)

Challenges in Environmental Education:

Educational methods and systems are designed and implemented to benefit those involved, but there are sometimes aspects of a program or delivering institution which challenge the effectiveness of the education. With environmental education, this challenge aspect may include factors such as cultural, politics, economic/income level, social and even gender or age based. A one size fits all mentality certainly does not apply.

Formal Challenges:

The four themes - 1) the *objectives and goals* of the educational institution, 2) presenting information to be *personally relevant and meaningful* while *engaging learners*, 3) what personal *change* happened because of the education, and 4) the *program's complexity* - seem almost obvious to have as a part of any educational model, program or curriculum. However, many educational programs, especially in a formal school setting, have challenges in accomplishing the incorporation of these themes.

One issue for formal program success, is that they need to abide by certain standards. Regional, state and/or national policies and standards may be in place, and the educator has to make sure their teaching methods fall under these protocol and standards. Some of these standards make it very hard to incorporate any hands-on/experiential work, making it sometimes difficult to engage learners and design a lesson to include an aspect which may connect to them personally. This can especially be an issue in classrooms/schools with a variety of student backgrounds such as ethnicity, income, lifestyle or home life. Another issue is providing educational curriculum that can fit many students/schools across a region or state(s). Environmental education that works in one locale, may not fit for another. This may be particularly true when the learners have different backgrounds, interests, political or financial differences, as well as ages or gender. For example, different backgrounds can matter when one student is from a wealthy American family and has been raised not caring about conservation, while another student is from a family which has recently migrated to the US and has to worry about where they spend money. Ages and gender may also categorize conservation measures, due to what males and females may appreciate doing differently and at different points in their life (45). Designing an environmental educational platform for "all" is simply not an easy task in formal education.

Teaching to a variety of students like this can be extremely challenging in accomplishing the lessons goals. Different regions (both politically and geographically) also can present problems when having to fall under certain formal educational guidelines or restrictions. People in different regions may have different viewpoints on what they relate to (the relevant and

meaningful aspect) and what they enjoy (which can spark the engagement piece). Someone living in a low lying coastal region can be quite different than someone from a high alpine desert environment, even if they are politically aligned.

Another challenge of formal environmental education is what may be a lack of experience in a formally based teaching system/method. In Milbrath et al (1990), they conclude that even when students are concerned or aware of environmental issues, they don't have the knowledge or learned connection with how an environment works, or how society and personal actions play a role in the impact to the environment, compared to how the environment can impact a community or one's personal life (25).

While environmental education does take place and has a beneficial roll in formal settings, it is important to understand the potential challenges when trying to design and implement programs. The review of positive program aspects like the four themes, along with existing models like the 5E's, are ways to help limit potential educational challenges.

Non-Formal Challenges:

Non-formal environmental education may have similar challenges to formal education, but they also can have a different set of challenges. An organization's mission, level of topic-qualified employees and board, funding, industry or community connections and respect, and even location, can all play a role in the accuracy and quality of their non-formal programs.

As discussed earlier, when someone attends a non-formal educational program, the institution presenting the education/information dictates how and what is to be presented. This can turn into a challenge, when the information being shared by the organization may only look at "their" viewpoint. Non-profit organizations and other club type groups have (or typically have) a mission which the board and the employees need to follow. Sometimes that mission, and hence the focus of their education programs, may only present particular aspects of a subject which supports the mission/viewpoint of the organization, and could miss what others may consider keys elements to understanding a topic. Basically, each organization has a bias, and

that is what they tend to teach.

The strength and depth of the knowledge an organization has can be a huge benefit, or a challenge. Non-profit organizations that provide programs on certain topics do not typically need to be certified or even reviewed by any outside entity. While this can allow for an appreciated and sometimes a highly needed educational avenue, it also can be hard to know if what is being produced from the organization is accurate or inclusive. The employees should also have a solid foundation in the topic they teach and be experienced in teaching the program numerous times with proper evaluation. It's also good for the people on the board to actually be professionals not just "friends and family", which can happen in the non-profit world.

Another challenge, especially in the environmental education realm, is money. Making sure there is enough and consistent funding for the organization and the programs ahead of time will improve success. Lack of funds can lead to cutting corners in an educational model. A very important aspect of funding is where the money is coming from and what "strings" may be attached. A donor may say their donation can only be used for X, or sometimes a donor only supports an organization that will help their personal or business goals. The source of funding as well as raising an appropriate amount, is an ongoing challenge in some organizations providing non-formal education. It is therefore important to learn about this aspect of any organization presenting education for accuracy and quality.

The credibility of an organization can also impact educational programs. It can take time and connections to gain respect within an industry, educational field, or community and when this hasn't happened or isn't happening, the challenge of getting people interested and taking a course or class can pose a problem. This issue is normally combined with some prior mentioned challenges - good funding, having a professional team, and appreciated mission - can all add to the complications an organization may have.

Most people have heard location, location, location, are the three most important aspects of a business. Even for a non-formal structured organization, the location can influence their success. Location is also typically connected to what is being presented. Without some

forethought to being in the right place for the desired clientele, could yield an unnecessary challenge in attracting those interested in the environmental education.

Evaluation Challenges:

There are four circumstances Thomson et al (2010) list specifically to help in making sure evaluation is effective.

1- "When the program has few routines and little stability". An educational program or model that has not been around long enough, or does not have consistent teachings (like only doing a two-week summer program one time a year) may not have the history or enough data for a proper and thorough evaluation. This does not mean no evaluation should happen before enough time or program experience has happened, any evaluation can happen during such a pilot phase.

2- "When those involved in the program can't agree as to what it is trying to achieve". Without clear and agreed upon objectives and goals, it's hard to know what to evaluate. In using Outcome-based evaluation, how you review something needs to be clear and understood, of what the reason is for the education.

3- "When the sponsor or program manager sets limits as to what the evaluation can study, putting many important issues off limits". Evaluations need to make sure to capture the positive, as well as what is not going well. While showing a positive only evaluation can make the program administrator look good, it will not benefit the organization or the students in the long term.

4- "When there are not enough funds, resources, or staff expertise to conduct the evaluation". The biggest reason evaluations do not happen, or does not happen with enough detail or in a timely manner, is because of planning, skill, time and money. (14-Thomson et al 2010)

Advance planning is a key element for any evaluation method (36). The four guidelines from Thomson et al (2010), help to align prior planning, to assist in a well thought out evaluation plan.

Chapter 3

Examples of Environmental Educational Programs

The following examples have been chosen to highlight themes and methods and provide examples of challenges reviewed in this MP. Example 1 looks at the *personally relevant & meaningful/engaging to learner* theme and lists the challenge of a program being appropriate for each student in a rural mountain setting. Example 2 reviews the same theme of being *personally relevant & meaningful/engaging to learner,* but uses a vastly different setting, in this case a low income area of a mid-western city. Example 3 uses the BSCS 5E Instructional Model which helps show how using an existing educational model can benefit the design of an educational program. Example 4 reviews a program to understand more about *complexity*, via a traveling art and education model, which because of it's simple design, is used across many venues and regions.

Example 1:

CHANGE (Curriculum in High Altitude Environments for Teaching Global Climate Change Education) is a hands-on environmental educational program for middle school students from Storm Peak Laboratory in Colorado and provide in classroom lessons combined with field trips using science based principles and equipment. These principles include reviewing chemical composition and atmospheric layers with equipment such as a wind meter, particle counter and a Pocket Weatherman. CHANGE uses unique props (like using a pizza divided into slices to represent atmospheric gases) and the scientific tools for data collection, during field excursions on the student's local ski mountain. The students also present their collected data of pressure, temperature, relative humidity, particle concentration and wind speed, followed by answering questions and discussion on how climatic changes will impact their winter activities. By working with the students to answer the question, "How and why will the weather and particle concentration change as we ascend the mountain?", this environmental educational program from CHANGE is a great example of trying to make the subject/lesson *personally relevant & meaningful and engaging to learners,* by connecting the students skiing activity to how it may

change with environmental changes (11).

Where CHANGE struggles to fulfill a fully successful program, is that not all students are always active skiers or winter sports enthusiasts.   For the potential student who does not ski or enjoy a snowy winter, their connection (and interest) to this program could be quite different, since they will not feel the personally relevant and meaningful aspect of environmental education. Another challenge with this program is how the non-skier may not even be able to attend the field excursions.   If a student can't ski down the mountain, this isolates them from the lesson plan, making the lesson design not appropriate for all students.

Example 2:

A paper by Krajcik et al's (2000) team from the Center for Highly Interactive Computing in Education entitled "Inquiry Based Science Supported by Technology: Achievement among Urban Middle School Students" developed a project-based science curriculum over a 10-year timeframe. The team used an urban setting in Detroit to test students on how they engaged on inquiry supported educational models via pre-and post-program tests. Krajcik's team used a variety of engagement and personally relevant/meaningful techniques in their program, offering a solid base for testing their curriculum. These techniques of designing investigations around a real world problem the students were familiar with, combined with data gathering, analyzing and developing conclusions, helped students become knowledgeable on something of interest to them. One topic they reviewed looked at the question, "What is the quality of water in our river?". In this lesson plan students learned about concepts such as ecosystems, biodiversity, watersheds and macro invertebrates, with hands-on engagement doing water quality testing for fecal chloroform, pH and dissolved oxygen. Another class had the question "What is the air like in my community?". This lesson plan reviewed science based concepts (air composition, chemical reactions, compounds, atoms, elements, and states of matter) and how technology could help in solving an environmental issue. Educational context around real-world and personally relevant experiences, having students help plan experiments, ask questions, and collect data, combined with group collaboration and presentations, all aided in programs design for effectiveness (25).

Example 3:

In her MP entitled "Sea Level Rise Education and Outreach for Coastal NC", Dziuba (2011) uses the BSCS 5E Instructional Model to help with public education and outreach, to learn about sea level rise through the design of an educational model for middle school aged students. By addressing each of the 5 BSCS components: *engage, explore, explain, extend and evaluate*, students are encouraged to learn through constructing their own knowledge, rather than just being "taught". Dziuba's curriculum has the teacher use some of the following questions and methods to highlight the use of the 5E's and hands-on learning.

Engage- Teacher asks questions about sea level rise and other ocean related topics, to learn what students know already and what they may want to learn.

Explore- This is the hands-on aspect. Experiments like turning a solid, into a liquid, into a gas, is a beneficial educational example. This type of a hands-on project can also be used for using predictions and hypotheses of possible outcomes, through an interactive task or project, can help students learn.

Explain- The teacher plays the primary role here offering explanations and feedback. The use of visuals through methods like a PowerPoint, can be very beneficial in helping to clarify what the students accomplished in their hands-on work.

Expand- More interactive activities work well in this phase to have students use their new knowledge in additional hands-on task(s). The learners use some of their new knowledge to look at problems and make decisions.

Evaluate- Receiving feedback from the students, which could be in the form of student presentation, a class discussion, or even a test, helps to confirm the learned knowledge of the students through the program.

By using an existing instructional model (BSCS's 5 E's), Dziuba (2011) is able to benefit in designing a successful program, by following protocols and practices lined out in a proven educational system (16).

Example 4:

The deep sea marine science art exhibit, highlighted in Bosock's MP (2008) *Beyond the Edge of the Sea,* was implemented to help students understand the significance and importance of an area of the oceans which most people know little about. This outreach program, designed for grades K-12, uses a traveling art exhibit of illustrations showing the various unique and beautiful organisms that live in the deep sea's hydrothermal vents. Bostock's MP (2008) brings in a concept which the Ocean Literacy Workshop developed; "Ocean literacy is understanding the ocean's influence on you and your influence on the ocean" (26), so students would learn and become aware of the organisms living in the deep sea. Seven fundamental concepts are listed as key principles to be an inspiration for learning and hopefully thoughtful decision making around the health of our oceans. **(**Bostock, *Beyond edge of the sea*, 2008)

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1. Earth has one big ocean with many features.

2. The ocean and life in the ocean shape the features of Earth.

3. The ocean is a major influence on weather and climate.

4. The ocean makes Earth habitable.

5. The ocean supports a great diversity of life and ecosystems.

6. The ocean and humans are inextricably linked.

7. The ocean is largely unexplored

(Ocean Literacy Network 2005).

SAILwind Curriculum:

Environmental education using an organization such as SAILwind has many advantages. The non-formal structure allows for greater variety in environmental educational methods, helping to align with a different age groups, backgrounds and interests. This structure also works well to incorporate into the curriculum, the successful themes and practices mentioned in this MP. To recap, the four themes are: 1) satisfying the *objectives and goals* of the educational institution, 2) presenting information to be *personally relevant and meaningful* while *engaging learners*, 3) creating a personal behavioral *change* of each student, and 4) making sure program has an appropriate level of *complexity* and fits the learner. The three modules which have been created for SAILwind are in areas of interest to the organization and appropriate for the coastal region they currently work: Module one "What's really in the Ocean?" - The Ocean's Physical Properties and Water Sampling, module two "Thar she blows" - Humpback Whales, and module three "Where does that toothbrush go?" - Marine Debris. Each of the educational modules include good themes and practices gleaned from article and organization reviews and highlighted in this MP. This will help achieve the goals and objectives (theme one) of SAILwind – experiential ocean based education, combined with having fun, leading to an action or behavioral change to increase environmental stewardship.

Module one is called "What's really in the Ocean?", and is based around sampling water from the ocean (in the bay) or along the shore (typically by a river mouth), to teach the students about the ocean's physical properties and related environmental concerns. Scientific techniques and equipment are explained and used by the students. By having the students involved incorporates theme two, engaging the learners and does so by having them: use a plankton tow and debris net to capture plankton, microplastics and marine debris, with post trip use of a microscope, use a simple jar test for toxic algae testing and a membrane filter for fecal coliform testing, and record data of salinity using an electrical conductivity (EC) meter, an electrochemical DO sensor for dissolved oxygen (DO), and a pH meter for measuring pH. The module also seeks to encourage theme three, an action or behavioral change, by connecting the students to the ocean through talking about conservation and protection of the area they

live and play. This connection is accomplished through showing how the ocean and marine life is impacted by human actions, specifically marine debris and polluted water.

Module two is called, "Thar she blows" and focuses on Humpback whales and other marine life. This lesson engages the learner (theme two) through using scientific techniques which include visual behavior observation, photo ID, and the use of hydrophones.   The follow-up in-classroom lesson can be very enjoyable for students when using the whale photographs to help to identify individual whales (database matching) through fluke pigmentation patterns, fluke shape and scarring. This photo ID element is also designed to connect the learner to conservation. By showing a scarred whale due to a boat strike or from an entangled fishing net, may produce a change (theme three) in the student's actions on shore once they learn how the scar happened. This lesson is also easily adaptable for different age groups, helping to satisfy a range of complexity options to benefit many age groups/skill level for a successful program.

Module three is called "Where does that toothbrush go?" and is about marine debris and is aimed at behavioral change, educational practice number three.   The rivers, beaches and ocean have a marine debris problem and helping learners see how and where their waste actually ends up, can be very personally relevant (theme two). Coastal or river walks and using the plankton tow and debris nets, will engage learners (part two of theme two) into seeing what ends up along the coast and in the ocean. Discussion will be facilitated to see how marine debris moves around the ocean and how these plastics impact the ocean, through images of distressed or dead marine life, or maybe even "live" while on the excursion part of the module. This program has a few options around the complexity theme, one example being the ability to add the connection of marine debris to tourism/economics, for older students.

These educational modules for SAILwind are designed to combine adventure with science and conservation, while incorporating successful educational themes and practices as best as possible in the design of each module.   Each module also hopes to achieve success beyond the eyes of SAILwind and the participants. Since a major goal is to encourage "a change", this

change should be noticed in the conservation or protection of the environment. An example of this, like making sure to not use plastic bags, is beneficial to all people when we see less plastic bags in the oceans, rivers or on beaches.   SAILwind hopes that by "playing with a purpose", people will enjoy and learn about natural systems, how their personal actions and choices can affect nature, and then make a personal change to leave less of an impact.

SAILwind
Science and Adventure through Interactive Learning

Educational lesson plans combining
Ocean sailing excursions with pre and post trip classroom education

Title: "What's really in the ocean?"
The Ocean's Physical Properties and Water Sampling

Lesson Summary:

Students will use scientific techniques and equipment to learn about the physical properties of the ocean. Some research will occur on the boat or shoreline with instant results: water temperature, salinity using an electrical conductivity (EC) meter, dissolved oxygen (DO) using an electrochemical DO sensor, and pH using a pH meter. Water samples will also be taken from the boat or shoreline for post trip/in classroom exercises. This classroom work will include using a simple jar test for toxic algae and a membrane filter of .45 microns for fecal coliform testing. The students will get to use a plankton tow and debris net to capture plankton and microplastics/marine debris, followed by the use of a microscope to look for plankton (phytoplankton and zooplankton) and plastics. Questions and discussion topics are included to help students understand why this research is important and how human actions and behaviors impact marine ecosystems.

Objectives:

- Introduction to scientific equipment, terminology and methods - both in the field and in the lab/classroom.
- Learn how the data is collected and processed, and how this can help us understand current environmental issues.

- Connect how people's actions (or lack of) impact the regional water ways including rivers, coastlines and the ocean.
- Form a personal commitment from each student on something they plan to change in their life because of this lesson/experience.
- Adventure on a sailboat in Bahia de Banderas.

Vocabulary/Key Words:

Ecosystem, point source pollution, non-point source pollution, watershed, plankton, salinity, dissolved oxygen, toxic algae, fecal coliform, pH and marine debris.

Materials Needed:
SAILwind will provide all the scientific equipment listed in the module that will be needed and help lead the in-classroom lessons. The only thing teacher/students will need are permission slips. If your school does not have these, please let us know and we can provide a template.

Lesson Introduction:
(This is to be used by teacher to introduce students to the lesson. Teacher can use what is appropriate from below, depending on class/grade, and add whatever else may be beneficial to help fit into a larger educational picture they may be looking to accomplish.)

Bahia de Banderas is Mexico's largest bay and is situated along the Pacific Ocean coastline. The Sierra Madre mountains rise to over 3000 meters above the bay funneling seasonal rainfall down to the bay via three main rivers. Humpback whales migrate to the bay in the winter to mate and give birth. The Marietas Islands sit at the entrance to the bay with numerous marine birds including seagulls, frigates, brown and blue footed boobies, and pelicans. Along the coastline, there are diverse fauna including iguanas, jaguars and crocodiles. The region was founded in the 16th century by the Spanish and Puerto Vallarta is now a densely populated coastline. Tourism, fishing and agriculture are now the economic inputs to the region.

People living by an ocean impact the ocean in many ways. Pleasure activities like surfing, swimming and sailing, along with commercial activities like fishing, development and agriculture, all effect the ocean. To help protect the people and the ocean, there are rules, laws

and management regulations, however pollution and other environmental damage still can happen when these rules and laws are not strong enough or not followed/enforced. Protecting the ocean and all it provides for us (pleasure and commercial) is the responsibility for everyone. This lesson about physical oceanography and water quality, is designed to help students understand some of the science around this coastal ecosystem, while learning how to connect people's actions (or lack of action) to how it can harm an ecosystem.

Pre Trip –In Classroom:
(This list below is a recommended guideline. Teachers can work with SAILwind staff to adjust, add, etc, as needed to fit into a potential larger educational goal.)

- Discuss with class the lesson plan:
    - A combination of pre classroom work, sailing/research trip, post classroom work
    - Read (or paraphrase) the lesson summary
- Review the lesson introduction
- Talk about the objectives
    - Discuss why important to have objectives
- Show map of Bahia de Banderas
    - Show - where trip starts, where school is and/or the student's town, or if visiting where they are staying
    - Discuss - size of the bay, coastal features, islands, beaches, rivers, mountains, development
    - Ask to have students point out a coastal or ocean area/feature they have been to or know about.
- Discuss/show the scientific equipment to be used and what they record or collect. If not physically available, show pics/videos.
    - Salinity using an electrical conductivity (EC) meter, dissolved oxygen (DO) using an electrochemical DO sensor, and pH using a pH meter
    - Explain the collection of water from trip and using a jar test for toxic algae and a membrane filter of .45 microns for fecal coliform testing.

- o Explain the plankton tow/net which is used to capture plankton and microplastics/marine debris, followed by the use of a microscope to look for plankton (phytoplankton and zooplankton) and plastics.
- Discuss conservation and protection
  - o How humans impact nature
- Review what to expect on SAILwind excursion
  - o The organization, the trip plan and what to bring
  - o Have teacher divide class into groups of 4
- Remind the need for permission slips for sailing trip

SAILwind Excursion:
- Brief review of plan for the day - Safety, Science, Sailing, Fun!
- Introduction to SAILwind Crew
- SAILwind Captain and crew will take over and…
  - o Introduce the boat, safety and rules
  - o What SAILwind does and why
  - o Discuss plan for the day:
    - ▪ Leave the harbor, set the sails, look for whales, collect water samples and the plankton tow for in-classroom work, and collect other data (temperature, salinity, DO, pH).
    - ▪ Ask students what they learned/plan to expect - related to todays trip
    - ▪ Ask about conservation/protection ideas
  - o Push off from dock - Let's go play with a purpose!
- Discuss Humpback whales and other species we may see.
  - o Why they are here, for how long, where they go to, explain their activity
  - o Discuss conservation issues and ask about protection ideas.
- Kids are divided into groups of 4.
  - o Each group will rotate among the 4 stations with 30 minutes at each.
    - ▪ Collecting water samples

- ▪ Using the plankton tow

- ▪ Salinity, DO and pH tests

- ▪ Sailing

- On return trip into marina:

  - o Ask each group what they learned, enjoyed, and plan to do to help protect the bay/a species.

  - o Say thanks, goodbye and a group photo

Post Trip – Classroom:

- Review the trip:

  - o Show some pics (hopefully some good whale/wildlife images)

- Divide into the 4 groups

  - ▪ Each group is led to process/analyze the data collected:

    - • Water samples - jar test for toxic algae and a membrane filter of .45 microns for fecal coliform testing

    - • Charting data of temperature, salinity, DO, pH

    - • Using a microscope to look for plankton (phytoplankton and zooplankton) and plastics

    - • Lists as many sailing and ocean terms they can remember

- Review/Discussion:

  - o What did collecting the data help us learn about the physical ocean?

  - o How does the shoreline impact the ocean? (Natural and man-made features)

  - o Why do we need to take care of the ocean?

  - o What could happen if we don't?

  - o What action can you do (each student) to have less of an impact?

Title: "Thar she Blows" - Humpback Whales

Lesson Summary:

Students will take a sailboat trip in Bahia de Banderas and use scientific techniques and equipment to learn about cetaceans, with Humpback whales being the primary species we see on trips. Scientific techniques include visual behavior observation, photo ID, and the use of hydrophones to learn about species in Bahia de Banderas. The photo ID's help to identify individual whales through fluke pigmentation patterns, fluke shape and scarring, which provides for a great post trip in-classroom follow-up lesson. Questions and discussion topics are included to help students understand why scientific research is important and how human actions and behaviors impact marine ecosystems.

Objectives:

- Introduction to cetaceans and the related scientific equipment and methods
- How observation, photo ID's and hydrophones helps to understand a species
- The human vs whale history (include CITES)
- Current threats to cetaceans
- Connect how people's actions (or lack of) impact the bay and the marine life
- A personal commitment from each student on something they plan to change in their life because of this lesson/experience
- Adventure on a sailboat in Bahia de Banderas

Vocabulary/Key Words:

Ecosystem, marine debris, CITES, endangered, threatened, migration, cetacean, acoustics

Materials Needed:
SAILwind will provide all the scientific equipment listed in the module that will be needed and help lead the in-classroom lessons. The only thing teacher/students will need are permission slips. If your school does not have these, please let us know and we can provide a template.

Lesson Introduction:
(This is to be used by teacher to introduce students to the lesson. Teacher can use what is appropriate from below, depending on class/grade, and add whatever else may be beneficial to help fit into a larger educational picture they may be looking to accomplish.)

Bahia de Banderas is Mexico's largest bay and is situated along the Pacific Ocean coastline. The Sierra Madre mountains rise to over 3000 meters above the bay funneling seasonal rainfall down to the bay via three main rivers. Humpback whales migrate to the bay in the winter to mate and give birth. The Marietas Islands sit at the entrance to the bay with numerous marine birds including seagulls, frigates, brown and blue footed boobies, and pelicans. Along the coastline, there are diverse fauna including iguanas, jaguars and crocodiles. The region was founded in the 16th century by the Spanish and Puerto Vallarta is now a densely populated coastline. Tourism, fishing and agriculture are now the economic inputs to the region.

Bahia de Banderas provides a diversified ecosystem for many marine life species. Humpback whales and other marine life migrate to or through this coastal region and due to the physical features of the bay, allows for some great observation of marine life. Human activity has impacted cetaceans in some positive ways and some not so beneficial ways. Whaling almost wiped out a few cetacean populations, but protection from organizations such as CITES (Convention on International Trade in Endangered Species - of Wild Fauna and Flora) has helped increase the number of whales in the oceans. However, people still provide challenges to marine life from fishing gear/entanglement, underwater noise, vessel strikes and habitat impacts. This lesson revolves around marine life in Bahia de Banderas, has a focus on Humpback whales, with students also learning how to connect people's actions (or lack of action) to how it can harm an ecosystem.

Pre Trip – In Classroom:
(This list below is a recommended guideline. Teachers can work with SAILwind staff to adjust, add, etc, as needed to fit into a potential larger educational goal.)

- Discuss with class the lesson plan:
    o A combination of pre classroom work, sailing/research trip, post classroom work

- o Read (or paraphrase) the lesson summary
- Review the lesson introduction
- Talk about the objectives
  - o Discuss why important to have objectives
- Show map of Bahia de Banderas
  - o Show - where trip starts, where school is and/or the student's town, or if visiting where they are staying
  - o Discuss - size of the bay, coastal features, islands, beaches, rivers, mountains, development
  - o Ask to have students point out a coastal or ocean area/feature they have been to or know about.
- Discuss cetaceans
  - o Definition - a marine mammal of the order *Cetacea*; a whale, dolphin, or porpoise (Oxford Dictionary)
  - o Show examples of cetaceans and what species students may see in the bay
  - o Show map of Humpback migration route(s)
  - o Humpback behavior students will watch for on the trip
  - o How photo ID's will be used to identify individual whales through pigmentation patterns, fluke shape and scarring
- Discuss conservation and protection
  - o How humans impact marine life
  - o CITES
  - o Marine Debris
- Review what to expect on SAILwind excursion
  - o The organization, the trip plan and what to bring
  - o Have teacher divide class into groups of 4
- Remind the need for permission slips for sailing trip

SAILwind Excursion:

- Brief review of plan for the day - Safety, Science, Sailing, Fun!

- Introduction to SAILwind Crew

- SAILwind Captain and crew will take over and…

    o Introduce the boat, safety and rules

    o What SAILwind does and why

    o Discuss plan for the day:

        ▪ Leave the harbor, set the sails, look for whales and other marine life, take photos, use hydrophone, review marine life behavior

        ▪ Ask students what they learned/plan to expect - related to todays trip

        ▪ Ask about conservation/protection ideas

    o Push off from dock - Let's go play with a purpose!

- Discuss Humpback whales and other species we may see.

    o Why they are here, for how long, where they migrate, explain their activity

    o Discuss conservation issues and ask about protection ideas

- Kids are divided into groups of four.

    o Each group will rotate among the 4 stations with 30 minutes at each.

        ▪ Hydrophone

        ▪ Photography

        ▪ Behavior

        ▪ Sailing

- On return trip into marina:

    o Ask each group what they learned, enjoyed, and plan to do to help protect the bay or a species.

    o Say thanks, goodbye and a group photo

Post Trip – Classroom:

- Review the trip:

    o Show some general pics of the day

- o Divide into the four groups – each group reviews the trip
  - ▪ Listen to the acoustics – what other sounds besides whales can be heard
  - ▪ Look at photo's and try to match to database
  - ▪ What was some of the marine life behavior students witnessed
  - ▪ Lists as many sailing and ocean terms they can remember

Discussion questions:

- o Why and when are Humpback whales are in the bay?
- o What is the connection between whaling history and conservation?
  - ▪ Why did some whales almost go extinct? And why are they doing better today?
- o How do people and development impact marine life?
  - ▪ How do ships and other vessels impact whale habitat?
- o Why do we need to take care of the ocean?
- o What could happen if we don't?
- o What action can you do (each student) to have less of an impact?

- Review/homework.
  - o Have each student share what they learned from the hands-on experience.
  - o What each student is planning to do or change in their lives to have less of an impact on the ocean.

Title: "Where does that toothbrush go?" - Marine Debris

Lesson Summary:

Students will be assisted by scientific techniques, such as the use of a plankton tow and nets to capture plastics and other human discarded items, to learn about marine debris. Discussion will be facilitated around where marine debris comes from, how it moves into and around the ocean, and how it impacts the ocean and marine life. Post trip lesson includes the use of a microscope to see what plastics etc were collected, combined with an activity trying to ID the debris found on the excursion. Questions and discussion topics are included to help students understand why this research is important and how human actions and behaviors impact marine ecosystems.

Objectives:

- Introduction to marine debris – what is it and where does it come from?
- How does marine debris harm the ocean and marine life?
- What are microplastics and how do they get into the ocean?
- Connect how people's actions (or lack of) impact the bay and the marine life
- A personal commitment from each student on something they plan to change in their life because of this lesson/experience.
- An adventure on a sailboat in Bahia de Banderas.

Vocabulary/Key Words:

 Marine debris, microplastics, trash gyres, ecosystem, watershed

Materials Needed:

SAILwind will provide all the scientific equipment listed in the module that will be needed and help lead the in-classroom lessons. The only thing teacher/students will need are permission slips. If your school does not have these, please let us know and we can provide a template.

Lesson Introduction:

(This is to be used by teacher to introduce students to the lesson. Teacher can use what is appropriate from below, depending on class/grade, and add whatever else may be beneficial to help fit into a larger educational picture they may be looking to accomplish.)

Bahia de Banderas is Mexico's largest bay and is situated along the Pacific Ocean coastline. The Sierra Madre mountains rise to over 3000 meters above the bay funneling seasonal rainfall down to the bay via three main rivers. Humpback whales migrate to the bay in the winter to mate and give birth. The Marietas Islands sit at the entrance to the bay with numerous marine birds including seagulls, frigates, brown and blue footed boobies, and pelicans. Along the coastline, there are diverse fauna including iguanas, jaguars and crocodiles. The region was founded in the 16th century by the Spanish and Puerto Vallarta is now a densely populated coastline. Tourism, fishing and agriculture are now the economic inputs to the region.

People living by an ocean impact the ocean in many ways. Pleasure activities like surfing, swimming and sailing, along with commercial activities like fishing, development and agriculture, all effect the ocean. To help protect the people and the ocean, there are rules, laws and management regulations. However, still pollution and other environmental damage can happen. Protecting the ocean and all it provides for us (pleasure and commercial) is the responsibility for everyone. This lesson about marine debris, is designed to help students learn how and why "peoples trash" enters a coastal ecosystem and how this waste impacts the ecosystem, while learning to connect people's actions (or lack of action) to how they can be harmful.

Pre Trip - Classroom:

(This list below is a recommended guideline. Teachers can work with SAILwind staff to adjust, add, etc, as needed to fit into a potential larger educational goal.)

- Discuss with class the lesson plan:
    - A combination of pre classroom work, sailing/research trip, post classroom work
    - Read (or paraphrase) the lesson summary
- Review the lesson introduction

- Talk about the objectives
    - Discuss why important to have objectives
- Show map of Bahia de Banderas
    - Show - where trip starts, where school is and/or the student's town, or if visiting where they are staying
    - Discuss - size of the bay, coastal features, islands, beaches, rivers, mountains, development
    - Ask to have students point out a coastal or ocean area/feature they have been to or know about.
- Discuss Marine Debris
    - What is marine and debris and where does it come from?
    - What are microplastics?
    - How would scientists collect marine debris?
    - How does debris move around ocean – include gyres
    - How does marine debris impact the ocean, marine life and people?
- Discuss conservation and protection
    - How can humans help?
    - Ideas on what each student can do.
- Review what to expect on SAILwind excursion
    - The organization, the trip plan and what to bring
    - Have teacher divide class into groups of 4
- Remind the need for permission slips for sailing trip

SAILwind Excursion:
- Brief review of plan for the day - Safety, Science, Sailing, Fun!
- Introduction to SAILwind Crew
- SAILwind Captain and crew will take over and…
    - Introduce the boat, safety and rules
    - What SAILwind does and why

- Discuss plan for the day:
    - Leave the harbor, set the sails, look for marine life and marine debris.
    - Ask students what they learned in class and plan to expect - related to todays trip
    - Ask about conservation/protection ideas
- Push off from dock - Let's go play with a purpose!
- Discuss Marine Debris
    - What is marine and debris and where does it come from?
    - What are microplastics?
    - Introduce the plankton tow and capture nets
- Kids are divided into groups of 4.
    - Each group will rotate among the 4 stations with 30 minutes at each.
        - Plankton tow
        - Capture net work
        - Marine species
        - Sailing
- On return trip into marina:
    - Discuss conservation and protection
        - How can humans help?
        - Ideas on what each student can do.
    - Say thanks, goodbye and a group photo

Post Trip – Classroom:
- Review the trip:
    - Show some general pics of the day
    - Divide into the four groups – each group reviews the trip
        - Analysis the plastics/debris collected
            - By eye and microscope
            - Try to ID and categorize all the marine debris found

- What was some of the marine life behavior students witnessed
- Lists as many sailing and ocean terms they can remember

- Review/homework.
  - Have each student share what they learned from the hands-on experience.
  - What each student is planning to do or change in their lives to have less of an impact on the ocean.

Discussion questions:

- What is marine debris?
- What are microplastics?
- Where does marine debris come from?
- How does the shoreline development impact the ocean?
- What did the plankton tow and the nets catch?
- Why do we need to take care of the ocean? What could happen if we don't?
- What action can you do (each student) to have less of an impact?

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