VERMILION SEA INSTITUTE
AVENTUREROS

THE PLASTICS PROJECT HANDBOOK

A youth-centered and co-designed curriculum for realizing environmental change and care.

HOLA!

LAND & WATER ACKNOWLEDGEMENT

The Aventureros live, study, explore, and work as environmental stewards on the Lands and Waters surrounding what is presently known as Bahía de los Ángeles, on the Baja Peninsula in Mexico, these are the traditional homelands of Cochimí Peoples. Our goal is to learn and work in ways that acknowledge and honor these first protectors of the Lands and Waters.

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BACKGROUND: THIS HANDBOOK WAS MADE FOR SHARING

Purpose of the Handbook:

This handbook offers general guidance and inspiration for informal and formal educators looking to engage youth in participatory forms of environmental science education, research, and action. The primary goals of the handbook are to:

- Support youth in conducting participatory environmental science education around an environmental justice issue;
- Provide guiding principles and lab practices for educators interested in taking up community and/or youth participatory science methods;
- Offer a variety of activities designed using the Guiding Learning Principles that can be modified so youth engage youth in consequential and critical thinking;
- Emphasize justice-oriented scientific sensemaking and show how this might be taken up through learning.

General Outline of the Handbook:

The first section offers guiding principles, and lab practices that we have found useful for grounding how our lab works. Following this, there are extensive set of activities that have been designed using the Guiding Learning Principles. Each of these has been written so educators can quickly understand the activity, gain inspiration, and start thinking about how to modify the activity and take it up with youth they are working with. Rather than provide step-by-step directions (as is common in lesson plans), the activities feature educator considerations and discussion questions that nudge learners toward more critical and justice oriented sensemaking.

A Note on Sharing and Material Use:

All of the materials in this handbook were intentionally created as open education resources—meaning everything in the handbook is free to use, tweak, and share broadly. However, the resources created here should not be turned into materials for profit and as it makes sense please give us credit for having developed these activities and supporting material or inspired your own variation. And we ask that you please consider giving back to The Aventureros to support their ongoing work.

Gratitude for NOAA Funding and Support:

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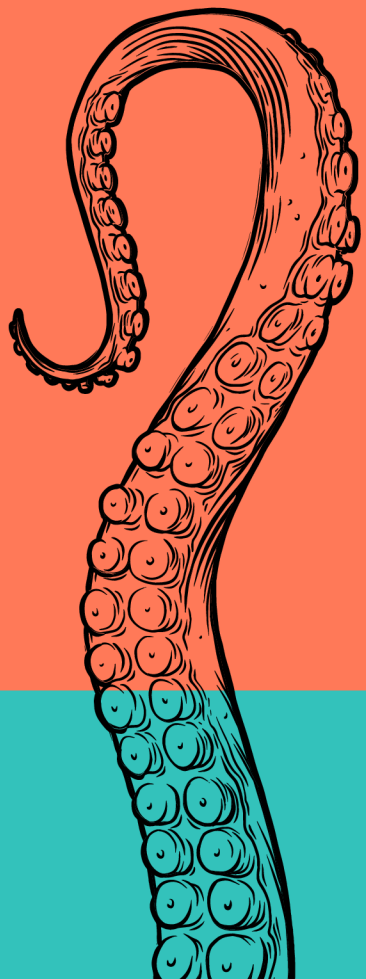

ACTIVITY STRUCTURES

The six activity structures, and their corresponding icon, are used throughout the handbook to indicate various activity structures that youth will engage in. These are intended to help elevate Science and Engineering Practices (SEPS; see Next Generation Science Standards) that are unfolding and educators should be prepared to support or elaborate on. These icons are also designed to help educators select activities and ensure youth are being engaged, and challenged in diverse ways.

Collect, analyze, and interpret data (SEP 4), often using mathematics and computational thinking (SEP 5). This can include adding to and organizing data sets or creating data visualizations and models (SEP 2).

Share with public and scientific community about research by obtaining, evaluating, and communicating information (SEP 8) and presenting explanations and solutions (SEP 6).

Engage in engineering practices (scientific, everyday, or from tinkering/crafting models) to design and build solutions (SEP 6) or lab equipment needed for conducting research.

Discussion of ongoing questions, defining problems (SEP 1), constructing explanations (SEP 6), surfacing tensions or ongoing dilemmas, and engaging in argument (SEP 7).

Record ideas, data, and reflections to capture individual thinking (SEP 1, 2, 3, and 6) or use writing to create new protocols or materials to share with scientific community or public (SEP 8).

Work in groups collaboratively---this requires negotiation, shared labor, clear communication (SEP 8), openness to different ideas and ways of being, and care for one another, and everyone upholding responsibilities.

NGSS CONNECTIONS

The work and learning of the Aventureros, is by nature interdisciplinary--this is what keeps it relevant, and interesting, for the youth involved and community. However, many pieces of what happens in the lab, and community at large, aligns well with the Next Generation Science Standards. Below is a list of some of the main Disciplinary Core Ideas (DCIs) that we frequently attend to. Please note that the lab is intergenerational and spans many grades, so for simplicity we selected high school standards only, but related standards from younger grades could also be mapped onto this list.

Life Science

- LS1.A: Structure and Function
- LS2.C: Ecosystem Dynamics, Functioning and Resilience
- LS4.D: Biodiversity and Humans

Earth and Space Science

- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.E: Biogeology
- ESS3.A: Natural Resources
- ESS3.C: Human Impacts on Earth Systems
- ESS3.D: Global Climate Change

Physics

- PS1.A: Structure and Properties of Matter

Engineering, Technology and

- ETS1.A, B, and C: Defining and Delimiting an Engineering Problem, Developing Possible Solutions, and Optimizing the Design Solution

SCIENCE-ING TOGETHER

We recognize that learning and doing science together well means cultivating a caring and respectful community that holds each other accountable for our shared commitments. Guiding Learning Principles that we co-constructed set the norms that steer our actions and activities, while the collection of Lab Practices maintain these through regular cultural practices. Together these along with The Committee Model, Critical Community Science Tool, and Socio-ecological Minding protocols help maintain our collaborative, caring, and future-oriented commitments to doing science together.

GUIDING LEARNING PRINCIPLES

Thinking Beyond the Plastiocene

Working with youth to study plastic pollution can be heavy emotional work that can quickly become all-consuming and lead to questions about what future we are preparing them for. However, our learning is always future-facing. This means that the focus is on building skills and expertise to, yes reduce plastic pollution, but more importantly develop solutions for issues beyond the plastic problem.

Youth are Experts

Youth know many things and are capable of greatness just as they are. Considering this, we resist using age as an excuse for not understanding or determining participation---Youth of all ages prove their readiness and their readiness, like adults' is constantly in flux.

"Sentipensar"

Contrary to other labs and science educators, we believe scientific work, and learning more broadly, should not be separated from our feelings--often what we do is fun, exciting, scary, depressing, or infuriating. When we think with our heart, or feel with our brain, our work can make a bigger difference.

Better Together & Survive!

Spending time practicing and discussing what it means to be a team, collaborate and do this work safely is not beneath our work---we may argue that it is our work.

LAB PRACTICES

These “Lab Practices” support and help recenter the Guiding Learning Principles throughout our work. These are core Aventureros activities (or rather systems) that help uphold and cultivate the four overarching principles. Each is fluid enough that it can be adapted to meet the needs of the team and day but the structure remains the same to help communicate clear expectations and, over time, allow youth to lead the practices themselves. Below are short descriptions of each of these practices.

Attendance: Youth respond a team chat (which includes guardians) that they will be showing up or participating in activities. They must do this to participate in lab activities. Then, once they arrive at the station they write their name on the white board so attendance can be physically tracked and everyone accounted for.

Check-ins: Everyone circles up to review the plan for the day, share directions and announcements, and give/receive reminders to honor particular lab practices. Most days we go around the lab answering some type of warm-up question. Here are a few...

- What is one thing you have already been amazed by today?
- What are you hoping to do in lab?
- What is something you can’t stop thinking about?
- What is one skill you want to work on during lab today?
- What is one word that describes your current mood?
- What do you need from us to be successful, safe, and welcomed today?

Water & Land Safety: Many of the youth (and all of the adult leaders) have their wilderness first aid certifications. We talk about safety frequently and staying calming and breathing in challenging situations. We also share a motto “Sobrevivir!”---which means survive and this is considered a central tenant of this lab. Additionally, everyone must always use the buddy system and if going off-site, or further than can be communicated with a yell, adults in the lab must know and permission and instruction. A whistle in the water cues everyone to get out of the water immediately.

Throughout the activities in this handbook, youth and adult participants will be playing, learning, and leading outdoors, using sharp tools, and potentially encountering hazardous debris on the shoreline. We encourage you to develop your own expectations and norms for safety in a variety of situations, and having adults or youth leaders supervise any activities that may require it.

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LAB PRACTICES

Grades: Teachers and parents are asked to keep adult educators in the lab updated on school events, youth participation, and grades. Youth who are struggling in school are of course still welcome but cannot participate in field work, boat days, or trips out of the community until their grades and/or school participation improve.

Chefcitos: Meals are together but everyone needs to help cook and help clean. Often 1-3 youth will be assigned (or will ask for) chefcito duty for the day and help prepare the meals. This is a practice of love and care and one of the easiest to enforce. ☺

Gear Checks: Youth are taught (and then teach each other) how to maintain all swim, snorkel, boat, and fieldwork equipment and where to put it. Gear is checked daily when possible. If anyone's gear is not taken care of properly or not put away, the entire group will have a lab meeting, and future opportunities will be greatly constrained/ reduced until gear checks consistently meet the agreed upon standard.

Clean-up: A list of small chores for the lab is posted the last 10-15 minutes of each day and youth either self-select or are randomly assigned tasks to complete. Youth who finish quickly are encouraged to keep helping with the chore list until everything has been cleaned up and signed-off by a lab leader. Similar to gear checks, when expectations are not met opportunities are lost.

Check-outs: At the end of the day youth share reflections on how the activities went. This could be "highs-n-lows", "favorite moments", "most challenging moments", or reflections on what we need to do better. Check-outs are done both verbally and physically through writing.

THE COMMITTEE MODEL

10 minutes to establish committees
Committee worktime varies

Overview: One way to ensure youth voice are driving the lab is to use as frequently as possible “the committee model”. In this approach youth either sign-up or are randomly assigned to a committee to help plan, create, and implement an event or activity that has already been brainstormed by the group. This model for learning is successful because youth are trained to take leadership roles in a setting where their ideas, expertise, and skillsets are used to create real change in this world. Committees help increase participation, engagement, adult community participation, and respect and responsibility beyond the committee work.

Objectives:

- Ensure youth voice and perspectives are guiding what happen at and through the lab.
- Foster a sense of community, belonging, and self-determination through active participation in student committees to design and organize events, ongoing research, and activism.
- Develop teamwork, collaboration, organizational, and problem-solving skills by addressing challenges that arise when working together in student committees.

Materials:

- Committee specific (group created/shared folders and documents, check-lists, etc.)
- Paper and pencils
- Budget and protocol for tracking money and maintaining receipts
- Documentation of each committee (who, what, needs, next steps)
- Varies by event and activity created and implemented

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THE COMMITTEE MODEL

Educator Considerations

- Although youths' interests and preferences should be a central focus, often power and conceptualizations about who is fit to make group decisions leads to youth being told what to do, say, and how to act. However,it is crucial for educators to empower youth committee members by providing them with opportunities to take on leadership roles, make decisions, and contribute their ideas. This can help boost their confidence and sense of ownership.
- Ensure that the youth committee is inclusive and welcoming to all members, regardless of their background, abilities, social popularity or perspectives. Creating a safe and respectful environment is key to fostering collaboration and creativity.
- Guidance youth committee members as they navigate their roles and responsibilities. Providing resources, feedback, and encouragement can help them grow and develop valuable skills.

Tips for running youth committees:

- Have students brainstorm the responsibilities of each committee *before* assigning members to committees.
- Set overall budget for entire event—scaffold further by breaking the total into assigned amounts for different committees. This helps teach budgeting skills.
- For trips away, give each youth 1,000 pesos to use as they want.
- Create a visual anchor chart to show where each committee is at with their planning—include due dates, next steps, and needs from the entire team.
- Save some simple tasks that require no prep for youth who have jobs, homework, sports, or other commitments that prevent them from helping with a committee. This will ensure they still have a role and can contribute to the group. Some of these tasks could include: meal clean-up, helping unpack the van, logging data, carrying research equipment, etc.
- Debrief with committees after each event/activity. Let the group start by talking about what they think went well and why they think that. Then pivot to things that could have gone better. Try to end the debrief with some future-facing goals and gratitudes between committee members—this will help future committee work run more smoothly and youth will learn more quickly from their mistakes.

THE COMMITTEE MODEL

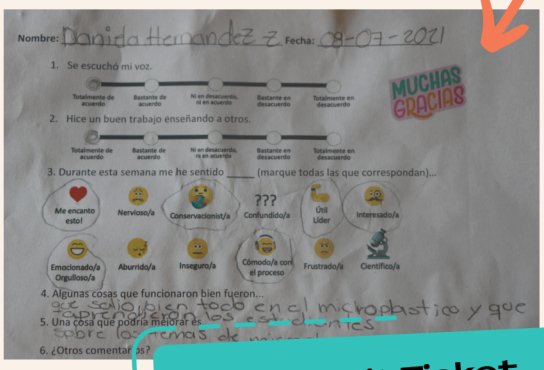
Some Committees That Work Well...

1. **Equipo-equipo:** This committee is responsible for inventorying, packing, and putting away equipment. They are also responsible for safety things like the first aid kit,.
2. **Games:** This group plans a series of games that can be used for various moments or purposes. Sometimes these games will help break the ice with visiting groups, other times these will help with team building, or serve as entertainment on a long drive.
3. **Field Trip Excursions:** This committee is responsible for researching about the place being visited and helps plan sightseeing stops, free-time activities (visit a market, go to movies, visit university campus, etc).
4. **Food:** Sometimes this group is broken into smaller ones, each group should get at least one specific meal.
5. **Presentation:** The entire team brainstorms what should be presented but a small group is responsible for creating the slides or materials that will be used, assigning presentation roles, and making sure everyone is prepared for their part.
6. **Music:** This committee pulls together music recommendations, creates playlists, and helps negotiate what gets airtime.

Discussion Questions:

1. Why are you interested in helping with this?
2. What do you hope to get out of this experience?
3. What are some expectations and rules we want to agree to? What should happen if someone breaks these rules?
4. How will we solve differences to keep our work moving forward?
5. Who has experience doing something like this and what are somethings we should keep in mind as we begin planning?

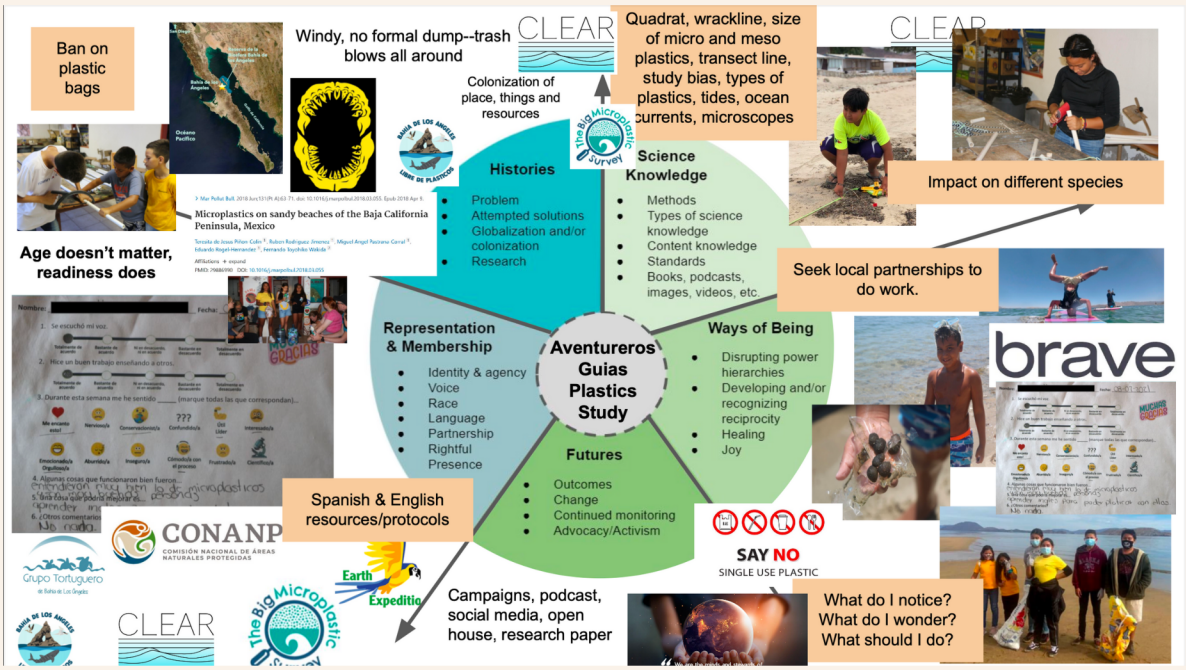
Exit tickets and surveys are a good way at the beginning to get youth feedback on how their committee is functioning--it can feel less risky than an open discussion. With time groups can transition away from this.



Link to Exit Ticket

CRITICAL COMMUNITY SCIENCE TOOL

5-90 minutes



Overview: Scientific research (especially with youth) often oversimplifies sociopolitical and cultural histories and obscures very real tensions and obstacles—making much of the research and scientific work obsolete or inefficient. Using the Critical Community Science Tool (Fowler, 2023) with youth over time can help facilitate difficult conversations among the team, track the group's efforts, and push for improvements that are informed by collective community expertise. The tool asks everyone involved in the research (the Plastics Project in our case) to consider five different dimensions of Critical Community Science and think about how our work is attending to that dimension and how it could improve. Within the context of each of these dimensions, participants discuss what is known, what they wonder, what should be done, and what connections they can make. This discussion can "make visible the complex sociopolitical and cultural connections to places, projects, problems, and science practices at work," (Fowler, 2023). The next two pages offer details, including prompts and considerations for how to use the tool.

Check out this article for a detailed account of how we use the tool and its origins.

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CRITICAL COMMUNITY SCIENCE TOOL

Objectives:

- Develop the ability to facilitate difficult conversations within a team.
- Recognize the importance of considering sociopolitical and cultural histories in scientific research, especially with youth.
- Learn to track group efforts and progress over time.
- Promote a deeper understanding of community and justice-oriented improvements.

Materials:

- Pens, pencils, and/or markers
- Copies of the Critical Community Science Tool or something to write on (post-its, whiteboards, journals, group poster, etc.)

Representation & Membership	Histories	Science Knowledge	Ways of Being	Futures
Consider: -Identities, agency & voice -Involvement and presencing of marginalized communities -Languages & age -Forms & norms of partnership	**Consider:** -Origin of the problem -Attempted solutions -Influence of colonization, consumption, politics, and other systems	**Consider:** -Variety of methods & technologies -Background knowledge -Established standards -References & resources	**Consider:** -Disrupt power hierarchies -Prioritize relationships -Urgency vs. going slow -Wonder, joy, grieving, safety, critical, etc.	**Consider:** -Local & global community goals & impacts -Stewardship & sustainability -Action/Advocacy/Activism
Prompts to ask: -Who in the community is involved or impacted? [Be sure to include more-than-humans (other species or parts of nature) or others often overlooked.] -Who has a voice in designing the project? How? -Name who has locally and globally been working on or influenced what is understood about this topic? -What are the various ways people can contribute? -Who has typically not had power in this community that should? -How is the project designed to disrupt harmful power dynamics between members? -How are partnerships formed and maintained?	**Prompts to ask:** -What is the problem? (at different scales, times, and from different perspectives) -How does this project connect with past ecosystems, peoples, more-than-human life (other species or parts of nature) and/or cultures? -What role has colonization or other systems of oppression played in creating this problem? played? -What would this phenomenon look like if colonization and/or globalization were not a factor? -What systems should be considered?	**Prompts to ask:** -What methods will be used and why? -What technologies will be used and why? -Who are the major scientists and community leaders that have expertise in this area? -Are there global or local solutions or project that can inform this work? -Who has been, or is, working on a similar project? -What standards exist for this type of work? -Who is working on similar problems and what can we learn from their work?	**Prompts to ask:** -What agreements will guide how this project unfolds? -How is the balance between urgency and going slow met? -How can the work be done in decolonizing, Anti-racist and Anti-capitalist ways? -What space is given for connecting with nature and how is this fostered? -Where is there space for wonder? -What opportunities are there to heal and process difficulties that surface? -How is wonder joy, grief, safety, criticality, and solidarity experienced? -Who and what will be a priority?	**Prompts to ask:** -What outcomes are expected? -Is the project sustainable? What needs to happen so that it is sustainable? -How does the project foster community sustainability, health, and futurity? -How will the project support the most at-risk? -How will learnings connect to personal, local, global, and societal interests? -What space is created for imagining and speculating about the future? -Whose futures matter?
Starter references: -Sanchez, 2023 [forthcoming] -Tuck, 2009 -Taylor, 2019 -Calabrese-Barton, 2012	**Starter references:** -Bang & Medin, 2010 -Whyte, 2018 -Liboirin, 2021 -Learning in Places, n.d.	**Starter references:** -Wölfle-Hazard, 2022 -Morales-Doyle & Frausto, 2021 -Arvada, Sanchez & Bell	**Starter references:** -Bang & Marin, 2015 -Wall Kimmerer, 2013 -Ray, 2020 -Puig de Bellacasa, 2017	**Starter references:** -Wallace, Bazzul, Tolbert, & Higgins, 2022 -Mitchell & Chaudhury, 2020 -Tuck & Wang, 2018

(Fowler, 2023)

Educator Considerations:

- This tool helps scaffold the planning of future activities, or methods, provides a structure for inventorying the team's work, and is a generative mid-project reflection prompt.

CRITICAL COMMUNITY SCIENCE TOOL

- While it can be intimidating to discuss whose voices are valued, historic environmental racism, and ways youth's research are reproducing harm, if we want science to be a powerful tool for improving the world well into the future, we need to support youth in making these complex connections and tensions visible. Rather than telling youth what is or is not working, use prompts from the tool's accompanying table to elicit youths' own ideas and support them in more deeply noticing sociopolitical and cultural connections and implications of their work.
- Everyone can contribute to one large tool, or small groups or individuals can create their own and then present out to surface a wider range of ideas. It is helpful to return to the tool at major pivot points in the project and add revisions and updates.

Reference Citation:

- Fowler, K. (2022). The Critical Community Science Tool: A youth-centered approach to designing, evaluating, and maintaining environmental justice projects. Target journal: *Connected Science Learning, 5*(1).

SOCIO-ECOLOGICAL MINDING PROTOCOL

15-90 minutes

Overview: It is important that scientists, including youth, learning to slow down and consider non-dominant or diverse sociopolitical perspectives about what is happening in the field. With practice thinking this way, less unintended harm, improved long-term stewardship of an area, and more sustainable and just ways of doing the work can be fostered. The Socio-ecological Minding Protocol offers educators a guide for facilitating intentional whole-group or small-group reflections that are more critical and will help move the group to be more honest with each other and more meaningful forms of socio-ecological caring. These discussions are designed around critically noticing, perspective-taking, and building collaborative meaning of the shared scientific and activist work.

Objectives:

- Slow down scientific and activist work to engage in critical dialogue with peers to explore the impact of lab practices on the broader scientific community and local community (human and more-than-human).
- Learn that even research done with “the best of intentions” has unintended negative consequences on human-nature relations and reproduce harm and environmental/social violence.
- Analyze current lab practices and events through different perspectives to identify areas for improvement and innovation for human and more-than-human community.
- Demonstrate effective communication skills by actively participating in discussions about the ethical and social implications of scientific research and its relevance to contemporary issues.

Materials:

- Quiet space to talk and reflect
- Snacks are always a good addition
- Quetions to launch the Socio-ecological Minding Protocol

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SOCIO-ECOLOGICAL MINDING

Educator Considerations:

- Often environmental science research and activism is about taking action, making quick decisions, and/or continuing with set scientific procedures. This pace creates harm—some seen and some that remain invisible—to help limit and track this harm, researchers need to reflect on their motivations, methods, and specific impact regularly.

- Youth, and adults, need to be engaged in more "should we" deliberations (Sherry-Wagner, J, Pugh, P., Guevara, C., Rhinehart, A., Bang, M., & Zhou, C., 2021).

Socio-ecological Minding Protocol:

1

Open reflection on activities of the day (e.g., peaks and pits; favorite moments; questions; concerns).

"We keep losing the plastic bowls we process microplastics in".

"It takes a lot of gas to go out to the beach sites---is it worth it?"

2

Focus in on something that was shared that is "messy", doesn't have a clear answer, and relates to the ethics of doing research or activism--it is best if there are already some doubts and tensions surfacing about the topic.

3

Ask students to answer some of the questions designed to cultivate socio-ecological minding. The primary goal is for students to consider unintended consequences, human relations with land, and diverse perspectives.

4

Discuss and determine "what should" be done given the discussion. Sometimes there is nothing that should be done--the reflection is what is most important. Identify if next steps and changing our other work makes sense.

SOCIO-ECOLOGICAL MINDING

Discussion questions relating to our environment and upholding obligations:

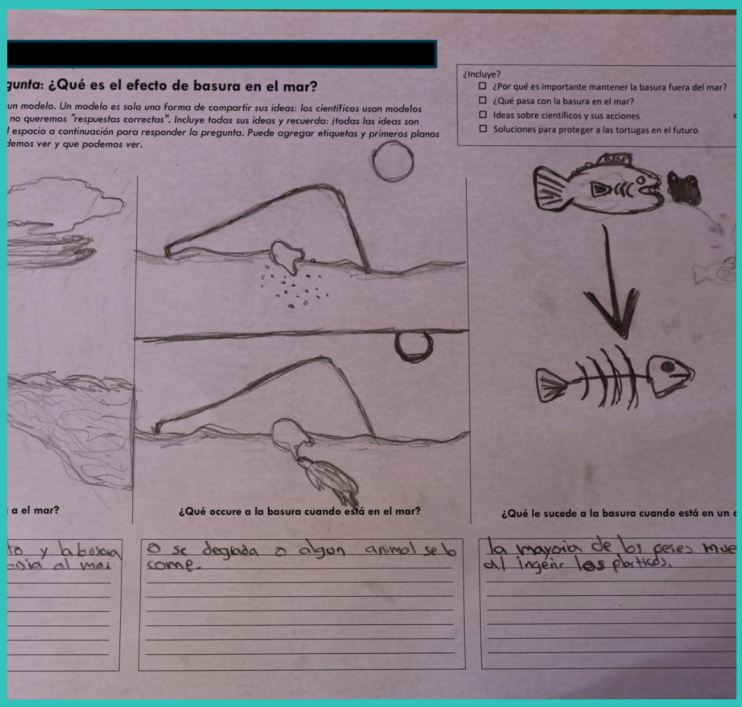
1. What personal and communal relations and obligations do we need to recognize and care about?
2. Who/what is related to this topic? How are we honoring these creatures through our research?
3. How does our learning connect with people, multispecies and places?
4. What other perspectives, including multispecies and other-than-being beings, should be considered?
5. What might [insert part of the environment] tell us to do differently if it could? What should we do differently moving forward?

Questioning our research and activism protocols and actions:

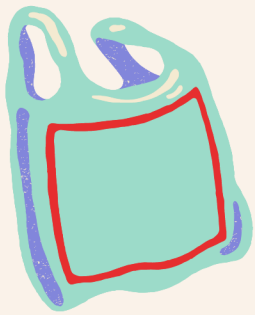
1. What has been overlooked and how are we attending to these "neglected" relations and ways of being?
2. Who are our communities? Are we having the impact on these communities that we should?
3. How are you feeling about our fieldwork? Why?
4. What could better support you in doing this work?
5. What reasons do we have to be hopeful within our research? We can't just go forward without hope, so how could we seed more hope through our research? Should something change?
6. What do you think about leaving some human-made debris in the water (like soda cans) but not everything? How do we decide what to remove and what should stay? Who might be impacted by our good intentions that we can't see? What should we do?
7. What makes fieldwork complicated and messy? What do we do about this?
8. What message are we sending about land and waters when we do investigations on/to them? How can we avoid victimizing nature moving forward while still shining light on ecological destruction?
9. The world is full of mystery, how do we decide which mysteries to try and solve and which should remain unsolved? Are mysteries property and what does this mean for how we conduct our research? What role do the Earth's mysteries play in how we act and engage with nature?
10. When does research "start" or "end"? How might science look differently if we accept that ideas and research are not static? How might we never be done with an inquiry? How might analysis be ongoing?

KNOWING THE PLASTICS PROBLEM

Many of our learning activities were designed to deepen youth understanding of plastic pollution and why it is a problem in their community. Often we tweaked or adapted lessons that are public domain for our own use. Rather than explain how we used these, this module includes five learning activities that begin with learning about what plastic is and where their stuff comes from through the human and environmental impacts it has.



15 PLASTIC CONCEPTS WORTH LEARNING



01. Plastics come from fossil fuels

At the core, plastics are made of fossil fuels through an energy-intensive and pollution- (water, air) heavy process, often in low socioeconomic and minority regions. Throughout their lifecycle plastics have a significant carbon footprint, accounting for 3.5% of global greenhouse gas emissions, and of that, 90% comes from production processes (OECD, 2024).

02. Chemical attributes of plastic

Plastics are hydrophobic, meaning water-hating, and attract other hydrophobic chemical compounds in marine environments. Plastics act as a sponge and a transportation vector for persistent organic pollutants (POPs) like DDT and PCB (Jambeck et al., 2015) and pathogens (Bowley et al., 2020).

03. Lifespan of plastics

Plastics are made of fossil fuels, composed of long carbon chains that are extremely difficult to break. As a result, plastic does not readily degrade and it is difficult to determine rates of degradation due to differences in polymer/chemical compositions and the fairly recent fabrication (~75 years ago) of plastics itself. In marine environments, degradation speed decreases further in habitats with lower UV and colder temperatures, decreased wave action, and changes in both pH and salinity (Hocker et al., 2014; Wadsö and Karlsson, 2013).

04. Pollution rates

Today, we produce over 400 million tonnes of plastic waste annually (UNEP, 2024), with projections to increase in the near term future. It is estimated that 4-15 million tonnes of plastic enters our oceans every year, however, research shows that as production increases, pollution increases at similar rate (Cowger et al., 2024). Plastic accounts of 80% of debris found in the ocean (UNESCO, 2022), making it the most prolific and overwhelming majority of debris we encounter.

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15 PLASTIC CONCEPTS WORTH LEARNING

05. Common types of plastic pollution

Single-use plastic makes up 60-95% of marine plastic pollution. Below are common types of plastic found in the ocean and examples of each:

- Polyethylene terephthalate (PET) - water bottles, packaging
- High-density polyethylene (HDPE) - shampoo, bleach bottles
- Low-density polyethylene (LDPE) - bags, packaging film
- Polypropylene (PP) - chip bags, bottle caps, rope
- Polystyrene (PS) - meat/poultry trays, protective & peanut packaging

06. Pathways to the ocean

It is estimated that only 9% of the plastic produced is recycled (Geyer et al., 2017), and as a result, much of it ends up in waterways via rivers and effluent from coastal populations (Jambeck et al., 2015). In addition to rivers and effluents (e.g. storm water), microplastics can travel via the water cycle, being transported with water molecules to clouds and return to the surface via snow, rain, etc (Bowley et al., 2020).

07. Plastic in the environment

In the ocean, plastics are ubiquitous across global waters, found in surface, pelagic, benthic waters, and substrates. Plastic fragmentation and eventual degradation occur when plastics are exposed to physical and chemical factors like wave action, temperature, wind, UV radiation, salinity, pH, and dissolved oxygen (Andrady, 2017; Wadsö and Karlsson, 2013; Urbanek et al., 2018). It is especially difficult to determine degradation rates due to differences in polymer/chemical compositions and relative newness in human history (~ 75 years!).

08. Microplastics

Microplastics are small plastic particles ranging 1 µm – 5 mm in size. They can either be produced as microplastics or larger plastics can break apart into microplastics over time. Microplastics in the ocean were first documented in 2004. Due to their small size and common presence, microplastics are ingested (drank, eaten, or absorbed) by organisms that live suspended in water columns (i.e., planktivores, detritivores, and carnivores) (Thompson et al., 2004; Wright et al., 2013; Frias et al., 2014; Van Cauwenberghe and Janssen, 2014; Avio et al., 2015; Palmer and Herat, 2021).

15 PLASTIC CONCEPTS WORTH LEARNING

09. Impacts on marine animals

Plastic debris has been shown to impact hundreds of marine species (Gall & Thompson, 2015) in highly varied ways. For example, exposure to plastics has been shown to affect marine organisms mechanically due to the physical structure (Wright et al. 2013) and chemically due to the reactivity of attached toxics (Paul-Pont et al., 2016)—If ingested by marine animals, plastic can cause gut blockages, lacerations, ulcerations, secondary infections, starvation due to a false sense of satiation, and partial or complete digestive system blockages (Laist 1997; Derraik 2002; Stephanis et al., 2013). Plastics may also disrupt organism's endocrine, reproductive, and immune systems, while macroplastics can entangle or trap individuals, destroy habitats, and transport species out of their natural habitat zones among other impacts (Li et al., 2016; Nabi et al., 2022; Gall & Thompson, 2015).

10. Bioplastic, biodegradable plastic, and compostable plastic

Bioplastics are derived from renewable biomass rather than fossil fuels, including veggie fats and oils, corn starch, and woodchips. While this material has the word "bio" in it, not all bioplastics are biodegradable nor do they degrade any more readily than normal plastic.

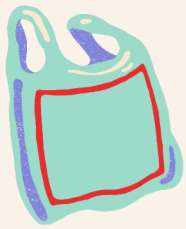
Biodegradable plastics are fossil-fuel based plastics that have been engineered to degrade, often through the addition of chemicals. There is no timeline on the degradation process, and bioplastics can persist in the environment like traditional plastics.

Compostable plastic (e.g. polylactic acid, PLA) is biodegradable, made of plant materials, and will degrade into soil conditioning material in industrial composting environments (EPA 2023).

11. Low recycle rates

Less than 10% of plastic is recycled globally every year. The low recycling rate is in part due to either loss to the environment (millions of tonnes annually) or being transported long distances just to be burned or buried (Geyer et al. 2017). In 2016, waste pickers were responsible for collecting over 50% of total recycled plastic (Lau et al. 2020). Another reason for low recycling rates is the lack of information about the types of plastic, which can decrease quality by mixing waste streams (Leslie et al. 2016).

15 PLASTIC CONCEPTS WORTH LEARNING



12. Recyclability (and downcycling)

Recycled plastic is generally made into items such as furniture, roads, packaging, bottles, and clothing. Generally, plastics that can easily be recycled, such as hard PET or HDPE, can be mechanically recycled (washed, ground, and made into a new product). Conversely, hard-to-recycle plastics, such as LDPE or film can sometimes be chemically recycled (polymer structure is changed and converted). Often, plastic is downcycled, or made into something less structurally strong, and has a finite lifespan on the market.

13. How plastics impact human health

Chemicals can leach from plastic-wares including water bottles, utensils and skin products to enter our bodies. Some of these chemicals are known to be tied to health issues such as endocrine disruption, weight gain, insulin resistance, decreased reproductive health, products. However, little research has been done on the impacts of plastic on human health - much of what we know is based on chemical compositions and impacts on other animals (UNEP, 2024).

14. Policies are pushing plastics out

There is sufficient evidence that policies can lead to reduced plastic production and consumption. For example, implementation of a plastic bag policy leads to a reduction in bag use by 33-96% (Schnurr et al., 2018). In 2019, the Conference of the Parties (UN framework) passed an amendment to the Basel Convention, placing restrictions on the international movements of hazardous waste, including plastic. Extended Producer Responsibility policies are gaining traction and place the responsibility of a product‘s post-consumer stage on the producers (companies) rather than consumers (us). In 2022, 175 nations convened and agreed to adopt the first legally binding global plastic treaty. As of 2024, the UN Environment Programme and International Negotiating Committee is still developing the treaty.

15. How plastic became so prolific

Mass production began after World War II, and plastic quickly replaced heavy, breakable, and expensive items. Industries have grown dependent on plastic, especially plastic films, for its flexibility, durability, and inexpensive price (Sivan, 2011).

STARTER K-12 EDUCATION RESOURCES ON PLASTICS

This handbook is intended to be a guide for supporting youth as they conduct their own research, lead community environmental justice efforts, and become scientist-activists for change. It was not designed to provide K-12 lesson plans about different facets of plastic pollution (although there is inevitably some overlap). Furthermore, it is our experience that there are already many quality (and free!) lesson plans, and activities, that are easily accessible online. If you are looking for resources to educate your learners specifically about plastics (where they come from, how they move globally with currents, different chemical compositions of plastics, etc.), we recommend starting with the curricula and projects bulleted below.

- NOAA, Marine Debris Program Educational Materials: https://marinedebris.noaa.gov/our-work/education/educators
- Monterey Bay Aquarium, Ocean Plastic Pollution: https://www.montereybayaquarium.org/for-educators/educator-professional-development/educator-programs/ocean-plastic-pollution-online-course
- University of Florida, Florida Microplastic Awareness Project K-12 Resources: https://flseagrant.ifas.ufl.edu/microplastics/k-12-resources/
- Ocean Wise, Ocean Plastic Education Kit: https://ocean.org/action/ocean-plastic-education-kit/
- UN, Marine Plastic Debris and Microplastics: Global Lessons: https://wedocs.unep.org/handle/20.500.11822/7720;jsessionid=23BBF18923D4400748F238241AA464A7

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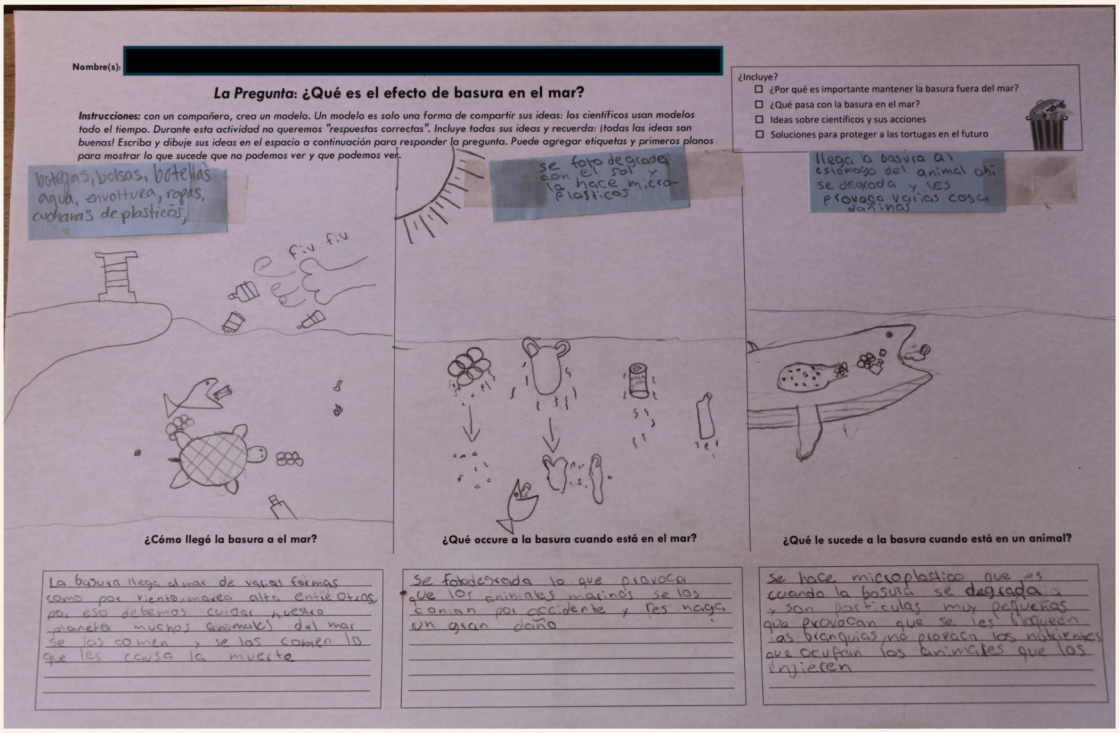
MODELING THE PROBLEM

30 minutes



Overview: In this activity, youth will draw, label, describe, and verbally share their current thinking on the big question of "What is the effect of plastic trash in the ocean?"

Objectives:

- Develop a scientific model and explanation to represent initial ideas, prior knowledge, and connections to the plastics problem and share their current thinking on the big question of "What is the effect of plastic pollution in the ocean?".
- Learn and use different modes to more fully represent scientific thinking (e.g. drawing, writing, labels, visual representations, gesturing, verbal descriptions).

Materials:

- Copies of model template for each youth, or pairs of youth
- Pencils and colored pencils

Educator Considerations:

- Developing and using models is a best practice for supporting sense-making that helps youth predict and explain phenomena, makes their thinking visible, and allows them to monitor their own progress toward deep understanding of a set of ideas. The goal is not to evaluate or assess initial thinking, but to create a practice of openly sharing thinking and taking intellectual risks.

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MODELING THE PROBLEM

More Educator Considerations:

- Often scientific models with youth can be void of meaningful phenomenon or prompts. Rather than skirt consequential (and often political) topics (species endangerment, climate change, human depletion of resources, more than human and human relations, etc.) prompt youth to wrestle with these topics explicitly and express their thinking.
- Although there are many types of models used in science—graphs, equations, computer simulations, physical replicas, charts, etc.—pictorial models are unique in that they require students to create their own images to explain what is happening and why (Windschitl, Thompson & Braaten, 2018).
- Keep an eye on how you push for evidence of learning and connections yet honor multiple ways of knowing and being in nature and in the world. What does it look like to accept multiple truths?
- Before prompting youth to model their ideas, ask them if they have ever seen marine plastic pollution before and to share a bit about what they've seen. After hearing some initial ideas tell youth that they are "going to model their current ideas about plastic pollution and marine debris, which is something scientists frequently do to capture their thoughts and questions". Be sure to encourage youth to add as much detail as they can and questions—tell them explicitly this is not about correct ideas and that all thinking is welcome (Windschitl, Thompson & Braaten, 2018).
- Give youth a chance to share with each other and the whole group their models when they are done—often times youth teach each other a lot of important ideas during this time—which helps cultivate a more collaborative sensemaking environment across the lab group.

General Questions To Ask Youth During Modeling:

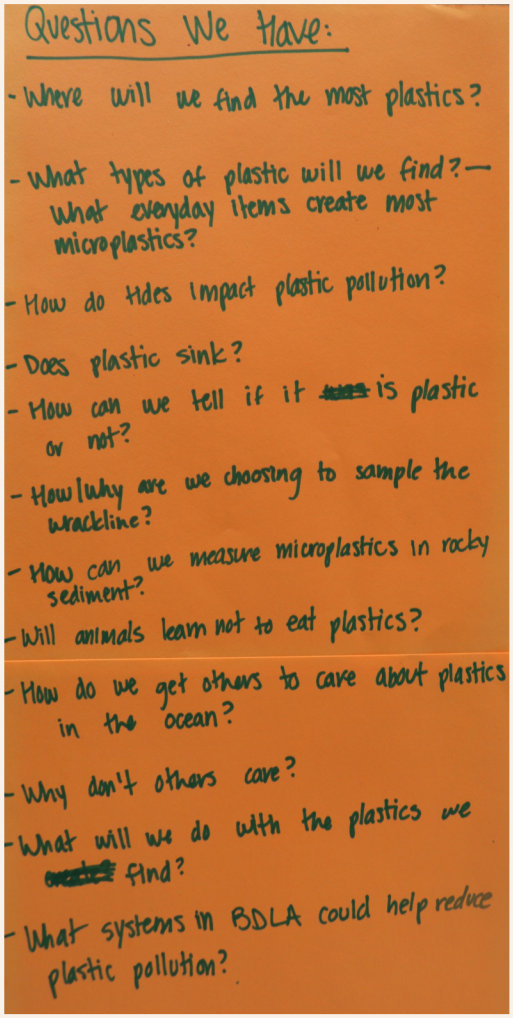
1. Can you tell me about what you are adding to your model?
2. I see you adding an idea about ____,
3. What are some different ways you could show that idea? 4. Oh, that's an interesting question–add that!
4. Can you give me an example? Have you see this out in the bay or ocean?
5. Why do you think that is happening?
6. Can you add a key to help us understand what you are drawing?
7. Can you say more?
8. Does this remind you of anything?
9. Okay, so what should humans do if they know this is true?
10. What might happen next?
11. It's okay to guess--what do you think is _____?

MODELING THE PROBLEM

Different Formats for Modeling:

- Whole group/team collaboratively creates one large model. This is done through numerous conversations or by allowing students to volunteer to add ideas as they come up.
- Small groups create models and share with each other.
- Individuals create models.
- Models are created individually or in small groups and then a whole group/team model is negotiated.
- Final models can always be painted, printed, or photographed and shared with larger community to teach others about the topic.

Record Ideas Shared Through Modeling:
Keep a list of the questions youth in the lab share through their modeling and discussion. Add and modify this list over time. This helps set a tone that thinking changes with new experiences and learning and that modeling and discussing hypotheses and what is known is a common scientific practice--having a "wrong" or different way of thinking about a problem should be welcomed.

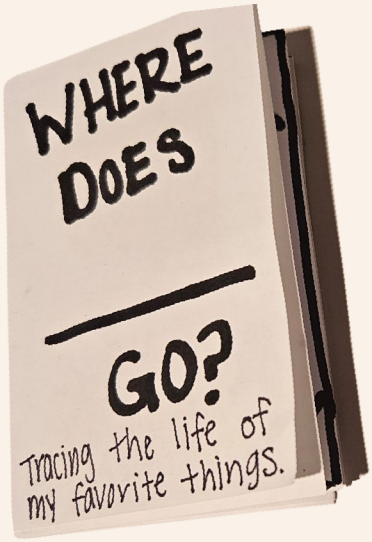


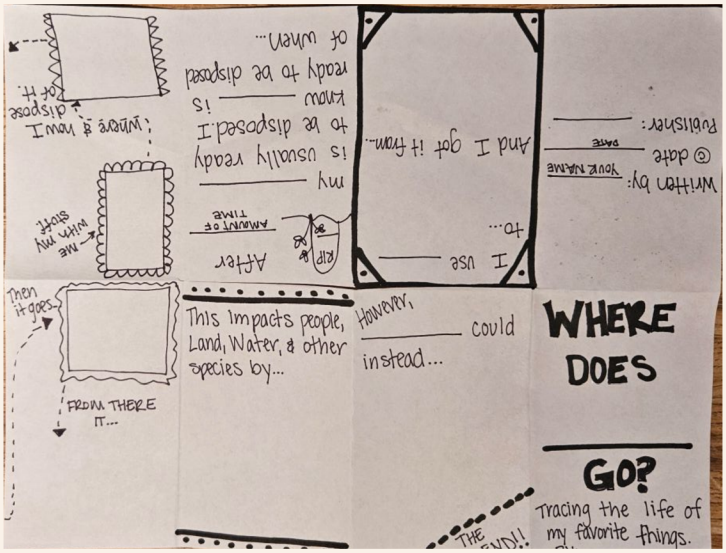
Resources for Learning More about Modeling:

- Windschitl, M., Thompson, J. & Braaten, M. (2018). Ambitious Science Teaching. Cambridge, MA: Harvard Education Press. [Check out accompanying website: https://ambitiousscienceteaching.org]
- Fowler, K., Windschitl, M. & Auning, C. (2020). A layered approach to modeling: Creating scaffolds that allow all students to show more of what they know. Science Teacher. NSTA.
- Wingert, K., Wagner, M., Shouse, M., Spodaryk, S., & Chowning, J. (2015). What is meant by engaging youth in scientific modeling? STEM Teaching Tool [website]. https://stemteachingtools.org/brief/8
- Passmore, C., Schwarz, C., & Mankowski, J. (2017). Developing and Using Models. In C. Schwarz, C.
- Passmore, & B. Reiser (Eds.), Helping Students Make Sense of the World Using Next Generation Science and Engineering Practices.Arlington, VA: NSTA Press.

WHERE DOES YOUR WASTE GO?

60+ minutes





Overview: Understanding where our waste goes and considering the impacts of how it is disposed of is an important step in disrupting patterns of overconsumption and poor waste management. The goal is for youth to think and learn about waste in terms of what is largely invisible to them and create a single-page zine showing their understanding of this.

Objectives:

- Investigate where different waste items go in your own community and learn what happens to those items once there.

Materials:

-Copies of zine template and directions to make zine from scratch for each youth, or pairs of youth.
-Pencils and colored pencils
-Waste experts or workers in the community to help answer questions

Educator Considerations:

- Often time the roots of violence and destruction that happens to communities and the environment around us is largely invisible, as you support youth in engaging in this activity prompt them to think about why it is important to shed light on unseen parts of systems. Draw comparisons between waste systems and other societal systems.
- Do some pre-research to be sure you have some general resources and information to help youth trace their waste and where it goes---consider experts and community members who can be guests during this activity.

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WASTE SORTING STATION

60 minutes to setup the station

Ongoing maintenance and engagement

Overview: Although this activity focuses on youth learning to use a waste sorting center, which seems simple, youth are also tasked with helping design and install a waste sorting station in the middle of the field station that everyone can use. This station supports their ongoing monitoring of waste disposal, and reporting and analyzing data on waste.

Objectives:

- Learn how to handle waste correctly and demonstrate commitment to waste management systems through daily sorting actions.
- Create space to normalize discussions on waste, life cycles, and visitor impacts.
- Transparently report waste findings to engage visitors and residents on how to handle waste and options available.

Materials:

Varies depending on local/municipal waste sorting practices, but the following are helpful:

- 3-5 bins or containers for different types of waste (trash, plastic, glass, aluminum, etc)
- Signs for each different type of waste
- Newton or step-on scale to weigh waste at designated intervals
- White board & markers to continuously update waste data for everyone to see

Educator Considerations:

- Weighing waste can be tedious and is best done at regular intervals - often weekly, monthly, or after an event are easiest to work into ongoing conversations.
- Each category of waste should be represented on the visualization board in addition to a graph - bar charts or pie graphs work well - to help with reporting, engaging, and interpreting.

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WASTE SORTING STATION

Educator Considerations:

- The waste sorting station data and visualizations can be paired with the data fluency portion of this handbook for accuracy and trouble-shooting (in case numbers are erased from the board accidentally).
- Facilitate a discussion around the waste sorting center and draw a link between waste, where it comes from, where it ends up (where does it go if there is no recycling in town?), and visitor impacts on the community.

Discussion Questions:

1. How is this system similar or different than others you have seen?
2. What are some ways that the waste sorting station works well? Why?
3. What are some ways that the waste sorting station is not ideal? Are there ways we could improve it?
4. What do you notice about how much there is of different types of waste? What can we conclude from this data?
5. How are you thinking differently about your waste and what you consume after having spent time using the waste sorting station?
6. What has the impact of the waste sorting station had on your own habits?
7. How might we redesign the waste sorting station to help people understand the pitfalls of recycling?
8. How would we need to tweak this system for your school or home? Think about how the users of systems dictate if a system works or not---and how efficiently?
9. Select one item from the waste sorting station and learn about its life cycle---where did it come from, how did it get here, and what are some options for what might happen to it?

DOING MARINE PLASTICS RESEARCH

In this module, we share our protocols, blueprints for lab-created equipment, and tools we have created while learning to study plastic pollution around our community. Several of these protocols are official, global protocols that we use, others are protocols that are in the process of being refined and tested but in all cases, we share approaches and tips for conducting viable, large-scale fieldwork with youth.

NOAA MARNE DEBRIS SHORELINE SURVEY

30 minutes prep

40 minutes survey & clean up

Overview: Use the NOAA Marine Debris Monitoring Shoreline Survey Guide as a baseline for monitoring beach sites for all types of beach debris pollution. Unlike other resources in this booklet, this guide provides detailed suggestions for how to scaffold the survey so youth can lead community participants (parents, friends, visiting scientists, and other adults in the community, etc) through the survey.

Educator Considerations:

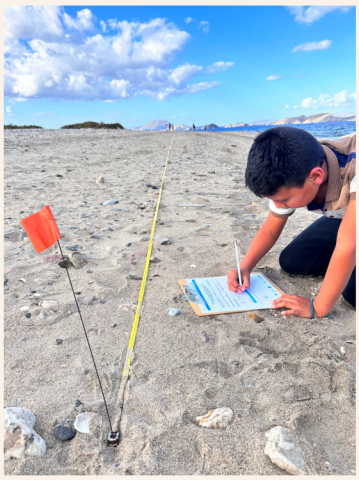
- It is important to prepare youth for conducting and leading this survey *before* getting out to the beach because even the most experienced groups (adults included) can struggle to organize and structure themselves under the beating sun, wind, crashing waves, and activity excitement. Be sure to mentally walk through the activity as an adult educator, youth leader, and visitor from start (selecting a beach and time for the survey) to finish (communicating to the community about what was found)—this will help you catch gaps in your plan.
- Although collecting viable and accurate data is the priority of this activity, be sure to plan for cultivating wonder and curiosity about shoreline and having fun. ☺

NOAA MARINE DEBRIS SHORELINE SURVEY

Materials:

- 1 copy of the NOAA Marine Debris Shoreline Survey Field Guide
- Day of survey educator guide
- GPS unit
- Newton scale
- Per 100m shoreline site:
  - Measuring device (surveyors measuring wheel or measuring tape
  - Transect markers (at least 4)
  - Reusable bags to collect waste
  - Water & snacks
  - First aid
- Per transect section:
  - Ruler
  - Camera device
  - Clipboard
  - Datasheets: Survey Cover Sheet, Shoreline Characterization and Debris Density Data Sheet
  - Pencils/writing device
  - Eco-trampa
- Laptop or internet access and files to record data digitally
- NOAA has a lot of educational resources available for supporting this work: https://marinedebris.noaa.gov/our-work/education/educators

Additional resources on survey protocol can be found here: https://marinedebris.noaa.gov/monitoring/marine-debris-monitoring-and-assessment-project



NOAA MARINE DEBRIS SHORELINE SURVEY

PREPARATION

- Review NOAA protocol with youth
  - Do a “dry run” but sped-up to make sure youth know the methods
  - Play a review game to revisit the methods and protocol vocabulary
  - (re)Watch video about protocol
- Identify roles for youth leaders (can be self-selected, randomly assigned or assigned by educator)
  - Generate random number for sub-surveys to start from (each number is a color)
  - Take attendance and choose different roles (this will vary by attendance numbers, could have 2 different transects running at same time)
- Roles:
  - Speaker: Gives introduction, thank you and helps run games
  - Photographer: Look over the photo instructions in the NOAA Marine Debris Shoreline Survey Guide—at a minimum, be sure to take photos of site, people and any interesting trash or other things
  - Transect Markers: set up 100m and mark the 4 transects
  - Site Journalist: Record information about site generally
  - Transect Blue (___-___m): survey for marine debris and records data
  - Transect Orange (__-__m): survey for marine debris and records data
  - Transect Green (___-___m): survey for marine debris and records data
  - Transect Purple (___-___m): survey for marine debris and records data
  - Trash Pick-Up Leaders: Check that people are putting debris in correct container and make sure no one enters the survey area
- Check team materials
- Have a plan for the trash collected—where will it get sorted and processed? If not on the beach site, who will transport the trash?

Event Introduction (given by Speaker role(s) to whole crowd)

- Thank you for coming!
- Where are we, any information about the site, why are we surveying and cleaning this site, what are we expecting to find, why is doing this important.
- Big circle with introductions if there is a partner group and/or adults there [name and ___(favorite animal, super power, food, place in town, etc.)].
- Go over different roles (this will vary by attendance numbers).
- Ask that everyone gather their materials/equipment and walk out to meet you to start the transect (this should not be too far away, the closer the better).

NOAA MARINE DEBRIS SHORELINE SURVEY

CONDUCTING THE SURVEY

There are four aspects to each survey:

1. Metadata and site characterization
2. Survey transects (4x in 100m) and item characterization
3. Collect ALL trash in 100m shoreline site
4. Record marine debris survey data on computer

1. Metadata and site characterization

- **Site journalist** characterize the site with the group and the records the information on the datasheets.
- **Shoreline Site** measure a 100m survey parallel to the water
  - Take GPS coordinates of the 4 corners of the survey area.
- **Transect markers** mark the 4 transects (choosen randomly with sub-survey)
  - Each transect is 5m wide (e.g. if "60m" is the sub-survey number, mark 60m and 65m) and extends from the water to a back barrier.
  - Complete pages 1-3 (Survey cover sheet and Shoreline characterization).

2. Survey transects and item characterization

- **Transect Teams** go to designated 5m section and draw boundary in the sand from the marked transect all the way to the ocean and up to back barrier, marking 2m into the barrier.
  - Walk the length and width of each transect, recording and collecting marine debris items LARGER than 2.5mm within the transect.
- **Photographer** takes photos of 100m, interesting or typical marine debris you find, and people doing surveying and other interesting things.

3. Do a whole beach clean

- **Trash Pick-up Leaders** help organize everyone into small groups of 3-5 people with 1 eco-trampa (described on pg. 80-81), 1 bag for plastics, 1 bag for other recycling, and 1 bag for trash to dump (may change depending on local infrastructure).
- Everyone helps do a beach sweep, collecting all debris and sorting.
- Place bags by designated signs by vans/boats/vehicles.
- **Photographer** takes pictures of all bags together and any interesting trash.
- **Weigh and record sorted debris**
  - Tare the Newton scale
  - Weigh each type of debris collected and record on the data sheets.

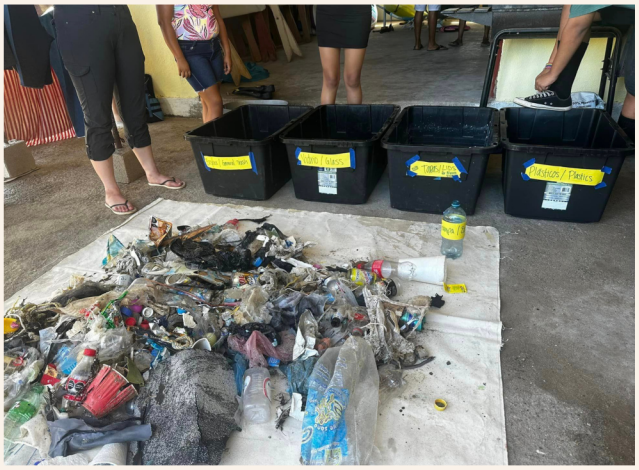
4. Record marine debris survey data on computer

- Hard copy - Each site completes a hardcopy of data sheets and stores them in a folder for each site
- Electronic - Upload photos and data sheets to online folder
- NOAA - Enter data into NOAA's database: https://mdmap.orr.noaa.gov/login

NOAA MARINE DEBRIS SHORELINE SURVEY

POST SURVEY DATA

- Double check all of the data has been recorded clearly and then sort and process trash found using the most sustainable waste management options the community has to offer.
- Dispose of waste in respective bins/waste centers, depending on your location.



Post-Survey Discussion Questions:

1. What do you notice about what we collected?
2. What do you wonder?
3. Were you surprised by anything we found (or didn't find)?
4. What should we do with this data? Should this data change our other plastic pollution research or activism efforts?
5. What new questions do we have?
6. What about how we lead the survey needs to be improved or changed for next, and why?

Extension Opportunities:

Host a lunch or post-survey party where part of the time participants can help enter data into the NOAA database and discuss the findings all together. The other part of the time can be used for games, learning about marine life, watching a movie, or going for a hike.

MICROPLASTICS PROTOCOL

30 minutes prep
15 minute survey
15-45 minute analysis & documentation

To read more about how we studied microplastics check out this blog post on Just One Ocean about our work.

Overview: Use the Big Microplastic Survey to collect data about the types of quantities of microplastics on sandy beaches. Similar to the other protocols, this guide provides detailed suggestions for how to support youth in conducting this protocol and leading community members (parents, friends, and other adults) and visiting scientists through their process for understanding local marine microplastic pollution.

Materials:

- Keep a log of all the Microplastic surveys
- Microplastic Raw Survey Spreadsheet
- 1 Bucket per transect survey
  - 1 Measuring tape
  - 1 Quadrat, PVC
  - 5 Cups
  - 5 Square frames, 10cm2
  - 5 Spoons
  - 1 Kitchen sieve
  - 1 Sample storage container
  - 1 Mesh bag for larger plastics
  - 1 Spanish/English Collection Protocol
- Labeled containers for sorting meso and macroplastics found on beach so they can be best disposed of
- Microscope
- Tweezers
- Sample jars
- Tape for labeling samples
- 1 Permanent Marker
- Lab table with good light

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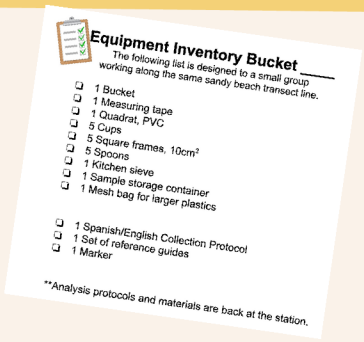
MICROPLASTICS PROTOCOL

Educator Considerations:

- With all of these research survey protocols (including this one), the goal is to support youth in being as autonomous as possible. Citizen science and other step-by-step research procedures often leave participants feeling undervalued, without any clear idea of what the findings are or what comes after data collection. It is essential to disrupt this! Below are some tips on scaffolding any field research procedures.

Turn protocol into a checklist with visual scaffolds. Print on colorful paper, laminate and hook together on a metal ring.



Occasionally do a "dry run" by walking through each step in fastforward and then pausing when the team needs to talk through challenges or mistakes, hypotheses, etc.

If there are at least 8 youth present, run 2-3 different transects. Each transect is a different survey and conducted by a different team--assign these team a color (green, purple, blue, and orange) that matches the colorful tape on each bucket. That team is then responsible for that bucket and all of the tape-marked pieces of equipment in it. This makes it easy to track equipment and help teams stay accountable for their research equipment.

Lunch, paletas, or smoothies make great snacks for analyzing samples--food and thinking tends to have a calming effect after hot field work.

Place sample jars out where lots of people in the lab will see them and think about them.

MICROPLASTICS PROTOCOL

Post-Survey Discussion Questions:

1. What observations did we make from what we collected during the survey?
2. What questions or curiosities arose during the survey that we could explore further?
3. Did anything unexpected come up from the survey findings, or were there any surprising absences?
4. How can we utilize this data effectively, and should it impact our future research on plastic pollution?
5. What additional inquiries or areas of study have emerged as a result of this survey?
6. Who was in a leadership role and how did this go? Feedback for leaders?
7. What is something we need to work on as a group during the next microplastic survey?

MANTA TRAWL

30 minutes prep

15 minutes survey

45 minutes analysis and documentation

Overview: Marine debris in the water (ocean, rivers, lakes) can be difficult to measure due to equipment and resource needs. Manta trawls are nets designed to collect particles by skimming along the water surface, often pulled by a vessel. Manta trawls can be engineered in classrooms and outdoor settings and deployed in nearly any body of water. This tool allows researchers to quickly and passively sample large volumes of surface water.

Objectives:

- Become familiar with a manta trawl and comfortable deploying one from a boat, stand up paddle board, kayak, or other vessel.
- Learn how collect and assess quantity and concentration of debris from surface waters.

Materials:

- Manta trawls can be engineered by youth following our guidelines on page 69 (also thanks to CLEAR for sharing their process doing this!)
- Stand up paddle board, kayak, boat, or other vessel
- Clipboard and data sheet
- GPS unit
- Metal sieve
- Spray bottle
- Reusable bags to collect waste

MANTA TRAWL

Educator Considerations:

- First and foremost, it is essential to slowdown when using this Manta Trawl or another—many there can be many unintended consequences of using this equipment and it is important to name what those are and think together about how to mitigate harm, or even if this protocol should be done given the context, environment, and purpose. Come up with a plan for reducing harm if you go forward with this protocol alongside youth—ethical conversations like this should become normalized as part of the work of field scientists.
- Although deploying the manta trawl is the priority of this activity, be sure to plan for cultivating wonder and curiosity about open waters and having fun. Ask for hypotheses of what and how much the manta trawl will collect and why--it is essential that youth are making sense of this experience and engaging in the data and process unfolding to deepen their own sensemaking and increase their connection to the place(s) the trawl occurs.
- Different types of debris occupy surface, beach, and sediment samples. Encourage youth to question why they are seeing specific types of plastic in surface samples yet not in other habitats.
- For the purposes of youth research and exploration, it may be beneficial to select a manta net with a larger mesh size. This will reduce the amount of algae and zooplankton present in the sample, leaving just larger macro-debris in the net.
- It is important to prepare youth for deploying the manta trawl and collecting data *before* getting out on the water because even the most experienced groups (adults included) can struggle to organize and structure themselves under the beating sun, wind, crashing waves, and activity excitement.

Deploying the manta trawl and collecting data:

1. Record measurements of manta trawl opening, mesh size, speed, start time, and GPS location before deploying the manta trawl.
2. Trawls should be deployed off the side of the vessel, keeping away from the wake and any other vessel-created water turbulence that may interfere with the collection process.
3. Ensure the manta trawl is secured to the vessel and not creating any safety issues.
4. Start moving forward at a slow speed, no higher than 3 knots.
5. Upon stopping, record time and GPS location. Double check speed recording.
6. Pull manta trawl out of the water, spray mesh with water from a spray bottle, pointing down to the cod end. Continue until all visible debris/algae is in the cod end.
7. Dump the cod end into the metal sieve. Continue spraying with water from a spray bottle.
8. Identify macro-debris and record all data.
9. Conduct multiple short trawls rather than one longer trawl.
10. Calculate the amount of debris per volume of water sampled. If multiple samples were taken, calculate the average concentration.

MANTA TRAWL

Discussion Questions:

1. Things can go wrong in the field and we can make an impact that we didn't intend. What are some risks of using a manta trawl? In what ways might this harm the species around us and their habitat? Are there other ways using this protocol might effect us or what is around us?
2. How can we mitigate (or reduce) these potential impacts?
3. Should we use the manta trawl? Why, what is our purpose? Is this purpose good enough?
4. What types of debris were identified? Are there specific types of debris we expect to find in surface samples? How may these differ from other habitats?
5. Why do some types of debris stay at the surface?
6. What are possible methods for plastics to sink or end up on shorelines? What about the opposite - what are possible methods for plastics to end up in surface waters?
7. How might results change if we increase or decrease the collection speed? What about mesh size?
8. What did we figure out? Are there next steps we should take?
9. How might we use the manta trawl differently in the future?
10. Manta trawls can be very expensive, but ours we created from mostly upcycled trash, how does this make you feel? What do you think about lab equipment built from upcycled materials?
11. How might this experience of designing and building our own trawl change how we think about what else is possible in the lab? What else might we try designing and building?

HAMBURGER SAFARI

25 minutes and eating together

Overview: This research protocol does not require going out to field sites. Instead hamburgers, burritos, or another comparable meal option is ordered from local food vendors “to go”. Youth then work in small groups to separate the food (including sauces) from the packaging. All packaging materials are weighed and recorded for comparison between vendors. Conducting the Hamburger Safari protocol several times over a year or more, helps track how restaurants are responding to efforts to reduce single-use plastics. The best part of this protocol is it concludes with everyone enjoying the food together!

Materials:

- Food orders
- Digital scale
- Soap and water for cleaning Hands and dishes
- Gloves for handling food
- Index cards & pens
- Digital database for recording weights of packaging materials

Educator Considerations:

- Like most lab activities, this one can easily be done in mixed aged groups--while older youth can lead small teams, younger participants should be supported in learning to use the digital scale, different types of packaging materials, and how to accurately round and record data that includes decimals.
- Be sure to talk with youth about the results and what to do with the data after eating!

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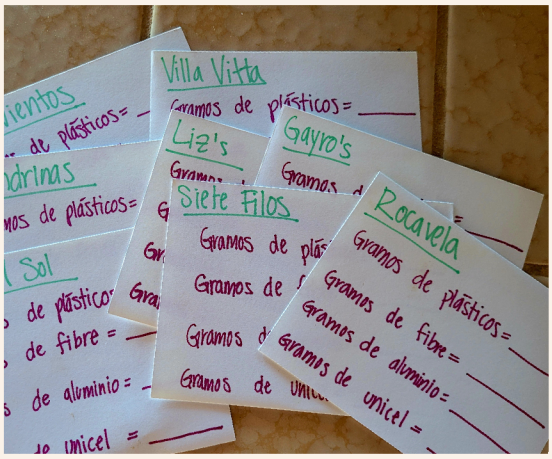
HAMBURGER SAFARI



Discussion Questions:

For this conversation, place all of the data index cards where youth can see and reference them (e.g. posted on a board with tacks or the center of a table). Ideally the index cards can be moved around during the discussion.

1. What do you notice about our data? Any patterns jump out at you?
2. How does this data compare to the last time we did this? Why do you think ___ changed?
3. Let's arrange the index cards by the trend we think is most obvious and important for us to talk about. (Move cards into an order or groups.)
4. Identify any "problems" or concerns in the data. Discuss these and what might be done with the data.
5. What can we do with this information? What *should* we do with this information and why might what we *should* do be different than what we can do?
6. What conclusions should we report out to the community or individual restaurant owners? Why? What are intended and unintended consequences of reporting this data?

For a deeper dive into the protocol check out the NOAA Marine Debris Program where you can find our guest blog, Hamburger Safari: Youth Scientists Document and Devour Data.

Extension Opportunities:

- Create a social media post celebrating the food vendor with the least plastic packaging and be sure to tag the vendor.
- Share trends and data back with participating food vendors--provide information or ideas for food vendors to reduce their use of plastic. Be sure to discuss with youth how to do this is in kind, non-problematic ways.
- Create a social media badge that restaurants can work towards earning to incentivize reducing plastic single-use plastic materials in their to-go orders. Publicize this badge and create a clear system for evaluating restaurants.

DESERT CLEANS

(RELAYS, POINT A TO B, & BINGO)

10-60 minutes (varies)

Materials:

- Mesh bags for trash clean-up
- Scale
- Database to track trash collected (we recommend recording at least the weight)
- Varies based on protocol used but could include: notebook, paper, BINGO card, measuring tape, GPS Tracker, music and speaker

Discussion Questions:

1. What might we expect to find in this stretch of desert and why? How much are we expecting? What evidence is backing up our hypotheses?
2. Did we find what we expected to find? Why or why not?
3. What types of trash did we find? Any patterns that you noticed?
4. How will you describe what we found today to someone in your family or in the community? What is the most important information the town knows about trash in this area?
5. Should this new data change anything we are doing to reduce plastic pollution?

Overview: Trash that is near shorelines (in our case in the desert) can easily be blown onto beaches or into the ocean and Desert Cleans can help prevent this. In this resource, we offer three different ways of facilitating a Desert Clean that are low-prep, can be quick, but also accumulate a lot of important data.

Educator Considerations:
Youth should scout out locations for desert cleans and deliberate about which sites should be prioritized for cleaning and why (most trash, most remote, close to turtle nesting sites, in public view, near ecotourist site, near water aquifer, etc.) Be sure to ask for permission from the proper community members before engaging in a desert clean—this requires talking with private land or business owners. Also, invite them to join in caring for their land!

Desert cleans could be protocol and material-intensive (there are lots of options for this!) but we intentionally keep these light to quickly steward an area and have fun while doing it. A secondary goal should be guiding students to make sense of the data they are collecting/noticing and connecting this with what they are noticing in other areas of the research.

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DESERT CLEANS

(RELAYS, POINT A TO B, & BINGO)

Desert Clean Relays (good for large open area with lots of macro-plastics and a lot of variety in the trash)

1. Divide everyone into teams of 4-6, except for "the boss".
2. Have everyone start at a single point and explain that there will be X number of rounds where one person from the team will run out to find the item asked for by the boss and bring it back. As soon as someone is back, the boss will announce the next item. This will continue until all of the rounds have been completed. (We recommend each person on the team goes 2 or 3 times, so the total of rounds would be 8-18).
3. The team to complete all of the relay rounds first and make the boss happy wins!
4. Optional: sort, weigh, and record litter at the end.

Potential items the boss could request...

- Something round
- Something blue
- Something with writing, or letters, on it
- A food wrapper
- Something bigger than a water bottle
- A water bottle
- A cigarette butt
- Something that weighs more than 1 lb
- Something with red on it
- Something that is clear
- Anything plastic
- Something soft

Point A to B (easiest to facilitate, good to do when walking somewhere or to clean - up a route--it can be helpful to measure the distance between points A and B so that desert cleans could be compared).

1. Identify starting and ending points.
2. Have everyone walk along the same route (spreading out shoulder to shoulder if/when possible) and pick up litter.
3. Option to sort, weigh, and record litter at the end.

DESERT CLEANS

(RELAYS, POINT A TO B, & BINGO)

Desert Clean Bingo (activity that can be done in pairs or groups. This is a great intergenerational activity that can be done across entire community.)

1. Give each pair or group a Desert Clean Bingo card.
2. Tell everyone that they have X minutes to try and collect litter for the different squares on their BINGO card. Teams must physically collect each item by placing it in their litter bag and bringing it back to the start to get credit for having that item. All teams to get a "Black Out" at the end of the time will get a prize. Additionally, the first team to return with a "BINGO" and their items will win a special prize—only one team will get this and the time for the entire game will not pause. Clarify boundaries for searching for litter and be sure that teams know they must return with all their items to get credit.
3. Start the time and let everyone begin.
4. At end of the time check BINGO items, give out prizes, and sort, weigh, and record litter data.

To access a printable PDF with 30 Beach Bingo cards click here.

DATABASE FLUENCY

5-20 minutes

Overview: Having youth contribute to, interpret, and even help design the team's research database builds important analytic, interpretation, and problem-solving skills. It also provides opportunities for discussing protocols, data validity, and precision, studying emerging patterns, and expanding computer literacy. This guide is a bit different in that it offers several different structures, and mini-activities, to use when engaging youth with the database.

Objectives:

- Youth contribute to, interpret, and even help design the team's research database
- Build analytic, interpretation, and problem-solving skills
- Discuss protocols, data validity and precision, studying emerging patterns and expanding computer literacy.

Educator Considerations:

- Many traditional western-European conceptualizations of scientific research—especially what youth may learn in school—suggest that databases, like protocols, must remain the same throughout research (even if they are not working for the data or the team). Challenge the value of keeping a broken system in front of youth and support them in seeing modifications and improvements to database entries, and use, as another form of keeping a growth mindset.

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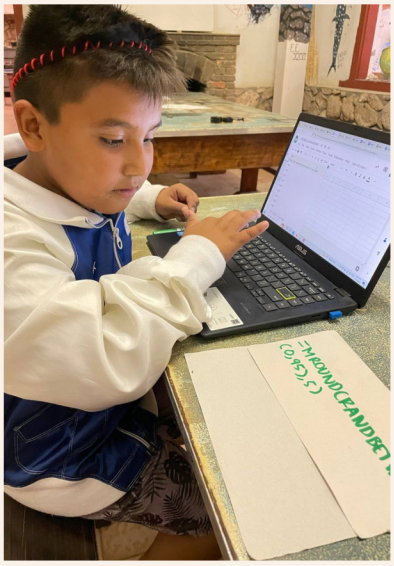
DATABASE FLUENCY

More Educator Considerations:

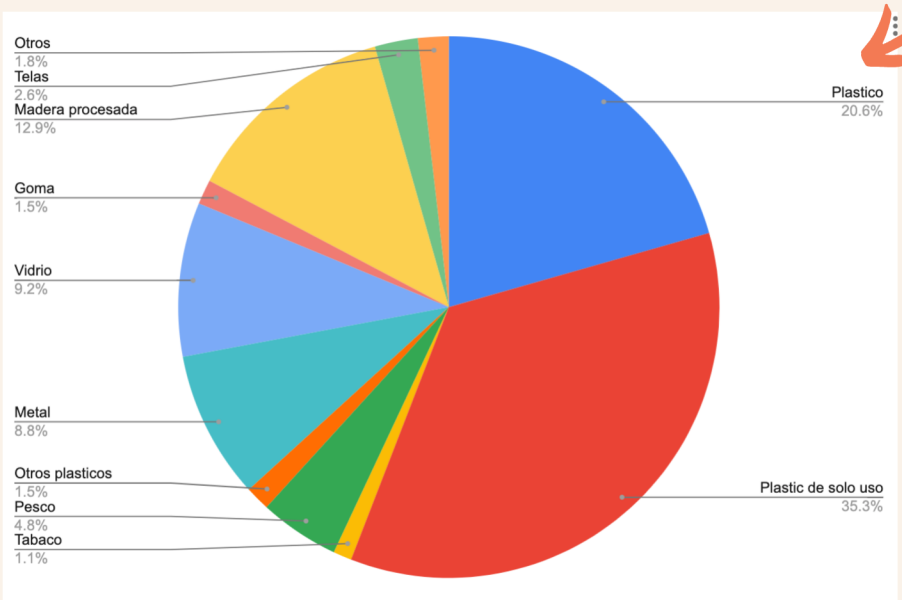
- Adding data into a database is often not youths' favorite activity—after fieldwork they are tired and frequently looking for a chance to mentally unplug and socialize after data collection. Consider doing data entry at a separate time from data collection and/or planning novel activities to follow database work.
- It can be helpful to work in visualizations that update automatically into the database (usually on a separate Excel or Google sheet) to see results in real-time and incorporate validation into the entry process. Discussing what types of visualizations can also help youths see patterns, draw conclusions, and make connections in what they see in nature and in future engagement opportunities.

Structures (and tips!) for Working with Databases:

This guide is a bit different in that it offers several different structures, and mini-activities, to use when engaging youth with the database.



1. Database fluency begins with complete, coherent, and congruent field notes, data collection, and site documentation. **Use similar language, units of measurement, and organization in field site paperwork as the database--Alignment between handwritten data records and digital records is key!** This will help reduce frustration around changing vocabulary, needing to flip through field notes to find data that easily could be recorded sequentially, and confusion over what data point to enter, and where.



DATABASE FLUENCY

2. Bring the **whole group together to sit around a single computer and projector**. Have individuals or groups enter their data in front of the team to make sure everyone is doing this the same way. This is a good time for drinks, popsicles, or snacks so that the whole group stays quiet. Group data entry works well when everyone wants to hang out together and when the team needs more support understanding the database. Have youth lead this time.

OR

Have **data collection teams work with the database to either enter their data and create a rapid report-out** that answers a specific research question/ wondering.

OR

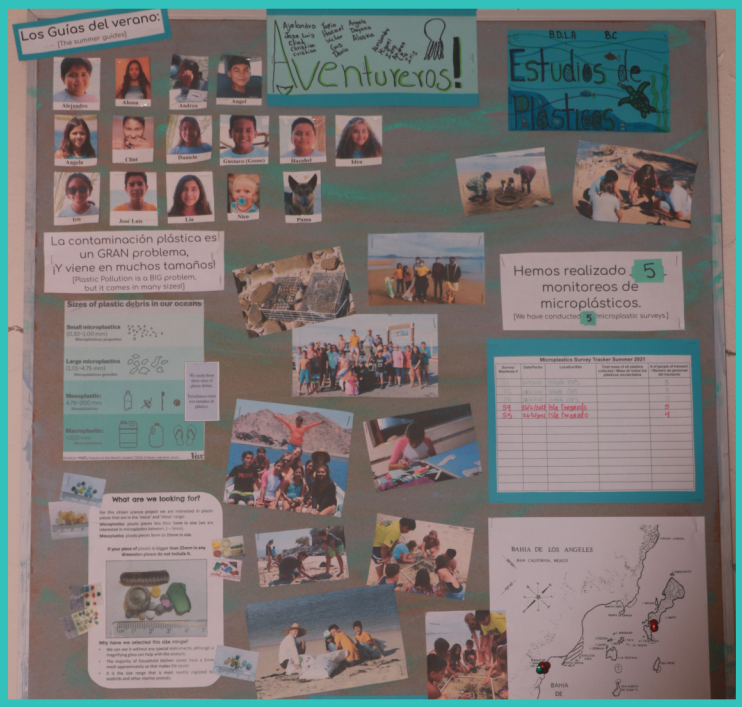
Pull **small groups** of youth together that share similar mathematical **readiness and comfortability with computers to enter data, redesign the database, create data visualizations, or pull findings to share in presentations**. The goal here is to expand what youth know about the database and support them in learning new skills related to the database and its function.

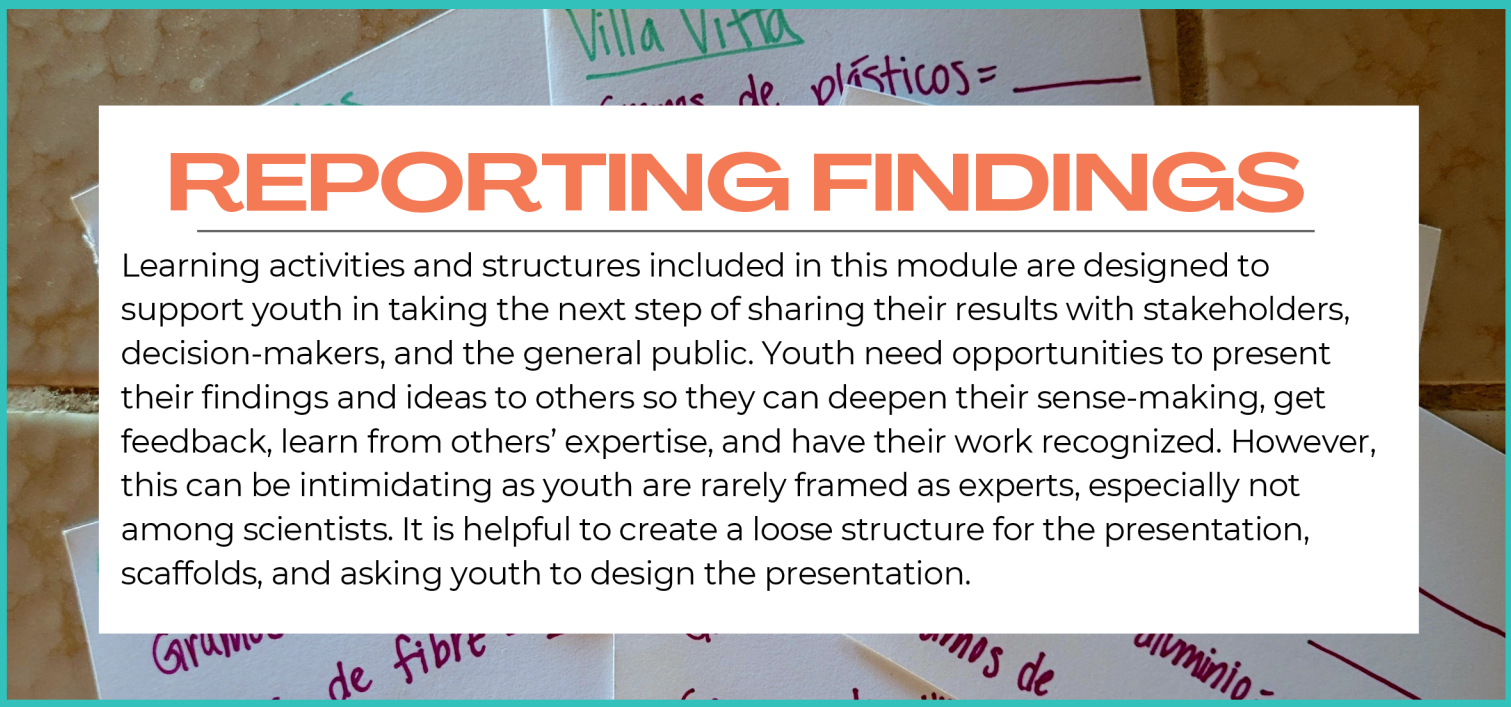
3. **After data is entered** prompt youth to...

- Visually review data for validation and to make sure nothing looks odd.
- Redesign parts of the database that were challenging to navigate or unclear.
- Create graphs, tables or other data visualizations with the data.
- Discuss or present summaries explaining: What story the new data is telling? And how this changes the big picture of what they understand about plastics (or whatever topic they are studying).

Discussion Questions:

1. Was the data sheet easy to enter into the computer? What would have made it easier? Is there room to improve our current dataset to do so?
2. Does the data “make sense” - is it what you expected or are you surprised?
3. Are there any trends or observations that jump out at you when you look at the visualization? What makes those observations stand out?
4. In 2 sentences, how would you summarize the data?
5. Is there a different way or visualization that would help interpretation or tell the story?
6. What is the take-home message from the data?
7. How can you use the data to inform community actions around plastic use or disposal practices?





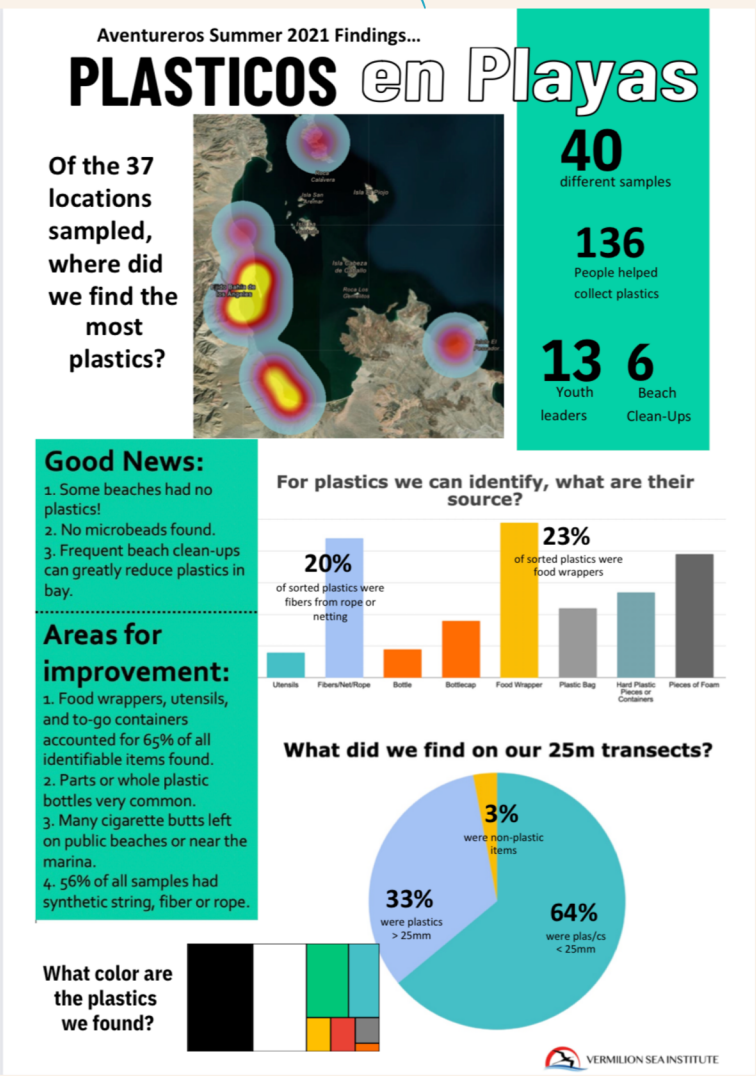
REPORTING FINDINGS

Learning activities and structures included in this module are designed to support youth in taking the next step of sharing their results with stakeholders, decision-makers, and the general public. Youth need opportunities to present their findings and ideas to others so they can deepen their sense-making, get feedback, learn from others' expertise, and have their work recognized. However, this can be intimidating as youth are rarely framed as experts, especially not among scientists. It is helpful to create a loose structure for the presentation, scaffolds, and asking youth to design the presentation.

A TRASHY 1-PAGER

40 minutes (over 2 days)

Overview: Show youth example infographics about topics they are interested in or that may be relevant to their lives. Youth then work together in small teams to sketch out a one-pager, marking what data (e.g. total number of local samples) and visuals will be used (e.g. bar graph). The best ideas from all of the sketches are combined to create the data visualizations and final one-pager.



Objectives:

- Youth learn to look across (and analyze) data sets and results to identify what is most important and combine these data points to tell a compelling story.
- Learn about different types of data visuals and best ways to present data.

Creating Trashy 1-Pagers:

- Show youth examples of infographics—be sure these are on topics they are interested in or that may be relevant to their lives.
- Youth then either create a list of major results to consider sharing out or are given a list to work from. Using this list, they sketch out a one-pager, marking what data (e.g. total number of local samples) and visual will be used (e.g. bar graph).
- Combine the best ideas from all of the sketches to create the data visualizations and final one-pager.

Materials:

- 4-5 Example Infographics (easy to find online)
- Paper, pencils/pens/ markers
- Access to research database
- Computer, or other art supplies, to create the data visualizations and final infographic/one-pager.

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A TRASHY 1-PAGER

Educator Considerations:

- This activity works best if ran across two days—data analysis is interesting, but only for so long for most people and especially youth. One day should be used to look at examples, brainstorming what findings to share, and designing the one-pager. A second day can be used to create the data visualizations, get/give feedback and to put everything together.
- Youth of all ages can participate in the brainstorming, discussion and feedback. However, the creation of data visualizations is a good opportunity for older youth to practice leadership and computer skills (excel, data visualization programs, etc).
- If time is tight, educators can create data visualizations based on the youth brainstorm and ask for feedback about the design and then edit.

Discussion Questions:

- What have been some of the things we have learned from our research and findings? Any surprises? Do we want to share this?
- What other information is most important for us to share with the community?
- What is the easiest and most interesting way to show what we want to communicate?
- Does our 1-pager clearly share the problem?
- Is our 1-pager depressing? Are there reasons to be hopeful or take action? Why is it important to communicate positive findings?
- What are the best ways to share our 1-pager with the community?

Extension Opportunities:

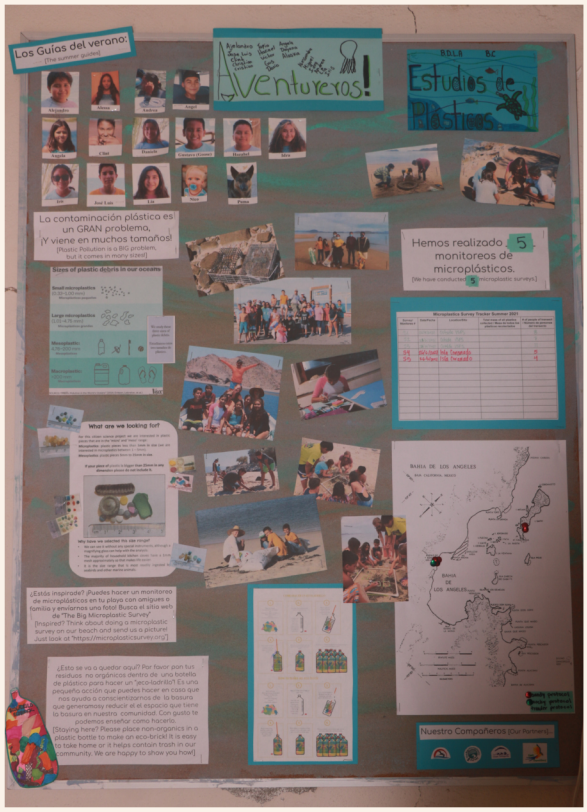
Print and post the 1-pager around the community. Or turn the 1-pager into a flyer that can be handed-out at community events.

Set a schedule (e.g., every quarter) for a new 1-pager to be created and shared with the public. Consider establishing committees for this.

Click here to check out this example! Spoiler, it is actually 2 pages!!

INFORMATION BULLETIN BOARDS

40 minutes (best over 2 days)



Overview: Bulletin boards, as well as other signs, can be helpful visual tools for communicating with others about the scientific research and work unfolding by the group. Youth often enjoy collaboratively planning and putting the information board together. They also learn a ton thinking about, and negotiating, what to include, how, and why.

Objectives:

- Youth work collaboratively (and creatively) to decide what information is must relevant to share and create a bulletin board to communicate this information.

Materials:

- Bulletin board or piece of plywood
- Art supplies (e.g. markers, pens, paper, glue, stapler, scissors)
- Photos or other artifacts
- Computer and printer—if wanting to print graphics, data, labels, etc.

Educator Considerations

- Let go of the perfectionism that most bulletin boards bring out and instead remember this is an opportunity for youth to practice communicating science ideas and creating their own narrative about their work—your job is to keep the decisions moving, give feedback for improving their ideas, and supply supplies.
- We recommend hanging the board where visitors and youth regularly see and/or not permanently hanging the board so it can be easily transported to community events or moved so large groups can more easily see it for reference during talks.

Discussion Questions:

1. What do we want/need to communicate from our experiences and research on our information bulletin board?
2. What pictures, data, stories, etc., should we include and why?
3. How will the board get and keep people's attention?
4. Is there a process for keeping the board up to date?

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PRESENTING TO VISITORS

(including community members, students studying at the field station, and traveling scientists)

Timing varies

Overview: Youth need opportunities to present their findings and ideas to others so they can deepen their sense-making, get feedback, learn from others' expertise, and have their work recognized. However, this can be intimidating as youth are rarely framed as experts and when they are their speech is often overly constrained and practiced. It is helpful to create a loose structure for the presentation, scaffolds, and ask youth to design the presentation and develop what they are going to say independently. These presentations (more formal or not) will become easier and smoother with time, practice and feedback.

Objectives:

- Youth design presentations to give visitors so they have a voice in what is presented, are experts on what is shared, and feel comfortable leading a sometimes difficult conversation.
- Engage with visitors and encourage them to care about plastic pollution and possible solutions.
- Lead by example, explaining the multiple ways in which youth are leading mitigation and prevention efforts.

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PRESENTING TO VISITORS

Materials:

- Varies, but it is helpful for youth to have visual or physical artifacts to support their presentation or to turn to as a safety net (e.g. photos, maps, data charts, physical spaces, materials to show a process).

Educator Considerations:

- Audiences of all ages benefit from hearing some directions about the structure of presentations and when they will be able to ask questions or give feedback. Making audience expectations clear from the beginning is important for protecting youth to share what they think is important, without a power struggle or air time reverting back to adults, and professional scientists. Some things to say in the framing:
  - "Our presentation is approximately ____ minutes, afterward we will ____."
  - "It can be helpful to know what we are going to talk about so first _____ is going to share about ____ and then others will talk about ____, _____, and _____."
  - "This is really informal, so feel welcome to ask questions whenever." OR "To make sure we get through everything we want to share, we are going to ask that you wait to ask questions until the Q&A at the end--thank you."
  - "I am/some of us are really nervous so if you could just be really supportive as we present our ideas that would be helpful."
  - "We are going to share about a lot of different things but at the end, we would like to hear your ideas about ___. We have been struggling with ____."
- Youth's presentations are not "cute"--be sure follow-up conversations are not patronizing. Be prepared to step in and (re)name brilliance and important ideas for listeners who are still learning to learn from/with youth.
- Be prepared to help facilitate any cross-talk between youth and visitors, paying close attention to how power is disrupted in the conversation, or not.
- After presentations it can be easy not to stop and prompt reflection, but this is an important step in youth getting better at presenting to people not part of the lab and for you to think about how you supported youths' voices in being heard and what you/everyone can continue to work on. During this time, be sure to also celebrate high points and interesting thinking that unfolded during the presentation.

Discussion Questions for Planning Presentations:

1. What do we hope changes or happens in response to this presentation? (e.g. litter less, fund more research, lead beach cleans, lab collaboration, feedback to improve protocols, etc.)
2. Considering this, what ideas and findings do we think are important to share? Why?
3. What do we think this group needs to learn about our work and why?

PRESENTING TO VISITORS

Discussion Questions for Planning Presentations (Continued):

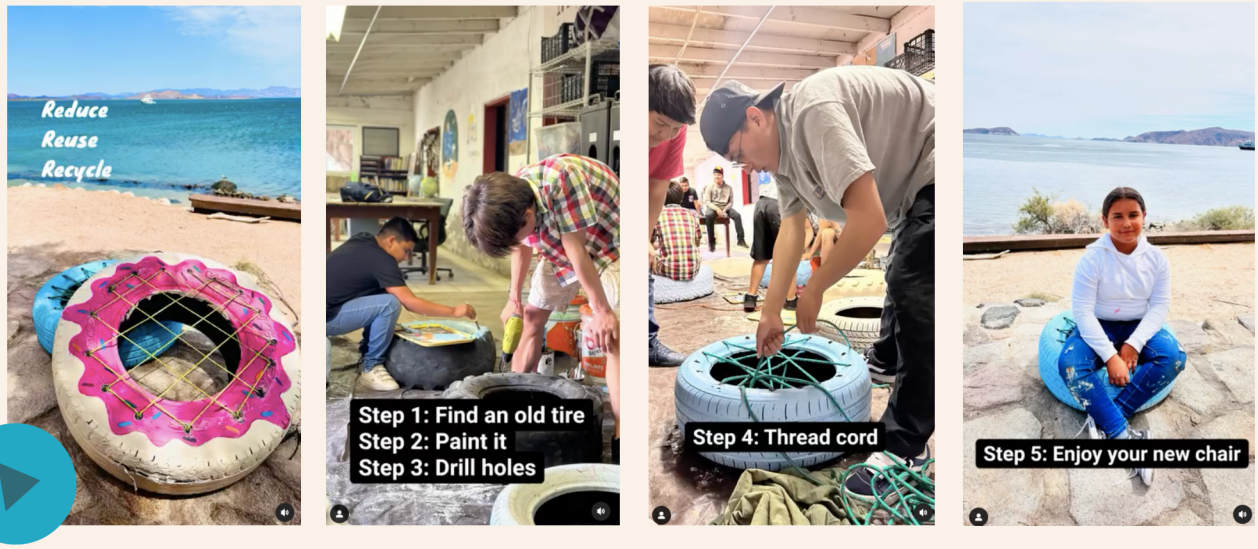
4. What are different ways we could share these ideas? Which ways will be most effective? Why?
5. Create an agenda for the presentation (design time so it aligns with the intended outcomes/goals in mind.
6. Which topics (or parts of the agenda) do you feel most comfortable presenting? Are these the same parts that you want to present? Assign youth parts to present and give them time to prepare.

Post-presentation reflection and feedback prompts:

1. How do you feel the presentation was received? What is your evidence? (What did you hear or see from the audience?)
2. What do you feel went well about your presentation and why?
3. Were there any parts you would do differently if you could?Why?
4. What did it feel like to present our work?
5. Was there an interesting topic or conversation point you hadn't previously considered? Is there an opportunity to think about it more and potentially work it into future presentations?

3 MINUTE SOLUTIONS

3-60 minutes planning interview
5-30 minutes conducting interview
20-90 minutes creating and editing video



Overview: Many youth want the opportunity to share what they are doing on social media or to improve their media skills. This activity offers this opportunity but in a hopeful and forward-facing way. Youth identify individuals on their team or in the broader community who have solutions to help reduce plastics. Photos, videos, and/or quotes are collected during the interview to create a public-facing short video (no longer than 3 minutes highlighting this person and/or their solution.

Objectives:

- Youth investigate and present unique solutions to help reduce plastic pollution in the community.
- Learn how to conduct interviews with community members about their solutions.
- Work collaboratively in small teams to design 3 minute videos that help present the unique solution, person/people behind the solution, potential impacts of this solutions, and other interesting connection.

Materials:

- Handout for planning 3-minute videos
- Phone or video camera
- Notebook and pen
- Social media app and account to edit and post video
- Varied other materials that you want to include in the video

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3 MINUTE SOLUTIONS

Educator Considerations:

- It is vital that youth have opportunities to explore, implement, and celebrate solutions to plastic pollution and other wicked problems impacting their lives. And learning about solutions that makes visible the solutionaries, problem-solvers, and those already working to mitigate plastic pollution helps deep pride of place and community in ways that help disrupt deficit narratives. So while these videos could be about problems, we really recommend spending significant time on solutions with youth.
- Creating videos about other people, even if positive, needs to be done with care and respect. Support youth in building the videos along with the change-maker, or at a minimal, get that person's feedback on the video and make adjustments before sharing,

Discussion Questions to Launch Activity:

1. What unique solutions to the plastic problem have you seen recently from family, friends o,r other people in the community? And why would this solution be one we want to tell others in our community about?
2. How can we make why the solution is potentially good and powerful obvious to viewers?
3. What should we consider when making a video to share with other people? Are there any rules we should agree to so people feel well-represented and honored through the videos?
4. How could we measure the success of our video?

Criteria for Video:

- There is a video title that helps introduce solution.
- If wanted, the name of the person interviewed and asking questions is shown.
- Strong visuals that help explain the issue and solution.
- Audio is clear and understandable–upbeat/catchy music if it is mostly photos or video.
- Video segments are interesting and give viewers new ideas about how to help reduce plastic pollution.
- Video is no longer than 3 minutes--ideally shorter to increase audience engagement.

3 MINUTE SOLUTIONS

1. Prepare for Interview

- **Select the interviewee and topic.** Think about a solution to the plastics problem you have seen in the community that you know someone is trying to develop, or that you or your partner have done. This could be a "perfect" solution, something someone did once to help reduce plastic pollution or an idea still in progress. The solution might even be something your partner did or wants to do! You are going to interview someone involved in the solution to get more information and share their idea with the community.
- **Think about what questions and data you will gather** during the interview. Some ideas for this are:
  - What is the general topic/solution that will be featured?
  - Who will be answering questions?
  - Who will be asking questions?
  - Choose 2-3 of the following questions to ask during the interview. Here are some ideas of questions:
    - What problem are you trying to solve?
    - Why is this problem important to you?
    - What solution are you proposing to reduce plastic pollution?
    - How did you think of this solution?
    - What have you already done to reduce plastic pollution?
    - What should people know about this solution (or problem)?
    - What challenges are there with this solution?
    - How can people get involved?
- **Think about what photos or videos** that are separate from the interview you might want to collect to help tell the story.
- **Decide where the interview will happen** (be sure it is quiet and that the background either helps tell the story or is not distracting).

2. Conducting the Interview:

- Make sure the person answering questions is comfortable. Be sure they know you won't use any bad part of the interview or any part they don't want used. This is research and journalism ethics!!
- Ask your questions and give the person plenty of time to respond.
- Ask questions along the way to get the person to say more.
- Be open to changing your vision for the video based on the story and solution that emerges!

3. After the Interview:

- Edit the video into a story. Think about the beginning, middle, and end.
- Use a video editor to add titles, the name of the person (if they want), and other details that make sense.
- Share video with 2 other groups or people to get feedback on what to improve.
- Make improvements and finalize the video.
- Have adults share videos on social media.

3 MINUTE SOLUTIONS

Extension Opportunities:

- Compile the solutions into one longer video and share broadly with community to introduce and support the implementation of new solutions.
- Challenge followers on social media in other communities to create videos of their solutions and to share them back—the goal is for solutions to pollution problems to become widespread and viral.
- Establish week- or month-long challenges that encourage people to try or engage with the different solutions and record ideas about what worked well or what could be improved.

HOSTING COMMUNITY EVENTS

40 Minutes for Initial Planning
Implementation time Varies by Event

Overview: If science and activism are to be grounded in community moving forward, youth must learn how to productively engage community members in issues. This learning opportunity supports youth involvement in identifying the purpose and structure of different events and designing for community learning and engagement.

Objectives:

- Youth learn how to plan, coordinate, and schedule events to communicate about their research, advocate for change, and engage new community members in mitigating plastic pollution or other aspects of their environmental justice work.
- Work collaboratively with other community members to organize the physical space and resources and implement the event.

Materials:

- Varies by event
- Community Event Planning Guide
- Food (free or discounted through the event)
- Educational materials and resources for attendees
- Thank you notes for sponsors and co-facilitators

Educator Considerations:

- Youth and adults who are collaborating to host community events need scaffolds and systems implemented so youth voice can be heard and respected throughout the planning process--without these structures youth often fall into labor-intensive roles (carrying equipment, passing out tickets, etc.), with little say or power over what happens during the actual event.
- The bigger the event and the more collaborators, the earlier you need to start planning for it to be truly collaborative.

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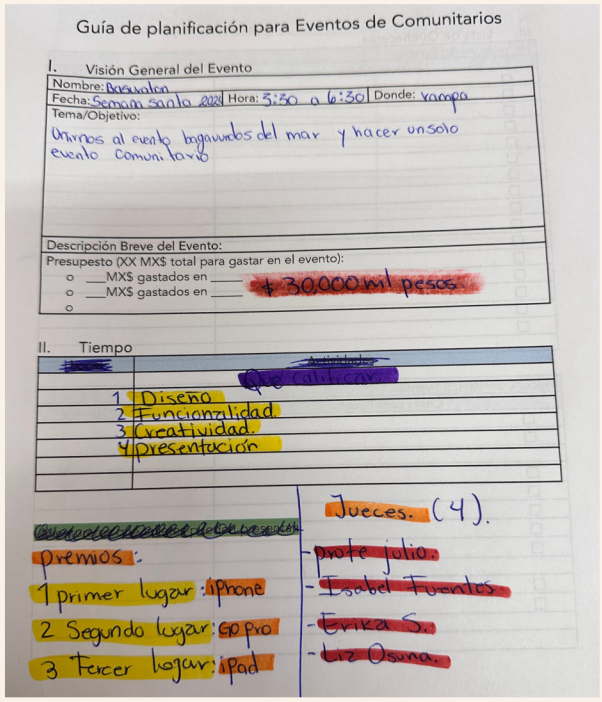
HOSTING COMMUNITY EVENTS



Tips For Planning & Organizing Events:

- Prompt youth to use the Community Event Planning Guide to track their plans and help communicate with other community members or adults next steps.
- Have large group of youth brainstorm event and then ask for a subcommittee of youth to lead the event and commit themselves to making it happen
- Set internal due dates and keep a detailed and public to do list that is easy to reference—this helps keep everyone accountable for their part.

HOSTING COMMUNITY EVENTS

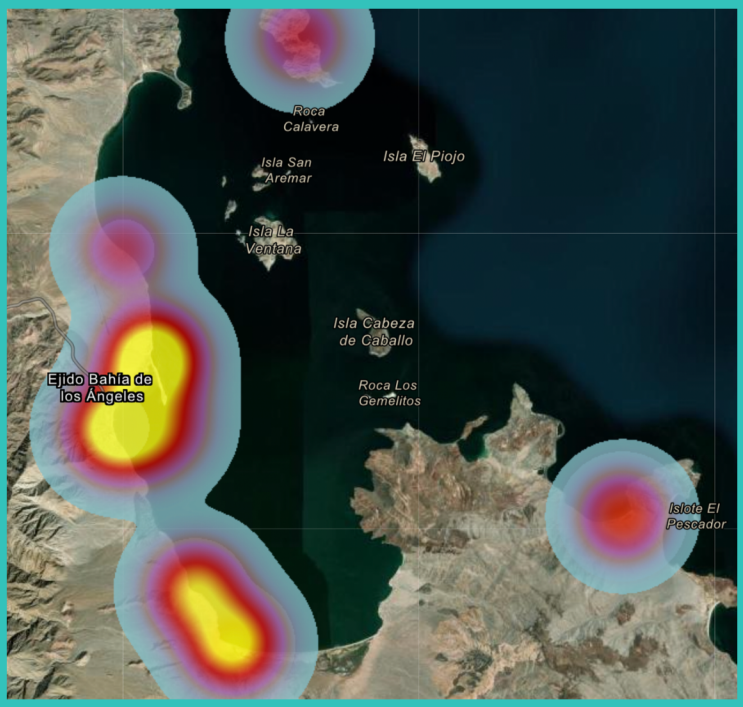
Discussion Questions:

1. What are some community events in the past that you have enjoyed and why?
2. What is our theory for engaging the community and supporting them in changing their behaviors? —What is our "theory of change" for this event? What do we hope to accomplish, why, and how will we know if the event was successful?
3. How will this event be interactive? What big ideas do we want attendees to learn about and walk away with?
4. Who do we want to collaborate with to host the event and why?
5. Who do we hope attends this event and why?
6. What should we do if someone on the planning committee doesn't do their role?

Halloween Upcycled Costume Competition

Community Event Ideas:

-Ecofair (artists, food vendors, and scientists come together)
-Spaghetti Dinners, Science Talks and Games
-Shark-Tank-style Competition: Reduce Local Plastic Consumption (See Pitch Azul)
-Compactor Design Challenge
-Marine Pollution Escape Room
-Ecoburrito Scavenger Hunt and Media Post
-Halloween Upcycled Costume Competition
-Beach Clean and Sunset Swim
-Receptacle Design Challenge



ENGINEERING SOLUTIONS & NEW SYSTEMS

This module shares different activities and projects that we have done to develop, design (or engineer), and advocate for more sustainable systems and solutions. Some of this section focuses on building physical solutions or alternatives, while other resources offer guidance for supporting youth in questioning systems and the status quo and designing for the futures they want, and that will help their community thrive.

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ENGINEERING LAB EQUIPMENT

15 Minutes (Varies)

Overview: Not all equipment is affordable or well-designed for transporting on small boats or across shorelines. To combat these challenges, we often make our own equipment using upcycled materials. This collapsable quadrat is one example.

Objectives:

- Students will demonstrate the ability to apply principles of design thinking in order to create innovative lab equipment using upcycled materials that are affordable.
- Students will develop the skills to design lab equipment that is well-suited for transportation on small boats or across shorelines, considering factors such as portability, durability, and functionality.

Educator Considerations:

- Ask youth what they feel is working or not working with their current equipment/process, and why. Reflect on this feedback together to identify priorities for modification. Anytime you elicit youth voice and feedback, you must be sure to respond to these ideas seriously—in this case, turn these reflections into engineer design challenges. Encourage youth sketch and talk to others about their designs before building a prototype. Ask them to test their designs in the field and adjust before replicating.
- As discussed with the Manta Trawl is essential to slowdown and identify unintended consequences of building our own materials (e.g. use of resources to build equipment that might not last or equipment that might breakdown and become marine debris). Be sure to discuss as a group how to mitigate harm, or even if this equipment should be built. Ask: “Will the benefits of this equipment outweigh the potential harms?”. Come up with a plan for reducing harm if you go forward with this protocol alongside youth—ethical conversations like this should become normalized as part of the work of field scientists.

ENGINEERED LAB EQUIPMENT

Educator Considerations Continued:

- Also, use upcycled materials as often as possible. Use this design time to discuss the fluidity of engineering and design and to de-bunk the linear engineering design process often forced on youth in scientific settings.
- Design the learning timeline to be for longer cycles of designing, testing, and refining new lab equipment around youths' wonderings and general needs of the lab. This might even span months. Elevate problems with current protocols related to equipment, discuss and introduce protocols used by other labs and identify what equipment would need to be built to do this. Build in time for talking about the need for quality equipment to collect accurate and precise data and how often equipment is unnecessarily expensive—which prevents many non-professional, and even professional, scientists from studying what they are interested in.

Materials:

- Variety of upcycled items
- Construction tools (hammer, saw, drill, etc)

Folding Quadrat: How can we construct more quadrats out of upcycled materials and design them to be easier to transport and store?

Directions:

1. Measure and cut pipe into 4 equal sections of 25 centimeters.
2. Thread 1 piece of sturdy rope through all 4 pipe sections, pull tight and tie off.
3. Fold and unfold quadrat several times to be sure it lays flat.
4. Fold up, carry to survey site, and use in the field by laying one edge against a marker and positioning edges into a square--the corner of a piece of paper works well for checking right angles.

ENGINEERED LAB EQUIPMENT

Rocky Sediment Plastic Traps: What can we build that will allow us to collect and study the microplastics that settle on rocky shorelines?

Research different plastic trap designs and pros and cons of each. Pay close attention to how each design and protocol mitigates harm to Intertidal species, habitats, and natural marine processes.

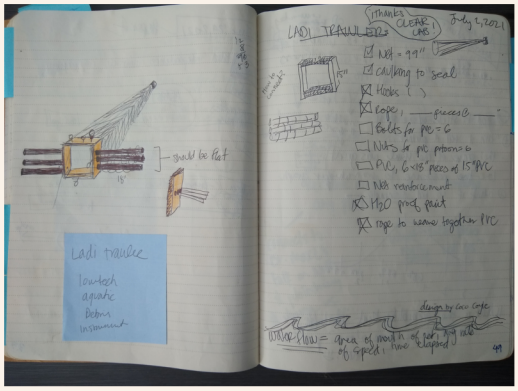
Be sure to mark the plastic trap as belonging to you and as “research in-progress, please don’t touch”! We had someone pull ours up unknowingly.

Be sure to mark the plastic trap as belonging to you and as “research in-progress, please don’t touch”! We had someone pull ours up unknowingly.

Also ensure you are secure the trap so that it cannot be taken out with the tide or broken up by storms/waves.

Discuss and iterate on your trap in short cycles until you have a protocol that limits harm and generates helpful data. If this doesn’t happen, be sure to discuss with youth how/when to stop conducting research — this is another opportunity to highlight the ethical decisions in the field.

Surface Trawler: How can we use materials we already have to build a plastic trawler (CLEAR LAB instructions) that we can use to study (and remove) micro plastics floating in the bay? What procedure would we need to follow to use the trawler?



OFRENDAS, PIÑATAS & OTHER TRADITIONS

120 minutes (2-3 different days)

Overview: Plastic has leached into traditions and ways of being that have existed far longer than the advent of plastics. Assist youth in noticing how plastics have become ubiquitous and finding ways to sustain (or even revitalize) their traditions that contribute more waste.

Objectives:

- Identify the use of plastics in community traditions and engage in critical discussions about whether this is something that should shift or not and why.
- Invent new ways for maintaining these traditions--or restoring them--while limiting pollution or other negative ecological impacts.

Materials for Ofrendas:

- Colorful paper, fabric, leaves, shells, rocks, clay, or wood
- Glue, scissors, and/or paint

Materials for Piñatas:

- Lots of used paper
- Something to use as a mold
- Bowl with water and glue mixture for paper mâché
- String
- Scissors
- Varies

Educator Considerations:

- Challenging cultural traditions should be done with care and reverence for the histories and people behind these traditions. Start with noticings, feelings, and openly talking about these traditions and what they mean for us and our families. And only then shift to think with youth about how to restore these traditions.
- Be sure to name how colonization, globalization, and consumption has remade many traditions (including through plastic use) and discuss the impact this has had on sustaining traditions.

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OFRENDAS, PIÑATAS & OTHER TRADITIONS

Discussion Questions:

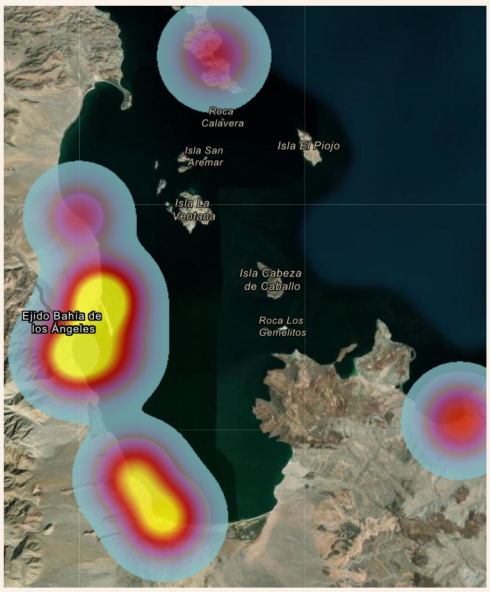
1. What does [insert tradition] mean to you and your family?
2. What thoughts crossed your mind during this activity? How does tracking plastic pollution in the way we did today help add depth and complexity to what we understand about this issue?
3. How do [insert tradition] become filled, or even dominated, with plastics, even though these old traditions didn't begin this way? And, what does this tell us about how plastics spread into all parts of our lives?
4. Should we collect plastic offerings from around the cemetery as "litter", or is it best to leave them be?
5. How did [insert tradition] occur before plastics became popular--what was used that we can return to or learn from? What might it mean to older community members to return to these ways of doing things?
6. How do we determine if a source of plastic pollution is something we care about and can change? How do we navigate the ethics around shifting cultural practices—what do you think is acceptable and what should our lab rules be for this?
7. How can we ensure that we are preserving the socio-cultural and historical importance while transitioning away from plastic usage? What clean-up rules should we set given that cemeteries are sacred sites?
8. In what ways can reducing plastic usage help sustain or rejuvenate a tradition more effectively? How might reducing plastic in one tradition lead to changes in other community activities?

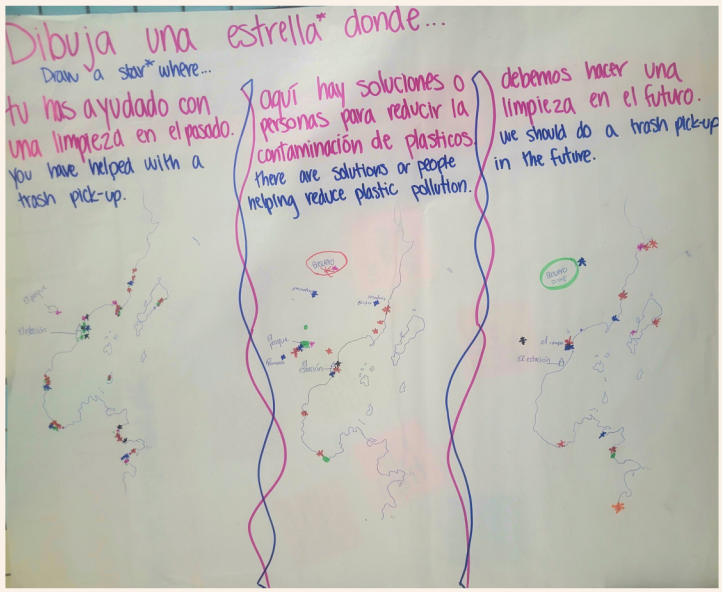
Extension Opportunities:

- Have youth research alternatives to plastics use in traditions--this could be online or through talking with older community members. This will help them generate more meaningful solutions. One example might be to redesign balloon releases after someone has passed away. There are many examples of traditions that could be updated not to include plastic.
- Carefully track community celebrations, parties, or times of mourning and host ofrenda or piñata making workshops to teach other youth and community members how to maintain their traditions while protecting Earth. Or make these Earth-friendly alternatives and sell them in local tiendas on commission.
- Host a community event where participants are challenged to take a family or community tradition and modify it so that the tradition doesn't lose significance, but rather becomes more sustainable and feasible.

MAPPING TOMORROW'S WASTE SYSTEMS

10 minutes speed mapping
30 minutes family interview
240 minutes longer mapping task
90 minutes planning through maps





Overview: Students will research current systems of waste management; identify environmental, cultural, and community shortcomings and opportunities of those systems; and will create speculative maps of new systems that highlight potential solutions to those failings.

Objectives:

- Collaboratively create detailed maps of pollution problems in the community, highlighting key areas and sources of pollution using study data (quantitative and qualitative).
- Identify and map out potential solutions to address pollution issues, to foster a participatory approach and incorporate input from various community members.
- Learn about different types of maps, the tools used to make these, and how maps can be used as a participatory form of speculative planning and social-material planning.

Materials:

- Varies by type of map
- Printed maps of community that are easy to annotate on
- Pens, markers, colored pencils, sticky notes
- ArcGIS

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MAPPING TOMORROW'S WASTE SYSTEMS

Educator Considerations:

- Designing new solutions should be done with deep consideration of communities, sociocultural and historic contexts, ways of being that must be disrupted and also continued—and these all connect deeply to place. Modern/global design often is location neutral, which does not attend to these place-specific contexts and often fails to foster change. Challenge youth to pay close attention to existing refuse and sites of harm, but also to sites of resistance and possibility by mapping these connections around the community and using the maps to inform future systems/ solutions development.
- Maps have been used as tools of conquest and colonization but also of liberation and resistance. Talk with youth about how different communities are using maps to win legal cases, get help protecting their community, documenting ecological abundance and proving lands rights. Discuss mapping as a way to (1) document refuse and destruction, (2) resistance and efforts to stop destruction and (3) reimagine a space/geography far into the future as if the problems has been solved--where there is ecological abundance and well-being.

Discussion Questions To Guide/Launch Mapping:

1. What information and data are you going to use to create your map?
2. What are some of the reasons people make maps?
3. What unintended consequences might there be if we only map problems across our community?
4. What are some different ways we can create our maps? What mediums would help us capture our ideas and/or communicate best with our audience?
5. Is harm and ruin the only thing we should spend our time mapping? Why?
6. How might a map of emerging or important waste management sites be helpful in our community? What would it include and why?
7. Should we include imperfect responses and acts of resistance? What are our criteria for putting something on the map and why?
8. How will this map be different than others? What change do we hope it catalyzes?
9. Why is it important to dream and imagine together? How does this help us innovate, design, and engineer differently?
10. How will we make sure we are (re)imagining a better future---not just a different one?

MAPPING TOMORROW'S WASTE SYSTEMS

ORIENTATIONS TO MAPPING

Mapping Refuse

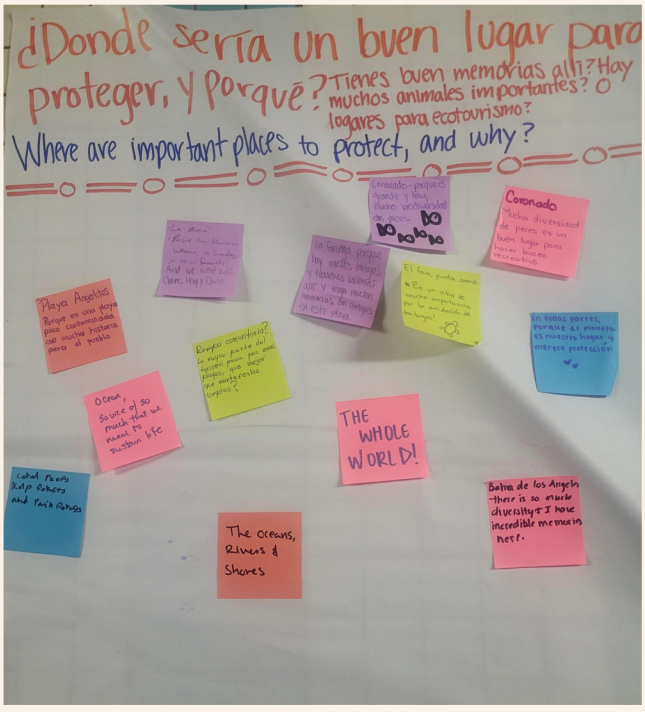
Official research data and/or other data collected by youth can be used to create a map showing pollution or sites of potential pollution. This is helpful for identifying sources of pollution and designing new systems.

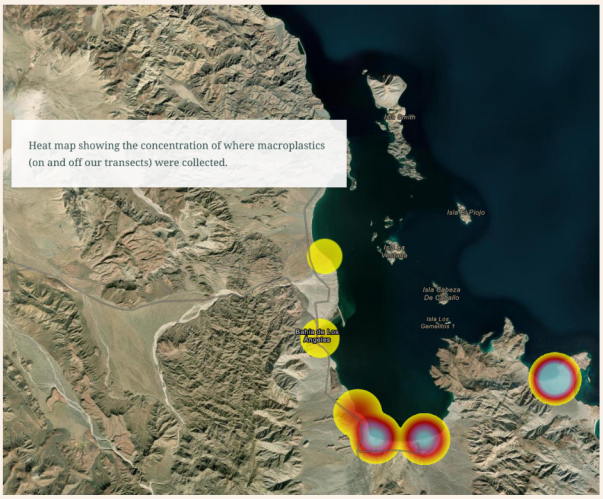
Mapping Resistance

Document sites of activism or infrastructure that at emerging or well-developed that are helping to resist (and reduce!) plastic pollution. Consider adding important people and leaders from these sites to the map——what and where matter, but so does who is doing the work!

Mapping the (re)Imagined

Speculating and dreaming are important aspects of designing and engineering new systems. Prompt youth to individually, or collaboratively, reimagine their community as a place of little to no plastic waste and environmental harm--these maps can be used to focus change and future efforts.





MAPPING TOMORROW'S WASTE SYSTEMS

10 Minute Speed Mapping

Youth are given a blank piece of paper or a simple printed map to sketch and annotate to answer the prompt. This is a short activity and typically used to gather specific known knowledge about where pollution is and where people are already trying out solutions.

Example prompts:

- **Refuse:** Where are at least 3 places in the community where plastic pollution originates?
- **Resistance:** Where are there solutions to the plastic problem in your community?
- **Refuse:** Where are 4 places we should go collect plastic pollution data and why are you curious about these places?

30 Minute Family Interview

Youth take a blank map home with them and ask their family to discuss the plastic problem in relation to different places around the community and annotate the map until it becomes a combination of notes, photos, poems, quotes, questions, etc.

Example prompts:

- **Refuse & Resistance:** How have different places around our community changed because of the plastic problem?
- **Reimagine:** What could we rebuild or redesign around our community to help mitigate and reduce the plastic problem?

240 Minute, Longer Mapping Task

Youth work on creating digital StoryMaps on ArcGIS using their quantitative and qualitative research data.

Example prompts:

- **Refuse:** What are the mot significant problems existing according to our data and where are these? What histories and decisions help explain what is happening?
- **Resistance:** What is one solution-oriented system in our community and how does it work?
- Resistance: What restaurants, food vendors, stores, hotels, and other businesses are dedicated to low-waste or zero plastic waste?

90 Minute Planning Through Maps

Teams of youth and adults sit together for a meal and discuss different areas of the community identifying refuse, resistance, and reimagining what is possible in the community. 1-2 people take notes and annotate large table sized map.

Example prompts:

- **Refuse:** Where are different places in the community where plastic pollution originates? Why?
- **Resistance:** For each source of plastic pollution identify solutions already being tried.
- **Reimagine:** What do we hope our community looks like in 20 years--- map and annotate parts of this vision that help reduce and contain plastic pollution.

PITCH AZUL

Afternoon of project proposal presentations

Evening of awards and celebrating

Overview: In this community event youth can either help host and organize the event or join a team and enter the competition. The competition — "Pitch Azul: Waves of Change" — was inspired by the ABC show Shark Tank to spur innovation and low-waste, zero-plastic initiatives and solutions across the community. Intergenerational teams, with at least 1 adult and 1 youth from the community, create and submit either a business proposal or a project/initiative proposal. Then each team comes to present their idea in a 15-minute chunk of time to experts. Teams can win seed money, up to $1,000, as well as ongoing consultation and mentorship to implement their project.

Objectives:

1. Learn about the environmental impact of plastic waste from local businesses and endeavors and the importance of transitioning to low-waste alternatives.
2. Acquire skills in market research, product development, and sustainable business practices to create innovative initatives or new projects for reducing plastic waste in the community.
3. Gain confidence in pitching business ideas and engaging with potential investors to secure support for implementing low-waste or zero-plastic waste initiatives.

Materials:

- Proposal Template
- Sign-up Google Form (asking for participants' names, contact information, partners, overarching idea, preferences for pitch day and time, and if they would like support on creating their proposals or presentations)
- Video recorder, microphone, camera, and place to hold (and record) the presentations for later sharing on social media
- Seed money ($50-$1,000 per proposal depending on ask)
- Music, food, speaker, fake checks, lights, and decorations for the celebration party

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PITCH AZUL

Examples of possible business proposals:

- Laundry paper strips or other alternatives
- Install water bottle refill stations around town (vending machine water but for reusable bottles only)
- New solution for plastic bag that holds ice
- Reduce plastic film at fish packaging and storage center
- Receptacle(s)
- Turning existing business into low-plastic waste generation
- Waste pick-up system
- Trash compactor
- Weaving furniture out of upcycled plastics
- Cookie, candy, and snack shop, no plastic packaging allowed!

ECO-TRAMPAS: A NEW SYSTEM

15 minutes (activity length can vary)

Overview: Youth identify shortcomings of two common solutions used for capturing single-use soft plastics (garbage bags and eco-bricks*) by examining their points of failure given the system and context in which they are being used. They then learn about an alternative solution (eco-trampas) and consider how this alternative solution better responds to the needs and materials of the community.

*eco-bricks are 1-2L water bottles that are carefully packed with plastic trash, sealed, and used to construct homes, tables, walls, etc.

Objectives:

- Youth learn about the how to create ecotrampas (not ecoladrillos, or eco-bricks) and how these can help reduce marine and desert plastic pollution.

Materials:

- Empty and cleaned 2L or larger plastic beverage container
- Paints, permanent marker, paper, string, or other materials to decorate and label the container with directions

Educator Considerations:

- Single-use soft plastics that can't be recycled often end up in waterways when garbage bags tear. “Eco-ladrillos” (eco-bricks) are a labor-intensive and fairly arduous low-cost solution that helps capture plastics and then can be used to build structures (eg., benches, houses, fences). "Eco-trampas" (eco-traps) are our twist on this. It is a simple solution that captures plastics, but unlike eco-bricks (which can be used to build things but must be built in very specific ways), these can be filled in any order and don’t have to be packed as tightly--which makes them easy to use during beach cleans, at the field station, in public spaces, and homes in the community with people of all ages and physical abilities.

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ECO-TRAMPAS: A NEW SYSTEM

More Educator Considerations:

- While it would have been cool to build an eco-brick bench, or expand the field station building using eco-bricks, the additional time and labor made the eco-brick making process inaccessible to our community. It wasn't a sustainable alternative to throwing trash out in a plastic garbage bag. So we decided to focus our updated system on capturing small pieces of plastics or soft plastics rather than creating a building material to meet other needs. Thinking this through with the materials, time, and resources you have is important.
- To foster transformation, individuals should consider designing solutions that align with community realities using a holistic systems thinking approach. Solutions and problems are interconnected with culture, power, politics, and relationships. Analyzing and redesigning solutions, even simply ones like eco-bricks, can contribute to a more just world.

Discussion Questions To Evaluate and Modify Existing Solutions:

1. Why do we think this solution/ system needs to be evaluated and possibly modified?
2. Who is this solution working well for? Who is it not?
3. What are long-term shortcomings of this solution? Or unintended consequences (good or bad) of this design?
4. What is this solution trying to disrupt (behaviors, pollution, etc.)? And what needs to change so this solution is more impactful and beneficial?
5. What impacts (good and bad) does this solution have on other humans?
6. What impacts (good and bad) does this solution have on social life and local culture?
7. What impacts (good and bad) does this solution have on other species and the ecosystems in which they live?

TO-GO CONTAINERS REMIXED

20 minutes

Overview: Youth are given different "takeout scenario cards" and asked to brainstorm design alternatives to the common (often plastic) to-go containers that best fit this situation. The aim of this engineering activity is to encourage youth to think outside of the box but hold onto context, customer base, and efforts to reduce waste.

Objectives:

- Brainstorm and evaluate innovative design ideas for reducing the use of plastic in common to-go containers .

Discussion Question:

1. Do you think any of these to-go container remixes could become common in the local community? Which and why?
2. What were the most challenging aspects of the activity, and why?
3. How did this activity enhance critical thinking skills and problem-solving abilities?

Materials:

- Takeout scenario cards
- Paper or copies of the To-Go Container Remix worksheet

Educator Considerations:

- Encourage youth to brainstorm multiple solution alternatives by thinking about replacement materials around the community but also about different containers they have seen in other places.

Extension Opportunities:

- Youth make prototypes of remixed to-go container and present to food vendors.
- Create a pamphlet or other reference that catalogs all of the hypothetical and real alternatives to different types of to-go containers.

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TINKERING AS MICROECONOMICS

120 minutes

Overview: Teach youth, or have youth teach each other, different tinkering and crafting skills they can use to upcycle materials and disrupt extractive consumer-driven cycles. Youth enjoy learning new skills and ways to give their things (well-loved but worn out or leftover trash) a new life as something fun, useful, or a gift.

Objectives:

- Foster creativity and environmental awareness by repurposing materials in engineering projects.
- Design innovative, low-waste solutions using nonlinear engineering and design processes.

Materials to Upcycle:

- String, yarn, netting
- Clothes, towels, hats, blankets, pillows,
- Plastic bottles, containers, tops
- Toys or trinkets
- Kitchen utensils, gardening equipment or fishing gear

Educator Considerations:

- Pair tinkering and crafting with engineering thinking to help youth see that engineering is less of a linear process than often depicted and that cycles of iteration are important for creating the products we want/need.
- Facilitate discussions with youth about how upcycling differs from recycling in important environmental, economic, and social ways.
- Have youth identify how tinkering and crafting often have roots in cultural ways of being that are important to them and their families .

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TINKERING AS MICROECONOMICS

DISCUSSION QUESTIONS:

1. What are some different ways that [insert skill] helps address plastic pollution?
2. What is "upcycling" and why is it important for the environment that our society becomes better at it?
3. What is a "circular economy"? (Could look at a diagram or watch short video.)
4. How is a circular economy different, or the same, as the economic system we currently have?
5. What unintended consequences does this crafting, or up cycling project have?
6. What are ways you, or your family, already tinker or craft to create new products?
7. Do you think it is more important for us to think about changing our individual choices about what we buy, and what we consume (microeconomics) or larger systems of consumption and capital (macroeconomics)? Which type of change do you think will help reduce the pollution problem and why?

Some Tinkering and Crafting Skills & Activity Ideas:

Sewing, Crotchet, and Knitting
Provide opportunities for youth to learn how to mend their own clothes, blankets, pillows, key accessories, etc. or to even create new things with fabric, yarn, or other textiles. This skill can save considerable money, reduces consumption of textiles, gives old/outdated textiles new life (rather than become trash) and helps youth feel more self-sufficient.

- Example projects: Pillows, T-shirt blankets, hats, socks, hammocks, wallets, fishing nets, patching pants/shirts

Woodworking & Carpentry
Youth generally love learning how to saw, drill, nail, and build things and these skills can quickly come in handy for family or community projects. Additionally, these skills can dramatically reduce the amount of energy and bi-products created in woodworking using raw materials.

- Example projects: Boxes, dressers, skateboards, picture frames, benches, tables, etc.
- Safety note: When working with sharp or potentially dangerous equipment, ensure there is enough supervision and support for students to learn safely. See Lab Practices for more ideas regarding safety and rules.

Redesigning, painting, building, crafting, etc: Upcycling and circular economies require innovation and creativity---give youth opportunities to play with materials and learn new crafting skills.

- Example projects: Plant vases, wreaths, snow globes, piñatas, children's toys, key chains, picture frames, puppets, models, bookmarks, artwork, etc.

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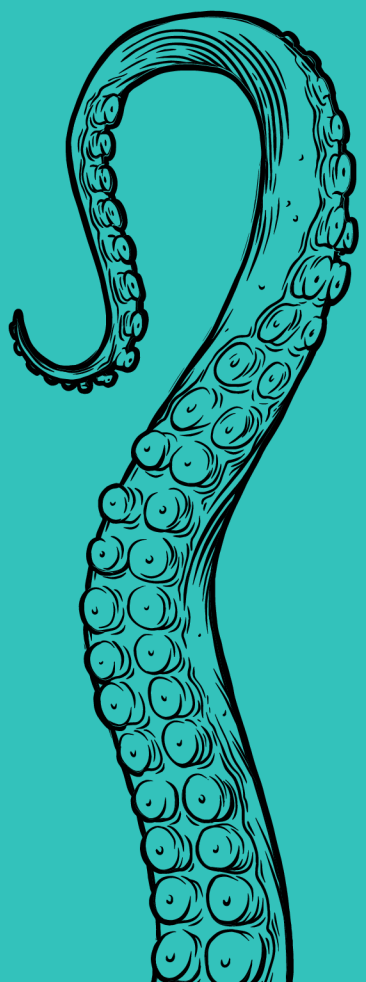

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