

# **Investigating the Effects of Changing Climate Conditions on the Kelp Forest of the Central California Coastal Region**

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Developed as part of the ARET@LTERS program, Summer 2025



<b>Teacher: Melissa Moore</b>	<b>Unit: Photosynthesis in the Ocean</b>
<b>Grade/Course: Marine Science Grades 11-12</b>	<b>Lesson Title: Investigating the Effects of Changing Climate Conditions on the Recruitment of Kelp in the Central California Coastal Waters</b>
<b>NGSS Performance Expectation: HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.</b>	
<b>Real World Phenomenon Addressed in the Lesson: How does climate change affect kelp recruitment?</b>	
<b>3 Dimensions of Science</b>	
<b>Science &amp; Engineering Practice(s) Used: Engaging in an Argument from Evidence</b>	
<ul style="list-style-type: none"> <li>● Develop and Use Models.</li> <li>● Plan and Carry out Investigations.</li> <li>● Analyze and Interpret Data.</li> <li>● Use Mathematics and Computational Thinking.</li> <li>● Construct Explanations.</li> <li>● Engage in Argument from Evidence - including dialogue.</li> <li>● Obtain, Evaluate, and Communicate Information.</li> </ul>	
<b>Crosscutting Concept(s) Used: Stability and Change</b>	
<ul style="list-style-type: none"> <li>● Patterns</li> <li>● Scale, Proportion and Quantity</li> <li>● Systems and System Models</li> </ul>	
<b>Disciplinary Core Idea(s): LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b>	
<ul style="list-style-type: none"> <li>● Life sciences</li> <li>● Earth sciences</li> </ul>	
<b>Background Information</b>	
<b>Prior Student Knowledge:</b>	
<ul style="list-style-type: none"> <li>● <b>Geography of the Santa Barbara Channel</b></li> <li>● <b>Basic knowledge of tides, winds, weather, and currents in the Santa Barbara Channel</b></li> </ul>	

**Possible Preconceptions/Misconceptions:**

- Kelp is a plant that grows in the ocean

**Content Information for Teacher:**

- **Student Materials:**

- Engagement  Sea Surface Temperature in Santa Barbara County
- Exploration  Kelp Germination Analysis
  -  Kelp Germination Analysis Answers
    -  Kelp Germination Analysis Answer KEY
  -  Moore Zoospore Release Protocol
- Explanation  Figures from The Blob marine heatwave transforms California kelp forest ecology
  -  Figures from The Blob marine heatwave transforms California kelp forest ecology
- Extension  Practice: Identify Scientific Question and Key Vocabulary
  -  KEY Practice: Identify Scientific Question and Key Vocabulary
- Evaluation  Article Reading Guide: Coastal Marine Heatwaves in the Santa Barbara Channel
  -  Student Work Coastal Marine Heatwaves in the Santa Barbara Channel: decadal trends and ecological implications
  -  Student Response to Marine Heat Wave Figures
- Extension  Kelp Forest Food Web
  -  Kelp Forest Food Web Student.jpeg

- **Websites:**

- <https://www.surf-forecast.com/regions/Santa-Barbara?hr=3&symbols=nodes.sst>
- [NDBC - Station 46063 - Climatic Summary Plots for sea temperature](#)
- [The Blob marine heatwave transforms California kelp forest ecosystems](#)
- [Coastal marine heatwaves in the Santa Barbara Channel: decadal trends and ecological implications](#)
- [Nutritional quality of giant kelp declines due to warming ocean temperatures - Lowman - 2022 - Oikos - Wiley Online Library](#)
- [Species identity drives ecosystem function in a subsidy-dependent coastal ecosystem | Oecologia](#)

- **Videos:**

-  Protecting California's Kelp

5E	Evidence of Use/Student Activity

<p><b>Engagement</b></p> <ul style="list-style-type: none"> <li>• Capture attention</li> <li>• Activate prior knowledge</li> <li>• Connects to the real world phenomenon</li> </ul>	<ul style="list-style-type: none"> <li>• During fall (September-November), give students a map of Santa Barbara County. Have students record the current sea surface temperature from <a href="http://Surf-Forecast.com">Surf-Forecast.com</a> onto the map.</li> <li>• Guide students in developing a key to color the map according to sea surface temperature (ie 68-70 degree is red, 66-67 is yellow, etc.) <ul style="list-style-type: none"> <li>▣ SST Santa Barbara Channel.jpeg</li> </ul> </li> <li>• Have students investigate high and low sea surface temperatures for the area using <ul style="list-style-type: none"> <li>☰ Sea Surface Temperature in Santa Barbara County</li> </ul> </li> </ul>
<p><b>Exploration</b></p> <ul style="list-style-type: none"> <li>• Test ideas and develop knowledge using explorations, investigations, experiments</li> <li>• For NGSS, provide an initial activity/lab that allows for investigation of real world phenomenon (ABC: Activity Before Content)</li> </ul>	<ul style="list-style-type: none"> <li>• Analyze Kelp Zoospore Data using Kelp Spore Germination Analysis Slides independently, in groups or as a class(data is from ARETs July 2025) <ul style="list-style-type: none"> <li>☑ Kelp Germination Analysis</li> <li>☰ Kelp Germination Analysis Answers</li> <li>☰ Kelp Germination Analysis Answer KEY</li> </ul> </li> <li>• Alternatively, if you have access to kelp sporophylls, use the following procedure to generate data on kelp zoospore germination <ul style="list-style-type: none"> <li>☰ Moore Zoospore Release Protocol</li> </ul> </li> </ul>
<p><b>Explanation</b></p> <ul style="list-style-type: none"> <li>• Analyze data/information and construct explanations</li> <li>• Communicate understandings orally and in writing</li> <li>• Describe possible solutions</li> </ul>	<ul style="list-style-type: none"> <li>• Guide students in analysis of the graphs from SBC-LTER's article describing the effects of The Blob marine heatwave. Focus on the relationship between ocean temperature, phytoplankton, invertebrate cover, species richness, and kelp forest growth <ul style="list-style-type: none"> <li>☰ Figures from The Blob marine heatwave transforms...</li> </ul> </li> </ul>
<p><b>Extension</b></p> <ul style="list-style-type: none"> <li>• Modify/refine procedures, prototypes, models, solutions, arguments, essays, etc.</li> <li>• Apply or practice in a new setting</li> </ul>	<ul style="list-style-type: none"> <li>• Introduce students to reading primary scientific literature through abstracts about kelp forests and marine heat waves. <ul style="list-style-type: none"> <li>☰ Practice: Identify Scientific Question and Key Vocab... <ul style="list-style-type: none"> <li>○ Identify key vocabulary terms</li> <li>○ Underline main findings of article</li> <li>○ Summarize main findings in simpler language</li> </ul> </li> </ul> </li> </ul>

<p><b>Evaluation</b></p> <ul style="list-style-type: none"> <li>• Self-assess understanding of concepts</li> <li>• Demonstrate understanding of concepts through performance-based tasks</li> <li>• Reflect and/or revise answers or solutions to a complex question, issue, challenge, or real world problem</li> </ul>	<ul style="list-style-type: none"> <li>• Assess student understanding of the effects of marine heatwaves by answering comprehension about marine heatwave journal article <ul style="list-style-type: none"> <li>☰ Article Reading Guide: Coastal Marine Heatwaves in...</li> <li>☰ Student Work Coastal Marine Heatwaves in the Sant...</li> </ul> </li> <li>• Alternatively, show students figures from the journal article and ask students to explain the meaning of the figure and connect it with what they have learned. <ul style="list-style-type: none"> <li>☰ Student Response to Marine Heat Wave Figures</li> </ul> </li> </ul>
<p><b>Lesson Closure/Extension</b></p> <ul style="list-style-type: none"> <li>• Summarize the lesson</li> <li>• Check for understanding via exit slip or exit ticket</li> <li>• Preview the next lesson</li> </ul>	<ul style="list-style-type: none"> <li>• Introduce Kelp Forest Biodiversity with Food Web Activity</li> <li>• Guide students in creating a food web. Students glue pictures of kelp, urchins, abalone, sea stars, and otter on a paper while answering questions from each slide <ul style="list-style-type: none"> <li>○ 🗑 Kelp Forest Food Web</li> <li>○ 📄 Kelp Forest Food Web Student.jpeg</li> </ul> </li> </ul>