Intertidal Bioblitz

Rocky Intertidal - Grades 9-12

Learning Objectives

A) Students will use the iNaturalist app to observe and record intertidal species at sites inside and outside of the South La Jolla State Marine Reserve [MR1] (Part 1.)
B) Students will use species richness and Simpson's Index to calculate the diversity present at the two study sites (Part 2.)
C) Students will compare diversity inside and outside of the MPA to draw conclusions about MPA impact on biodiversity (Part 3.)
[MR1]Why just at La Jolla? Can you make it more general to MPAs across the state so students in other areas can use the curriculum too?

NGSS: DCI (Disciplinary Core Ideas):
LS2.A
LS4.D

Time: Four to nine 50-minute class periods plus one and a half to two hour field trip

Materials for the Teacher
-Living on the Edge: Field Guide to the Intertidal

Materials for the Students
-Cell phone with iNaturalist app (per 2-4 students)
-Computer with Excel (per 2-4 students)

Part 1: Data Collection

Background information:
(recommended one to six 50-minute class periods)
See Living on the Edge: Field Guide to the Intertidal Zone for more background information and classroom activities that may accompany this lesson. It is recommended you take one 50-minute class period to cover each of the six topics covered in the field guide: The Intertidal Zone, Adaptations, Tidepools, Tides, Marine Protected Areas, and Taxonomy/ID.

Marine Protected Areas (MPAs)

We can think of **marine protected areas**, or MPAs, as underwater parks. Just like we have national, state, and regional parks on land, there are many different types of MPAs. Different parks allow different activities - same with MPAs! In some of them you can fish, while in others you can't. Some MPAs allow all kinds of activities (fishing, swimming, boating, etc.) while others are much stricter. By restricting what people can do and **take** in these underwater parks, we can protect California's **natural resources**.

California has 124 MPAs all along the coast. These MPAs protect many different habitats where many different animals live. MPAs give marine species a safe place to breed and grow. Animals inside of MPAs may be larger than those found outside of MPAs, allowing them to have more offspring than smaller animals. Offspring born within MPAs may also have access to more food, space, and ecological resources.

MPAs also provide opportunities for people to see beautiful, protected ocean spaces through snorkeling, scuba diving, swimming, kayaking etc. Sometimes, people don't know that they are in an MPA and accidentally do something they aren't supposed to do. That's why it is important to understand what MPAs are, why we have them, and where they are - so you know if you are in one!

Also, have students start to think about the following now. We will discuss it more in-depth at the end off the lesson: Evidence suggests that MPAs may increase biodiversity and abundance by giving species a safe place to live, grow, and reproduce; however, this success is threatened by other activities such as marine debris/pollution. What are some complementary solutions that may be enacted to help reduce or eliminate the threat of marine debris to MPAs?

Intertidal Zone

MPAs protect a wide range of ecosystems across California, including kelp forests, sandy shores, rocky reefs, and the intertidal zone. This lesson will focus on the unique and fun intertidal zone.

The **intertidal zone**, the area between the high and low tide lines, is a harsh and unforgiving habitat. The highly adapted species that live there are subject to the rigors of both the land and the sea, going from being completely submerged to only occasionally wet within just a few feet. Organisms that inhabit the intertidal zone must endure extreme fluctuations in moisture level, temperature, salinity, and sunlight. Those that are able to do so make up a robust assortment of biologically diverse organisms with specialized adaptations. Visiting these creatures in the space between land and sea is truly an adventure!

MPAs limit or prohibit which intertidal organisms humans may take. This reduces stress on intertidal organisms and safeguards marine resources within this dynamic environment.

iNaturalist Bioblitz

A "bioblitz" is a **community science** effort to record as many species within a designated location and time period as possible. Public participation is what separates bioblitzes from traditional biological inventories.

Bioblitzes are a way for us to measure biodiversity. The Greek root "bio" means life. That means that "**biodiversity**" is the diversity of life.
We live on a planet full of many different kinds of life - animals, plants, fungi, bacteria, and some things that are so weird that we hardly know what to call them. Scientists classify living things into different groups, with the smallest unit of classification being the species. Nobody really knows how many species exist on Earth because we haven't found them all - not even close! Some scientists think there could be a million species living just in the ocean.

Living organisms (**biotic factors**) interact with the non-living things (**abiotic factors**) around them - examples would be water, sunlight, wind, etc. We call a community of living organisms and their nonliving physical environment an ecosystem. Examples of ocean ecosystems here in California are kelp forests, sandy beaches, rocky shores (and tidepools), and the open ocean.

When scientists talk about biodiversity, they usually are referring to the diversity of both species and ecosystems.

For this activity, we will compare biodiversity between a **control site** (Windandsea Beach) and an **experimental site** (South La Jolla State Marine Reserve) to explore whether there is a difference in biodiversity inside versus outside of an MPA.

Vocabulary

-*Marine Protected Area (MPA)*: MPAs are areas in or near the ocean made to protect or conserve marine life and habitat, safeguard cultural sites, and provide enhanced recreational opportunities.

-*Take*: To hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill any natural resources.

-*Natural Resource*: Materials or substances such as minerals, forests, water, or animals that are found in nature and are valuable to humans.

-*Intertidal Zone*: The area of land in between the high and low tidelines.

-*Community (or citizen) Science*: The collection and/or analysis of scientific data by everyday people.

-*iNaturalist*: A community science project and online social network of naturalists, citizen scientists, and biologists built on the

Suggested procedure:

Teacher Prep

Create an Account on iNaturalist

Log on to www.inaturalist.org and click on “Sign Up” in the upper right-hand corner. Follow website prompts.

Create a Project

*Note: In order to do comparative data analysis between the experimental site (South La Jolla State Marine Reserve) and control site (Windandsea Beach) you will need to create two projects: one for each site.

For Experimental Site (South La Jolla State Marine Reserve)

1) Log in to your account. From your dashboard select “Projects” in the upper right-hand corner.
2) Select “Start a Project”
3) Select “Collection Projects”
4) Fill in Project Name and Summary using class information.
5) Upload whatever pictures you want the students to see under Project Icon and Project Banner.
6) Project Type = Collection
7) Places = South La Jolla State Marine Reserve
8) Date Observed = Range (enter date, start time and end time of your project)
9) Admin(s) = You are automatically an admin. You can add the usernames of any other teachers who need access.

For Control Site (Windandsea Beach)

Follow steps above, except give it a different name and for step 7 enter “Windandsea Beach”

Student Prep

1) In class, cover MPAs, the intertidal zone, bioblitzes, and biodiversity. Use the information and activities in Living on the Edge: Field Guide to the Intertidal Zone. Have students form a hypothesis in response to the following research question: Is there a difference in biodiversity inside an MPA compared to outside an MPA?
2) Break students into research groups of 2-4. Each group will need at least one cell phone.
3) Pass out the iNaturalist guide (available in Living on the Edge: Field Guide to the Intertidal).
4) Have students download the iNaturalist app onto their cell phones.
5) Have students create personal iNaturalist accounts (students must be at least 13 years old to complete this step.)

concept of mapping and sharing observations of biodiversity across the globe. iNaturalist may be accessed via its website or from its mobile applications.
-*Bioblitz*: A community science effort to record as many species within a designated location and time period as possible.
-*Biodiversity*: The variety of life on Earth.
-*Biotic Factor*: The living things in an ecosystem.
-*Abiotic Factor*: The non-living things in an ecosystem.
-*Experimental site*: The site receiving the experimental treatment (in our case the protection afforded by MPAs)
-*Control site*: The site not receiving experimental treatment

California Department of Fish and Wildlife Key Messages:
-MPAs protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.

i. Open the iNaturalist app.

ii. Click on Log in with Facebook or Google (preferred) or “Sign up now!” if student does not have a Facebook or Google account.

iii. Make sure to click “Yes, license my content so scientists can use my data.”

iv. Follow prompts to sign up and log in.

6) Go over how to make useful observations:

i. Take identifiable photos: fill the frame with your subject and make sure the picture is in focus

ii. Take multiple photos

iii. Focus on wild organisms

7) Have students join your project by clicking More > Projects and searching for your project name.

Tip: Have students practice taking good photos using iNaturalist’s Seek app. This is a separate app students may download that will allow them to take photos and identify organisms without actually submitting photos to iNaturalist. atershed models call them all

Field Trip **(recommended 1.5-2 hours in the field)**

1) Check the tide to determine which day and time will have an acceptable low tide for this project. Negative, outgoing tides are best, although tides under ~1 foot often work as well. The best tides are in the spring. Tides for La Jolla may be found here: https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=9410230

2) Before you go, distribute copies of the bioblitz pages from Living on the Edge: Field Guide to the Intertidal to each student. These pages include a two-sided guide and worksheet with the research question, project name, and a map of where to meet in case they drive separately.

3) Meet at the following location:

Windandsea Beach in La Jolla
Parking lot at the corner of Nautilus Street and Neptune Place
Street parking is also available for free.
Note, this location does not have public restrooms.

4) Make sure to cover good tidepooling practices with the students:

-Watch where you step, that might not be a rock!

-Leave things how you found them. If you turn over a rock, put it back exactly how you found it.

-Take only pictures. Leave all rocks, plants, animals, and other tidepool creatures exactly how you found them.

-Leave animals be. Tidepool organisms have a hard enough life as it is without being touched by a bunch of sticky fingers.

-Be careful where you put your fingers. Many animals like sea urchins and crabs have defenses against predators.

-Never turn your back on the ocean.... it needs you too much! But seriously, watch out for waves and the incoming tide.

-MPAs help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.
-MPAs improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and manage these uses in a manner consistent with protecting biodiversity.
-MPAs protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic values.

Connections:
Art, science, engineering

Ocean Literacy Connection:
-The ocean supports a great diversity of life and ecosystems.
-The ocean and humans are inextricably interconnected.

5) Designate a meeting location and end time for the activity. Depending on the group, tides, and weather conditions, often about 45 minutes to an hour is appropriate for data collection.
6) Split the class into two groups, making sure the student research groups of 2-4 students are kept together. One group will descend the stairs below the parking lot and tidepool on the rocks just to the north. This group is the Windandsea Beach control group.
7) The other group will head about 10 minutes south and take the stairs down to the beach by Palomar Ave. This group will be the South La Jolla State Marine Reserve experimental group.
8) Make sure to assign at least one chaperone with each group to ensure best practices are met. Once at the site, give students boundaries and remind them to stay
9) Once at the site, give students boundaries and remind them to stay together. Let student groups explore and make and record as many observations as possible within the iNaturalist app during the designated time period. Observations will be automatically added to the appropriate project.
10) Students will typically be excited about what they saw and will want time to share with others. Once the class regroups, give them time to share their observations as well as any surprises they experienced, challenges they faced, or favorite things they saw.

Suggested extensions:
-Omit the field trip portion and substitute with a mock bioblitz in the classroom. Team up with another teacher and designate one classroom as the MPA and one classroom as the control. Hide organism cards throughout the classrooms and allow students to search and record what they find. Create an Excel file with your findings or use included datasets and complete Parts 2 and 3 of this lesson plan.
-Omit field trip and do a bioblitz in the schoolyard. Use included datasets to complete Parts 2 and 3.
-For students with higher math levels: have them calculate biodiversity using the Shannon Index.
-Instead of calculating biodiversity in Excel students may do the math by hand.
- Mix and match the six lessons and various activities in Living on the Edge: Field Guide to the Intertidal to meet classroom needs.

PART 2: Data Analysis

(recommended two 50 minute class periods: one to cover background and species richness, one to cover Simpson's index)

Background information:

Measuring Biodiversity

A **biodiversity index** is a way of measuring biodiversity. Scientists use different biodiversity indices to measure diversity, and no single one will always be appropriate for the question being posed. In fact, for some conservation questions, more than one measure may have to be used.

There are two basic indices commonly used to measure biodiversity:

Species Richness

-The total number of species in an area

Species Evenness

-How evenly the species are represented in the area.

Species richness is the most commonly used type of biodiversity index because it is easy to calculate (the number of species reported in iNaturalist is the species richness for the site!), most people tend to understand what a species is, and it can be used to directly compare two sites (whichever site has the highest number is more diverse).

Many diversity indices have been developed that combine different measures of biodiversity. One is called the **Simpson's Index**. The **Simpson's Index** includes both species richness and species evenness in a single number.

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

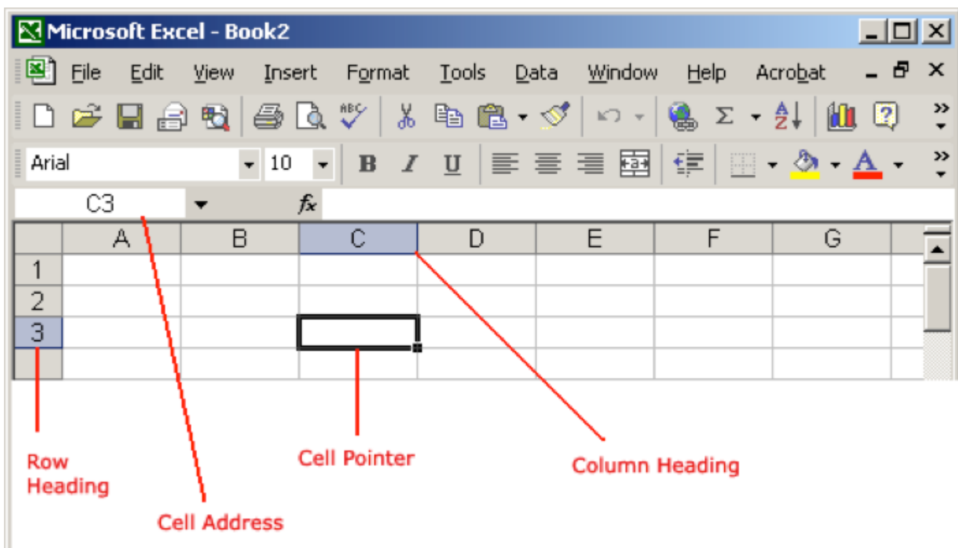
D = Simpson's Index
n = the total number of individuals of a particular species
N = the total number of individuals of all species

D values range between 0-1 with 0 the most diverse and 1 the least diverse.

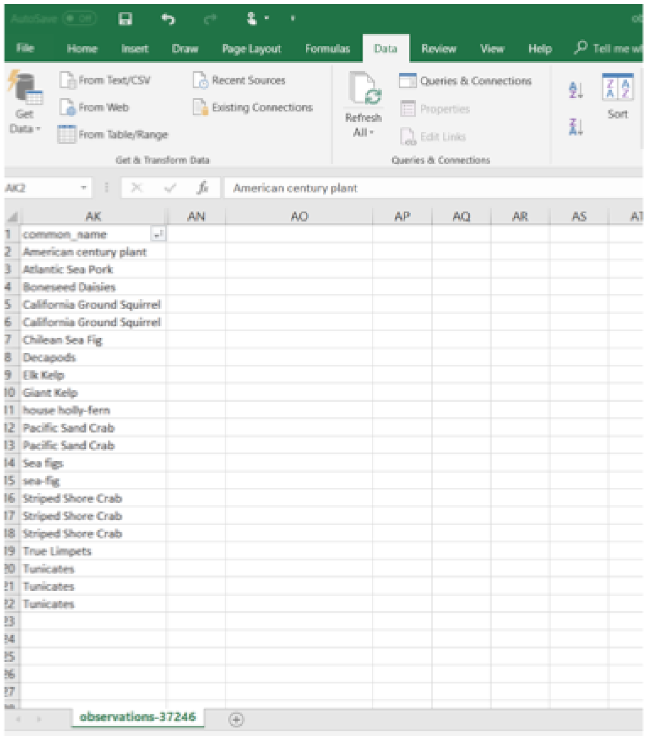
Teacher Prep
On the iNaturalist website, return to your project page. It will show pictures of some of the observations made, as well as stats for most observations, most species, etc. Click on Observations (either at the top, or "View All" next to recent observations.
Once on the observation page click on "Export observations" in the upper right-hand corner. You should not need to change anything in the query. Scroll to the bottom and select "Create Export." This process will take a minute or two and then a green dialogue box should appear at the top of the page with a download button. Click "Download" to download a copy of your class' data in Excel. You will need to repeat this process for each of your two projects.

-Allow students to conduct a separate inquiry project using the datasets they produce.

Suggested procedure:



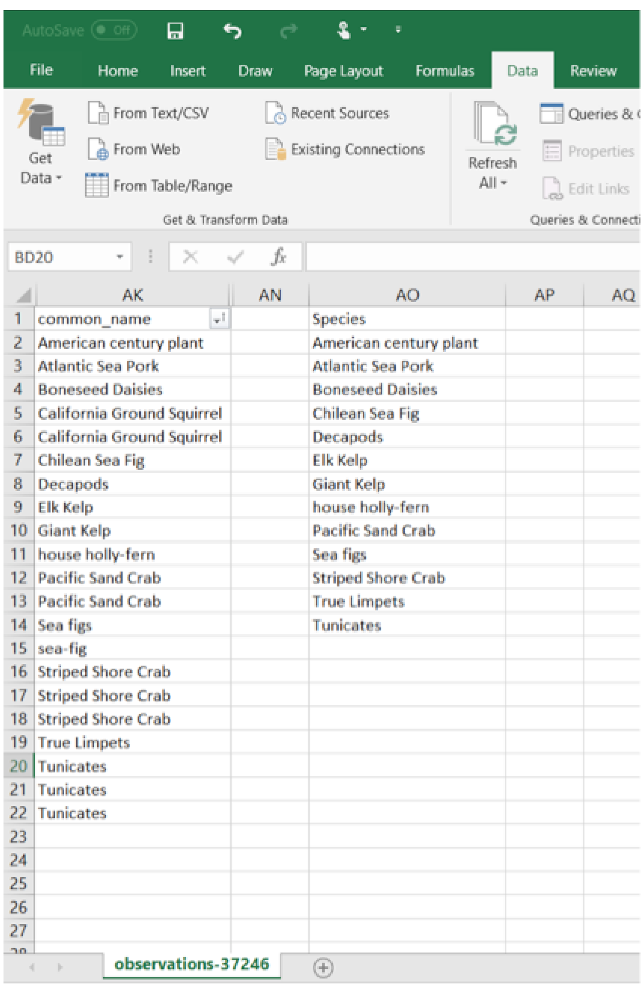
Set up Excel Worksheet
1) Each student research group will need a computer and a copy of the Excel file from their study site.
2) Open the Excel file.
3) Hide columns A-AI by clicking and dragging between column headings. Once desired columns are selected release the mouse, right click within the selected area, and click "Hide."
4) Repeat step 3 to hide columns AL-AM. The remaining columns should be AJ/Scientific Name and AK/Common Name.
5) Decide whether you want your class to use scientific name or common name. They may hide the other column.
6) Select Data>Sort>Sort by and then either common_name or scientific_name depending on which you are using. This will put the species in alphabetical order for easier counting.



	AK
1	common_name
2	American century plant
3	Atlantic Sea Pork
4	Boneseed Daisies
5	California Ground Squirrel
6	California Ground Squirrel
7	Chilean Sea Fig
8	Decapods
9	Elk Kelp
10	Giant Kelp
11	house holly-fern
12	Pacific Sand Crab
13	Pacific Sand Crab
14	Sea figs
15	sea-fig
16	Striped Shore Crab
17	Striped Shore Crab
18	Striped Shore Crab
19	True Limpets
20	Tunicates
21	Tunicates
22	Tunicates

Calculate Species Richness

1) Off to side of the species list, have students create a list of species (label this “Species”)
2) To calculate the species richness, simply count the number of species (not individuals) found. In this example, species richness is 13.
3) Write this number on the board for each site.



	AK	AN	AO
1	common_name		Species
2	American century plant		American century plant
3	Atlantic Sea Pork		Atlantic Sea Pork
4	Boneseed Daisies		Boneseed Daisies
5	California Ground Squirrel		Chilean Sea Fig
6	California Ground Squirrel		Decapods
7	Chilean Sea Fig		Elk Kelp
8	Decapods		Giant Kelp
9	Elk Kelp		house holly-fern
10	Giant Kelp		Pacific Sand Crab
11	house holly-fern		Sea figs
12	Pacific Sand Crab		Striped Shore Crab
13	Pacific Sand Crab		True Limpets
14	Sea figs		Tunicates
15	sea-fig		
16	Striped Shore Crab		
17	Striped Shore Crab		
18	Striped Shore Crab		
19	True Limpets		
20	Tunicates		
21	Tunicates		
22	Tunicates		

Calculate Simpson's Index

1) First we will calculate the top part of the equation: $\sum n(n-1)$. Next to your species list create the following columns:

- n
- n-1
- n(n-1)

2) To calculate n (the number of individuals of that particular species) have students count and manually fill in the data.

3) To calculate n-1, click on the first empty cell under n-1. Type in the following equation = (number1-1) and push Enter. In this case number1 is the n value of the first species, AP2 in our example. You may type in the cell number or click on the cell. So the keystrokes for this example would be =(click on AP2 cell-1) push Enter

AQ2 =(AP2-1)

	AO	AP	AQ	AR
1	Species	n	n-1	n(n-1)
2	American century plant	1	=(AP2-1)	
3	Atlantic Sea Pork	1		
4	Boneseed Daisies	2		
5	Chilean Sea Fig	1		
6	Decapods	1		
7	Elk Kelp	1		
8	Giant Kelp	1		
9	house holly-fern	1		
10	Pacific Sand Crab	2		
11	Sea figs	2		
12	Striped Shore Crab	3		
13	True Limpets	1		
14	Tunicates	3		
15				
16				

4) To copy the formula to the rest of the cells click on the cell you just calculated, click on the little green box in the bottom right hand corner of the cell, drag to the last row with species data, and release.

AQ2 =(AP2-1)

	AO	AP	AQ	AR
1	Species	n	n-1	n(n-1)
2	American century plant	1	0	
3	Atlantic Sea Pork	1	0	
4	Boneseed Daisies	2	1	
5	Chilean Sea Fig	1	0	
6	Decapods	1	0	
7	Elk Kelp	1	0	
8	Giant Kelp	1	0	
9	house holly-fern	1	0	
10	Pacific Sand Crab	2	1	
11	Sea figs	2	1	
12	Striped Shore Crab	3	2	
13	True Limpets	1	0	
14	Tunicates	3	2	
15				
16				
17				

5) To calculate n(n-1) click on the first empty cell under n(n-1). Type in the following equation =number1*number2 and push Enter. In this case number1 is the n value and number2 is the n-1 value.

AQ2 | =AP2*AQ2

	AO	AP	AQ	AR
1	Species	n	n-1	n(n-1)
2	American century plant	1	0	=AP2*AQ2
3	Atlantic Sea Pork	1	0	
4	Boneseed Daisies	2	1	
5	Chilean Sea Fig	1	0	
6	Decapods	1	0	
7	Elk Kelp	1	0	
8	Giant Kelp	1	0	
9	house holly-fern	1	0	
10	Pacific Sand Crab	2	1	
11	Sea figs	2	1	
12	Striped Shore Crab	3	2	
13	True Limpets	1	0	
14	Tunicates	3	2	
15				
16				
17				

6) To copy the formula to the rest of the cells click on the cell you just calculated, click on the little green box in the bottom right hand corner of the cell, drag to the last row with species data, and release.

7) To calculate ∑ (the sum), click on the cell below the last value in n(n-1) and type in the following formula: =sum(number1:number2) and push Enter. Here number1 refers to the first value in the n(n-1) column and number 2 refers to the last value in the n(n-1) column.

AR15 | =sum(AR2:AR14)

	AO	AP	AQ	AR	AS
1	Species	n	n-1	n(n-1)	
2	American century plant	1	0	0	
3	Atlantic Sea Pork	1	0	0	
4	Boneseed Daisies	2	1	2	
5	Chilean Sea Fig	1	0	0	
6	Decapods	1	0	0	
7	Elk Kelp	1	0	0	
8	Giant Kelp	1	0	0	
9	house holly-fern	1	0	0	
10	Pacific Sand Crab	2	1	2	
11	Sea figs	2	1	2	
12	Striped Shore Crab	3	2	6	
13	True Limpets	1	0	0	
14	Tunicates	3	2	6	
15				=sum(AR2:AR14)	
16					
17					

8) Record ∑ n(n - 1) on the board for each site.

9) Now we will calculate the bottom portion of the equation: N(N-1), where N is the total organis of all species.

10) Next to the calculations you just did for ∑ n(n - 1) create the following column labels: Site, N, N(N-1), ∑ n(n - 1), D.

BI11 | *fx*

	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
1	Species	n	n-1	n(n-1)		Site	N	N(N-1)	∑ n(n - 1)	D
2	American century plant	1	0	0		South La Jolla SMR				
3	Atlantic Sea Pork	1	0	0		Windandsea Beach				
4	Boneseed Daisies	2	1	2						
5	Chilean Sea Fig	1	0	0						
6	Decapods	1	0	0						
7	Elk Kelp	1	0	0						
8	Giant Kelp	1	0	0						
9	house holly-fern	1	0	0						
10	Pacific Sand Crab	2	1	2						
11	Sea figs	2	1	2						
12	Striped Shore Crab	3	2	6						
13	True Limpets	1	0	0						
14	Tunicates	3	2	6						
15				18						
16										

11) Under sites type in the name of your experimental site (South La Jolla SMR) and the control site (Windandsea Beach).

12) To calculate N, you will need to find the sum of all values in the n column. To do this, select the cell below the last value in the n column and type in the following equation: sum(number1:number2) and press enter. In this case number1 is the first n value and number2 is the last n value in the column

AP15 | *fx* | =sum(AP2:AP14)

	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
1	Species	n	n-1	n(n-1)		Site	N	N(N-1)	∑ n(n - 1)	D
2	American century plant	1	0	0		South La Jolla SMR				
3	Atlantic Sea Pork	1	0	0		Windandsea Beach				
4	Boneseed Daisies	2	1	2						
5	Chilean Sea Fig	1	0	0						
6	Decapods	1	0	0						
7	Elk Kelp	1	0	0						
8	Giant Kelp	1	0	0						
9	house holly-fern	1	0	0						
10	Pacific Sand Crab	2	1	2						
11	Sea figs	2	1	2						
12	Striped Shore Crab	3	2	6						
13	True Limpets	1	0	0						
14	Tunicates	3	2	6						
15		=sum(AP2:AP14)		18						
16										

13) Enter this number into the appropriate cell under N.

AU3 | *fx* | 20

	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
1	Species	n	n-1	n(n-1)		Site	N	N(N-1)	∑ n(n - 1)	D
2	American century plant	1	0	0		South La Jolla SMR				
3	Atlantic Sea Pork	1	0	0		Windandsea Beach	20			
4	Boneseed Daisies	2	1	2						
5	Chilean Sea Fig	1	0	0						
6	Decapods	1	0	0						
7	Elk Kelp	1	0	0						
8	Giant Kelp	1	0	0						
9	house holly-fern	1	0	0						
10	Pacific Sand Crab	2	1	2						
11	Sea figs	2	1	2						
12	Striped Shore Crab	3	2	6						
13	True Limpets	1	0	0						
14	Tunicates	3	2	6						
15		20		18						
16										
17										

14) To calculate N(N-1) select the appropriate cell in the N(N-1) column and type in the following equation: =number1*(number1-1) and push Enter. Here number1 refers to the N value you calculated in step 13.

AV3 | =AU3*(AU3-1)

	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
1	Species	n	n-1	n(n-1)		Site	N	N(N-1)	∑ n(n - 1)	D
2	American century plant	1	0	0		South La Jolla SMR				
3	Atlantic Sea Pork	1	0	0		Windandsea Beach	20	=AU3*(AU3-1)		
4	Boneseed Daisies	2	1	2						
5	Chilean Sea Fig	1	0	0						
6	Decapods	1	0	0						
7	Elk Kelp	1	0	0						
8	Giant Kelp	1	0	0						
9	house holly-fern	1	0	0						
10	Pacific Sand Crab	2	1	2						
11	Sea figs	2	1	2						
12	Striped Shore Crab	3	2	6						
13	True Limpets	1	0	0						
14	Tunicates	3	2	6						
15		20		18						
16										
17										

15) Transfer the value of ∑ n(n - 1) from step 7 (should also be written on the board) to the appropriate cell under column ∑ n(n - 1).

BH10

	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
1	Species	n	n-1	n(n-1)		Site	N	N(N-1)	∑ n(n - 1)	D
2	American century plant	1	0	0		South La Jolla SMR				
3	Atlantic Sea Pork	1	0	0		Windandsea Beach	20	380	18	
4	Boneseed Daisies	2	1	2						
5	Chilean Sea Fig	1	0	0						
6	Decapods	1	0	0						
7	Elk Kelp	1	0	0						
8	Giant Kelp	1	0	0						
9	house holly-fern	1	0	0						
10	Pacific Sand Crab	2	1	2						
11	Sea figs	2	1	2						
12	Striped Shore Crab	3	2	6						
13	True Limpets	1	0	0						
14	Tunicates	3	2	6						
15		20		18						
16										
17										

16) To calculate the D value, select the appropriate cell under the D column and enter the following equation: =number1/number2 and press enter. Here number1 refers to the ∑ n(n - 1) value and number2 refers to the N(N-1) value.

AV3 | =AW3/AV3

	AT	AU	AV	AW	AX
1	Site	N	N(N-1)	∑ n(n - 1)	D
2	South La Jolla SMR				
3	Windandsea Beach	20	380	18	=AW3/AV3
4					

PART 3: Drawing Conclusions

(recommended one 50-minute class period)

Class Discussion

1) Compare the species richness for both sites. Which site seems more diverse?
2) Now compare the Simpson's Index (D value) for each site. Keep in mind the D value for the Simpson's Index should be between 0-1 and is inverse, so 0 is the most diverse and 1 is the least diverse. According to the Simpson's Index which site was more diverse?
3) How do the two measures of biodiversity compare (species richness and Simpson's Index)? Did you get the same or different conclusions from both? Which measure of biodiversity do you think is the most accurate? Which measure of biodiversity would you recommend if speaking to the public? (Optional extension: How does the Shannon Index compare to these two indices?)
4) Do you think your results are accurate? What are some sources of error? What would you do differently if you did this project again? What would you suggest for future studies?
5) What natural resources did you observe that may be important to humans? How might MPAs protect them? What would happen to the ecosystem if that resource no longer existed? What would happen to humans if that resource no longer existed?

Activity

Assign each student research group a stakeholder group (i.e. local residents, surfers, recreational anglers, commercial anglers, members of a Native American Nation, decision/policy makers, enforcement officials, academics, etc.) and have them create an "elevator pitch" for MPAs to give to a representative of that stakeholder group based on their findings.

A good article about creating elevator pitches can be found here: https://slidebean.com/blog/startups/elevator-pitch-examples

Remind the students that the "product" they are pitching is MPAs.

Present elevator pitches to the class.

Engage: Play one of the games or complete one of the activities from Living on the Edge: Field Guide to the Intertidal. After going over background information have students practice data collection using iNaturalist's Seek app.
Explore: Perform a bioblitz using the iNaturalist app.
Explain: Explain biodiversity and how we measure it.
Elaborate: Have students calculate biodiversity using species richness and Simpson's Index.
Evaluate: Ask the students questions relating to what they have learned (more questions may be found in Part 3 of this lesson plan).
Q1: What are the differences between the various indices of biodiversity?
Q2: Which site had higher biodiversity? Inside the MPA or out? Does this result corroborate or refute the hypothesis? Explain.
Q3: What natural resources are present in the intertidal zone?
Q4: How do MPAs protect those natural resources?

NGSS Alignment

LS2. A Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem.
LS4.D Biodiversity is increased by formation of new species and reduced by extinction. Humans depend on biodiversity but also have adverse impacts on it. Sustaining biodiversity is essential to supporting life on Earth.

Science and Engineering Practices

Asking Questions: Ask questions that arise from examining models or a theory to clarify and/or seek additional information to determine relationships, including quantitative relationships between independent and dependent variables, and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the sustainability of a design.
Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution, apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data, and evaluate the impact of new data on a working explanation and/or model.
Using Mathematics and Computational Thinking: Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
Constructing Explanations and Designing Solutions: Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Engaging in Argument from Evidence: Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence and make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge.

Crosscutting Concepts

Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Online Resources

iNaturalist: www.inaturalist.org
La Jolla Tide Charts: https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=9410230

Measuring Biodiversity from the Government of Canada:
https://nature.ca/en/teacher-zone/teacher-resources/lessons/student-worksheet-measuring-biodiversity
How to Construct a Good Elevator Pitch:
https://slidebean.com/blog/startups/elevator-pitch-examples
South Coast Baseline Program Final Report: Rocky Intertidal Ecosystems:
https://caseagrant.ucsd.edu/sites/default/files/SCMPA-22-Final-Report_wAppendices.pdf

Appendices

See next page

Red Algae

Sea Lettuce

Wavy Turban Snail

Black Turban Snail

Keyhole Limpet

Limpet

Two Spot Octopus

California Spiny Lobster

Purple Sea Star

Purple Sea Urchin

California Mussel

Giant Sea Cucumber

Shore Crab

Hermit Crab

Barnacle

Chiton

Giant Green Anemone

California Sea Hare

Bioblitz Datasheet

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Experimental Site

Species recorded:

Sea Lettuce

Red Algae

Hermit Crab

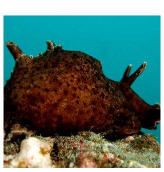
Barnacles

Purple Sea Urchin

Giant Green Anemone

Wavy Turbin Snail

Shore Crab



California Sea Hare

Two Spot Octopus

Bioblitz Datasheet

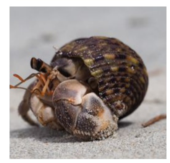
WILDCOAST COSTASALVAJE

Control Site

Species recorded:

Barnacles

Shore Crab



Hermit Crab

Giant Green Anemone

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SAN DIEGO MPA COLLABORATIVE

bioblitz

Bioblitz Guide

Introduction:

Tidepools and the creatures that live in them can be found along much of the coastline in San Diego County. These unique ecosystems are important shallow pools of water left by the outgoing tide, typically found along rocky intertidal zones. The organisms that call these places home need to have special adaptations to deal with changing tides, wave energy, exposure, predators and competition for resources. Although these organisms are resilient and have evolved to live in extreme environments, they are imperiled due to pollution and human activity.

Marine protected areas (MPAs) were established to protect the diversity and abundance of marine life, the habitats they depend on, and the integrity of marine ecosystems such as those found in the rocky intertidal. MPAs can also provide scientific reference points to assist with resource management decisions, and protect a variety of marine habitats, communities, and ecosystems for their economic and intrinsic value, for generations to come.

During the field trip you and your classmates are going to become scientists, collecting important ecological data to answer the following question:

Is there a difference in biodiversity inside an MPA compared to outside an MPA?

Write your hypothesis below:

Methods:

In order to test your hypothesis the class will be split into smaller research teams of 3-4 students each. Half the research teams will gather data inside an MPA while the other half collects the same data outside of an MPA.

To collect data we will be using the iNaturalist app on your cell phone. See the following pages for information on how to download the app, join the project, and take research grade photos. A map of the study site will also be included.

Write the project name here:

Bioblitz Guide

bioblitz

Activity:

Using the iNaturalist application on your (or a group member's) phone, explore the tidepools of La Jolla to photograph and submit observations on as many organisms as possible. iNaturalist is designed to help you identify what it is that you are looking at and each submission is shared amongst a group of global scientists that tracks ecosystem health, climate change and the shifting ranges of organisms.

Results:

1. Write the common name of 5 organisms your group identified while tidepooling:
    a.
    b.
    c.
    d.
    e.

Fill in the following:
*May be completed in the classroom

Total species found inside MPA	Total species found outside MPA

Conclusion:

2. Explain how your 5 identified organisms are similar. What characterizations/ adaptations do they share?

3. What are some potential threats to the everyday life of your observed organisms?

4. What ecological services do tidepools and kelp forests provide?

6. Compare the results of the group inside the MPA to the group outside of the MPA. What do these results tell us?

5. What can you do to enhance the conservation of our coastal and marine ecosystems and wildlife?

bioblitz

WILDCOAST COSTASALVAJE

SAN DIEGO MPA COLLABORATIVE

Getting Started

1. Create an account.
   Sign up at **inaturalist.org**, or install the mobile app so you can submit observations offline.
   Google play | App Store
2. Join nearby projects.
3. Tap Observe to start making observations.
4. Add photos.
5. Enter what you saw, or view suggestions and choose the best match.
6. When and where you saw it will be added automatically.
7. Save your observation.
8. For more information, visit inaturalist.org/pages/getting+started

Taking Photographs

- Be a safe, respectful naturalist—do not touch wild animals or poisonous plants, and stay on trails.
- You can upload several pictures per observation.
- Take photos that are sharp and in focus.
- Try to take a well-lit photo—keep the sun at your back.
- Get close, but not too close so neither you nor the animal is harmed.
- Make sure phone location services are on to record the exact location (longitude and latitude) of the photo.
- You can make observations in airplane mode then upload them later; original time and location will upload automatically.
- Never touch a dead animal.

Plants

- Photograph the entire plant.
- Take close-up photos of the front and back of a leaf or leaves with hand or the ruler in photo for scale.
- If in bloom, take photos of flowers from different angles: top, side, and bottom.
- Take photos of fruits and seeds if available.
- Use only one plant per observation.
- 4–6 photos per observation is best.

Join our scientists in documenting species.

theNAT SAN DIEGO NATURAL HISTORY MUSEUM

education@sdnhm.org
sdnat.org

In partnership with iNaturalist.org

Birds

- Photograph the entire animal.
- Take photos from different angles: side view and close-ups of head and beak are helpful.
- Take photos of surrounding environment.

Insects

- Photograph the entire animal.
- Take photos from different angles: top, side, and close-up of face are helpful.
- Take photos of the surrounding environment.
- If it has visible or spread wings, photograph its wing veins.

Reptiles and Amphibians

- Photograph the entire animal.
- Take photos from different angles.
- Take photos of the surrounding environment.
- If it is a snake, try to get close-up pictures of its head and tail, but put safety first as it could be venomous.

Mammals

- Photograph the entire animal.
- Take photos from different angles.
- Take photos of the surrounding environment.
- Photos of tracks and scat (animal poop) are helpful.
- If you find bones, take a photo with your hand or this ruler for scale.

Every observation you make with iNaturalist, from the rarest butterfly to the most common backyard weed, helps scientists understand the diversity and abundance of species.

inaturalist.org

cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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Meeting Spot
Wind and Sea Beach, La Jolla
Parking lot at the corner of
Nautilus St. and Neptune Pl.

Date

Time