Crystal Cove® CONSERVANCY

MPA EXPLORATION TEACHER GUIDE

Topic: Marine Ecosystems
Grade Level: 7-12
Unit Length: 10 sessions

Unit Overview
Student research teams investigate how best to protect the marine ecosystem in the Crystal Cove State Marine Conservation Area. As they explore how MPA regulations protect coastal marine ecosystems, students design a model, process data during a virtual monitoring cruise, analyze the data, and share their findings with Crystal Cove State Park.

At the end of the unit, in an optional culminating project, students use science communication strategies to create social media pieces that promote the protection of places like the Crystal Cove SMCA.

Essential Questions:
- How can we protect the Crystal Cove State Marine Conservation Area?
- How is the Crystal Cove State Marine Conservation Area changing over time?

NGSS Performance Expectations
MS-LS2-1
MS-LS2-3
HS-LS2-2
HS-ESS3-3

NGSS Crosscutting Concept
Systems & System Models

Welcome to Crystal Cove Conservancy's Marine Protected Area Exploration! As you and your students take part in real marine monitoring in Crystal Cove State Park's underwater park, you'll help researchers and natural resource managers understand whether regulations in the Crystal Cove State Marine Conservation Area are working.

The MPA Exploration is the result of a unique partnership between Crystal Cove Conservancy, Crystal Cove State Park, Newport Landing Sportfishing, UC Irvine researchers, and local educators. During this extended program, student research teams are introduced to California's Marine Protected Area network and how it helps to protect places like Crystal Cove's underwater park. By engaging in the practices of science, students develop a deep understanding of how environmental systems operate over time and build skills to engage in environmental research and science communication, preparing them to become informed stakeholders in the future.

Normally, the MPA Exploration involves an integrated curriculum that links classroom learning to a field trip aboard a fishing vessel owned and operated by Newport Landing Sportfishing. During the 2020-2021 school year, as a result of COVID-19, we have adapted the MPA Exploration so that students can participate virtually without the field experience.

The virtual version of the MPA Exploration is free for participating teachers and students, and was made possible thanks to support from the ***Ocean Protection Council*** and ***Coastal Quest***. For more information on the grant award, ***click here***!

If you would like more information on the program or would like to officially join, please contact Holly Fletcher, Crystal Cove Conservancy Education Manager, by emailing ***holly@crystalcove.org***.

If you have taken part in the MPA Exploration, we would love to hear from you! Please ***fill out this participation form*** if you have used any of the modules or would like to leave feedback.

Our Park

Located on the coast in the area that is today known as Orange County, Crystal Cove State Park is located on the traditional lands and waters of the Acjachemen and Tongva tribal nations. We are deeply indebted to these tribal nations for their continuing role as the caretakers of these lands and waters, and are committed to uplifting their voices and perspectives through our work.

Crystal Cove State Park today is a green enclave within suburban Orange County. It consists of 3.2 miles of protected coastline, 2,400 acres of backcountry in Moro Canyon, and a 1,150-acre offshore underwater park, designated as the Crystal Cove State Marine Conservation Area in 2012.

The park features the federally-listed Historic District, which includes an enclave of forty-five vintage coastal cottages originally built as a seaside colony in the 1930s and 1940s and a preserved Japanese school house, which was built by the area's Japanese farming community before they were deported by the federal government to internment camps during World War Two.

Who We Are

Crystal Cove Conservancy is the nonprofit public benefit partner to Crystal Cove State Park, supporting important preservation, education, and conservation initiatives to cultivate our planet's next generation of environmental stewards ensuring that Crystal Cove, and places like it, live on for generations.

The Conservancy's unique STEM (Science, Technology, Engineering, Mathematics) education programs use community science to immerse students and the public in becoming good stewards of our environment. During our programs, students take part in real scientific investigations, working alongside researchers and land managers to investigate challenges faced by Crystal Cove State Park. Student findings inform real land management decisions, and past student data has even been included in ***academic publications***, furthering our understanding of how best to protect wild places like Crystal Cove State Park.

For questions regarding MPA Exploration curriculum, logistics, and field trip scholarships, please contact:

Holly Fletcher
Crystal Cove Conservancy Education Manager
(949) 607-8709
holly@crystalcove.org

For questions regarding booking MPA Cruise field trips, please contact:

Jessica Roame
Newport Landing Education Coordinator
(949) 675-0550 x 118
jessica@newportwhales.org

Our Philosophical Approach to Science Learning

Crystal Cove Conservancy's STEM education programs are anchored in the idea of science-as-practice: that the best way to learn science is to do science. All of our programs integrate a three-dimensional approach to learning that aligns with the Next Generation Science Standards.

Our commitment to science-as-practice means that your students will really be helping to advance scientific knowledge as they participate in our STEM education programs. The research that they take part in is real, addressing real questions from scientists and land managers. Every year, we go into our program season unsure of what they'll find. Student data has even been included in scientific journal articles, like ***Dr. Peter Bryant's article*** on DNA barcoding techniques for plankton that was published in PLoS.

We also ground our work in sociocultural approaches to learning. We believe that people learn best by engaging in conversation with each other. Explaining reasoning out loud, asking questions of our peers, and responding to critique allows us to develop and test our ideas about how the world works. It also mirrors how professional scientists work by engaging in discussion and challenging ideas together.

Our Approach to Equity & Access

We believe in an assets-based approach to environmental education. The environmental movement has a long history of systematically excluding Black, Indigenous, and People of Color from both the movement itself and from parks and other outdoor spaces. Through programs like the MPA Exploration, we aim to empower youth so that they know that they can make a meaningful contribution to conservation.

We also recognize that all learners are natural scientists who possess an innate curiosity about the world. When students take part in the MPA Exploration, they are not learning to do science from scratch, but are practicing and refining the scientific skills that they already possess.

We are deeply committed to improving accessibility to our programs. Videos are close-captioned, and we've provided family-oriented materials in Spanish and English. If you need a different language or other technology to make the program more accessible for your students, please let us know.

Introduction to the Ecological Problem

Our ocean is one of California's greatest treasures, and it plays an important role in both our everyday lives and our economy. As our population has grown, human activity has put more and more pressure on our coastal and marine ecosystem. Overfishing has stressed not only many of the fish and marine species that we rely on for food, but also the marine ecosystems as a whole.

To prevent overfishing, governments can put regulations into effect that limit specific types of take. Marine protected areas are underwater parks where a government puts limits on specific human activities within defined boundaries. Scientific evidence has shown that these marine protected areas, commonly called MPAs, help to preserve biodiversity in marine ecosystems because they create a safe space where threatened species can breed and reproduce without pressure from people. As the fish or other marine populations grow within an MPA, they eventually spill over into unprotected waters, thus benefiting fishermen and others who rely on them for sustenance or economic value.

California has long had marine protected areas, but for much of our state's history, these parks were set up ad hoc without clear goals or objectives. A 1997 study found that they were giving little conservation value. To remedy this, in 1999, California's Legislature passed the Marine Life Protection Act (MLPA), which directed the state to review California's existing marine parks and redesign them as a coherent system grounded in science. This would allow the newly-designed MPA system to function as a network, helping to protect the state's marine life, marine ecosystems, and marine natural heritage. This historic law was the very first effort in the United States to set up such a statewide network of marine parks.

In June 2012, the new MPA network for California's South Coast was implemented. This included the establishment of the Crystal Cove State Marine Conservation Area (SMCA), the underwater offshoot of Crystal Cove State Park. However, at the time, there was no funding and no guidance on how the State Park should monitor the newly-established Crystal Cove SMCA to determine whether it was working or not.

That was how the Crystal Cove MPA Exploration was born. Crystal Cove Conservancy, the park's nonprofit partner, entered into a new partnership with Newport Landing Sportfishing, a nearby fishing company. At the time, the partnership was particularly notable because environmentalists and the fishing industry had been at loggerheads for so long during the MPA implementation process. The Conservancy then partnered with Crystal Cove State Park's natural resource managers and UC Irvine researchers to set up a series of monitoring projects, which we continue to this day.

The Intersection Between Science, Community Interests, and Policy

California's MPA Network also offers a unique opportunity for students to explore the intersection between policy, government regulations, community interests, and science. Early attempts to implement the MLPA and plan a statewide network of underwater parks stalled due to budget challenges and vocal opposition from several different groups. California's tribal nations possess unceded rights to access and care for California's coastal lands and waters, and they feared that those rights were being ignored by policymakers. In addition, fishing groups were vocally opposed to the proposed limits on fishing.

In 2004, a nonprofit organization called Resource Legacy Fund stepped in and signed an agreement with the State of California to start a new initiative to implement the act. From 2004-2012, RLF oversaw an extensive planning process, setting up scientific task forces and holding stakeholder meetings across the state to collect public input and expert ideas. The process became highly contentious. California's tribal nations, who frequently face racism and other systemic barriers that exclude them from California's governmental processes, feel strongly that their rightful interests were ignored during the review process. Fishing groups were also strongly opposed to the proposed reduction in permitted fishing areas.

Although California's new statewide system of marine protected areas is remarkable and historic from the perspective of science policy, there are still stakeholders today who feel as if their interests have been ignored or dismissed by the state. Most notably for Crystal Cove, this includes the Acjachemen and the Tongva, the two tribal nations whose historic lands and waters include the area that is now designated as Crystal Cove SMCA. Members of the local fishing community also remain frustrated by the regulations. If our goal is to protect and preserve our marine ecosystem, we need to find ways to include those who have been historically excluded from the political process.

The Challenge for Students

During the MPA Exploration, your students will have the chance to explore this intersection between science, policy, and stakeholder perspectives. Participating students will process and analyze real environmental data for three monitoring projects, helping us to better understand how the Crystal Cove SMCA is changing over time so that we can assess whether the regulations are working.

This year, in a new extension, students can also help us test new methods to build public awareness of the Crystal Cove SMCA by developing social media pieces aimed at specific audiences. Their creations will really be shared and evaluated through Crystal Cove Conservancy's social media platforms, helping us to build a better understanding of how best to promote awareness of MPA regulations among different audiences. By doing so, we will continue to ensure that Crystal Cove's underwater park, and other remarkable places like it, remain protected for future generations to enjoy.

Our Monitoring Projects

Since 2015, Crystal Cove Conservancy has partnered with Crystal Cove State Park and UC Irvine to run three monitoring projects in the Crystal Cove SMCA: using underwater cameras to survey the fish population in the kelp forest, conducting plankton tows and identifying plankton under a microscope, and collecting and testing water samples at different depths.

These monitoring projects are intended to help us understand how the ecosystem in the SMCA is changing over time. This will allow Crystal Cove State Park to make informed decisions about resource management and provide input on the MPA regulations when they come up for review in 2022.

Normally, the data for these three monitoring projects are collected by students during MPA Cruise field trips. Due to COVID-19 restrictions, in 2021, Crystal Cove Conservancy and Newport Landing will conduct monthly monitoring cruises to collect the data ourselves -- but although we've taken up the burden of collecting field samples, we still need help from students to record and analyze that data. During the MPA Exploration program, students will be responsible for processing the data during a virtual field expedition in Session 6, and then will analyze the full multi-year data set to look for trends in Session 7.

Driving Questions

How can we protect the Crystal Cove State Marine Conservation Area?
How Crystal Cove SMCA's ecosystem changing over time?
Are MPA regulations working?

Testable Monitoring Questions

- ***Monitoring Question (1):*** **Fish.** How is the presence of our target fish species changing over time in the Crystal Cove SMCA?
- ***Monitoring Question (2):*** **Plankton.** How is the presence of our target plankton species changing over time in the Crystal Cove SMCA?
- ***Monitoring Question (3):*** **Water quality.** How is the water quality in the Crystal Cove SMCA changing over time?

Learning Outcomes

During the MPA Exploration, students will be immersed in the practices and processes of scientific research as they take part in marine ecosystem monitoring in the Crystal Cove State Marine Conservation Area. By participating in the full program, they will build a broad understanding of marine ecology, MPA management, science communication, and how professional and community scientists can use science ideas and build public awareness to protect places like Crystal Cove's underwater park.

By the end of the program, your students will be able to…	*You can assess this using…*
1. ***Participate*** productively in scientific practices and the discourse of science.	Observations of student discussions throughout the program
2. ***Explain*** how MPA regulations can help to protect coastal marine ecosystems.	Observations of student discussions and science journals in Module 1
3. ***Use*** lateral search techniques to analyze sources and answer student-generated questions.	Research team presentations in Session 2 and Session 4
4. ***Construct*** a visual model of a marine ecosystem that shows how different factors and processes affect fish populations.	Research team models, created in Session 3 and revised in Session 4
5. ***Use*** their model to analyze how MPA regulations and changes to the environment may affect fish populations in a coastal marine ecosystem.	Research team discussions and field notebooks in Session 3
6. ***Reflect*** on why natural resource managers want to monitor ecosystems and collect and analyze data over time.	Field notebook reflections in Session 6
7. ***Use*** ideas about statistics to create mathematical representations and graphs showing changes in fish population, plankton population, and water quality data over time.	Research team products in Session 7
8. ***Construct*** evidence-based explanations about how the Crystal Cove State Marine Conservation Area is changing over time.	Research team products in Session 7
9. ***Apply*** science communication strategies to design a social media piece that communicates key science ideas related to Marine Protected Areas.	Final social media presentation in Session 10
10. ***Reflect*** on how we can use science ideas to protect places like the Crystal Cove SMCA.	Field notebook reflections in Session 7 and Session 10

Next Generation Science Standards Alignment

The MPA Exploration program is aligned with the three-dimensional approach of the Next Generation Science Standards. As students engage in community science research that focuses on a specific disciplinary core idea, they utilize science practices to plan and carry out investigations. Our programs frame science investigation through the crosscutting concept lens of Systems & Systems Models, challenging students to think about the visible and invisible interactions that affect environmental systems at Crystal Cove State Park.

By taking part in the ten sessions, students will be able to demonstrate understanding in the following areas:

Performance Expectations

Middle School

- ***5-LS1-1.*** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

- ***5-LS2-1.*** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

High School

- ***HS-LS2-2:*** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

- ***HS-ESS3-3:*** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Science Practices

1. Asking questions
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concept

- Systems and System Models

Session	Overview	Length
1 Exploring Crystal Cove's SMCA!	In this initial session, students are introduced to the MPA Exploration program. After learning about the project, they are divided into research teams and start their field notebooks. After, they explore a Thinglink of Crystal Cove's beach to meet different stakeholders and investigate why people care about protecting the Crystal Cove SMCA.	45-60 minutes
2 Asking Questions About MPAs	Research teams generate questions about Marine Protected Areas and then use lateral search techniques to assess sources and research information online.	75-120 minutes
3 Designing a Model	Research teams collaborate to design a model showing how different components and processes affect the fish population in the Crystal Cove State Marine Conservation Area.	90-120 minutes
4 Diving Deeper (optional)	Research teams identify questions about their model, and then conduct background research to answer their questions and refine their model.	45-60 minutes or longer
5 Preparing to Collect Data	Research team members are assigned to specialize and learn more about one of the three monitoring projects in the Crystal Cove SMCA.	45-60 minutes
6 Collecting Data	Via Thinglink, research teams take part in a virtual monitoring cruise. They learn about the data collection process via video and help record data for their specialized monitoring project.	45-60 minutes
7 Analyzing Data	Research teams are tasked with analyzing data and determining how the Crystal Cove SMCA is changing over time.	75-90 minutes
8 Choosing a Message (optional)	After determining how the Crystal Cove SMCA is changing over time, team members are tasked with developing a social media piece to increase community awareness of MPAs. After learning about the basics of science communication, they choose a message, an audience, and a platform and begin drafting an evaluation plan.	45-60 minutes
9 Refining Your Plan (optional)	Team members refine their messaging and begin developing their social media piece.	90-120 minutes
10 Executing Your Plan (optional)	Finally, team members finalize their social media piece and evaluation plan, and then share it on their chosen platform.	45-60 minutes

Required Student Assessment

Crystal Cove Conservancy has pre- and post-assessments to help us evaluate the program's effectiveness, measure its impact on students, and report back on student learning outcome to our funders.

Before you start the MPA Exploration program, please ask students to complete the pre-program assessment. After completing your last session of the program, please have them fill out the post-program assessment. You can assure students that their responses to these two assessments will not be graded or scored -- they're simply to help us assess the program itself.

Student Pre-Program Assessment: **https://forms.gle/eiGNwAGRY9RESTqs9**
Student Post-Program Assessment: **https://forms.gle/GjM3GjkYMiiScZev9**

Basic Session Structure

Each session within the MPA Exploration is broken down into four sections. These sections align with the five elements of the BSCS 5E Instructional Model (although we use slightly different names).

Launch *(or Engage)*

At the start of every session, a short video introduces students to the day's driving question and invites them to share their initial ideas.

Explore

Next, students take part in short investigations related to the module's driving question. These investigations are designed to be flexible, and can take place during scheduled class time or independently outside of class.

Share *(or Explain & Expand)*

Students come back together to share their observations and discuss their ideas with their peers. These discussions may take place in student research teams or as a whole class. In the Session 1 slideshow, we've included slides with suggested science discussion norms, sentence starters, and suggested questions to get you started! You can adapt these for your class.

Reflect *(or Evaluate)*

At the end of each session, students watch a video prompt and reflect on what they've learned so far in their field notebook.

Technological Platforms

Throughout the MPA Exploration, we use a few different technological platforms to support student learning.

Sharing Information

Most of the program's presentations are hosted on ***Google Slides***, with videos embedded from our ***Crystal Cove Conservancy Education Youtube*** account. Due to school permissions, you will likely need to make a copy of each Google Slides presentation on your school Google account so that students can access it.

Exploring Places Virtually

Thinglink is an easy-to-use platform that allows organizations to create interactive photo maps that users can click on and explore -- including 360-degree photos. During the MPA Exploration, students will use Thinglink ***to take a virtual tour*** of the Crystal Cove SMCA in Session 1, and then visit another Thinglink later in Session 6 to participate in a virtual monitoring cruise. (You will not need to know how to use it, other than demonstrating how to access virtual explorations and click through it!)

Creating Models

You can choose between two different options for students to use when they create a model in Session 3. The Session 3 lesson guide has more specific information on the advantages and disadvantages of the two platforms.

- ***Padlet*** is a collaboration platform similar to an online bulletin board, which will let multiple students collaborate and build a model at the same time. Free accounts (which students can sign up for) can create up to three Padlet boards. Pro accounts, which let a user create unlimited boards, start at $8/month. If you don't have access to Padlet but prefer a collaborative option for modeling, you might consider using ***Google Jamboard*** or another ***online collaborative whiteboard*** instead.

- ***SageModeler*** is a free, online modeling tool that can be used to build computer simulations of systems. Although it is challenging to collaborate on SageModeler because only one person can manipulate the model, this platform will also allow students to easily define computational relationships between different factors in their models and simulate how environmental change will affect them.

Analyzing Data

SageModeler has the ability to create graphs and display data using visualizations that are deliberately designed to help students think about data distribution and outliers. This can help students to build a conceptual understanding of ideas like statistical significance. It is also easy to use, which makes it ideal for younger students. However, it is challenging to collaborate on SageModeler because only one person at a time can manipulate it, and it is not a platform that would be used by practicing researchers.

Google Sheets is a more traditional data analysis platform that is very similar to Microsoft Excel. It allows students greater freedom in creating graphs and performing calculations, and it can also be accessed collaboratively, with multiple students working on the same document in real time. However, using Google Sheets requires students to be more attentive to the step-by-step process involved in creating graphs and performing calculations, which can detract from conceptual understanding.

Designing Communications

In Sessions 8-10, students are tasked with creating a social media piece to communicate ideas about the Crystal Cove SMCA to specific audiences. During Session 8, they're asked to pick a platform to reach their audience. Recommended options include **Youtube**, **Facebook**, **Twitter**, **Instagram**, and **Medium**.

Later on, in Session 10, students will need to design and produce their social media piece. You can use whatever graphic design or video editing programs you have access to at your school site. If you are not familiar with any programs, easy-to-use free Mac & PC options include **Krita** for graphic design and **Da Vinci Resolve** for video editing. Mobile options include **Adobe Lightroom** for image editing and design, and **InShot** for video editing.

If you prefer another platform that serves a similar purpose, please feel free to substitute it in. If you or your students have any trouble accessing the slideshows or videos, please contact Holly at ***holly@crystalcove.org***!

Decisions to Make

Before beginning the MPA Exploration, it will be helpful to think through how you want to integrate and support a few key aspects of the program. Below, you'll find more information on four key decisions that you may want to make.

Supporting Collaboration

We often learn science best by engaging in discussions and collaboration, but COVID-19 restrictions and time limitations make it challenging to support collaboration. As a result, it's worth thinking ahead about ways that you can intentionally support student collaboration.

We recommend dividing students into research teams early in Session 1. Students will continue to work in these same teams throughout the program. If you are teaching in a fully online or hybrid environment, you might consider dividing into small discussion groups on Zoom or giving students options to meet in their research teams independently.

Integrating Field Notebooks

Throughout the MPA Exploration, students are encouraged to use field notebooks to take notes, record observations, plan investigations, and reflect on their own thinking. This is intended as a teaching tool to support metacognition. Before beginning the program, we recommend thinking through the logistics of the field notebooks.

- ***What kind of journal do you want students to use?*** If you want to give students an opportunity to get off of their computers, you may ask them to use a physical field notebook, like a notebook, notepad, or paper stapled together. Individual Google Docs work for a digital option, which may be easier to review and assess.

- ***How much scaffolding do you want to give students?*** There is benefit to letting students use a free-form notebook, since it will force them to think through how to structure their thinking. However, some students may need more support which can come from pre-designed pages. If you would like to provide students with more scaffolding, we have provided scaffolded field notebook pages for each lesson.

- ***How will you assess the field notebooks?*** Consider whether you want to collect the journals, or if it's better to ask students to share photos of their entries so that you can assess their learning.

Assessing Student Work

Assessment can be challenging during COVID restrictions, so it is worth thinking ahead about how you will monitor and assess student learning. In the module lesson guides, we've identified learning outcomes for each module, along with suggestions for assessments.

- ***For formative assessments,*** you can observe student science journals and other student-created work, monitor students during discussions, and have students share a personal reflection at the end of each module.

- ***For summative assessments,*** you might decide to use our pre- and post-program learning assessments or have students or grade research team's final product using a rubric.