

FOLLOW

THE

GLIDER

ACTIVITIES

Educational tool for finding out what underwater gliders are and learning about their importance for coastal research



Follow the Glider is an educational tool developed by CEFAS (Centre for Environment, Fisheries & Aquaculture Science), IMEDEA (Mediterranean Institute for Advanced Studies, UIB-CSIC), and SOCIB (Balearic Islands Coastal Observation and Forecasting System) as part of the FP7-JERICO European project, and is based on the glider monitoring tool that is available at [www.socib.es](http://www.socib.es) and has been adapted for student use at <http://followtheglider.socib.es/en/>

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# TABLE OF CONTENTS

|                                       |   |
|---------------------------------------|---|
| 1. Introduction.....                  | 2 |
| 2. Project Description.....           | 3 |
| 2.1 Target Audience .....             | 3 |
| 2.2 Basic Skills .....                | 4 |
| 2.3 Overall Objectives.....           | 5 |
| 2.4 Methodology .....                 | 5 |
| 2.5 Contents .....                    | 6 |
| 3. Activities.....                    | 6 |
| 3.1 Objectives of the Activities..... | 3 |
| 3.2 Classroom Materials .....         | 3 |
| 4. Assessment.....                    | 7 |

## ACTIVITIES

|  |    |
|--|----|
| 1 Discover a Glider and Follow It .....                                    | 9  |
| 2 Your Glider Mission .....  | 10 |
| 3 Building a Glider .....  | 11 |
| 4 The Amazing Story of the Floating Egg<br>and the Colored Ice Cubes ..... | 12 |
| 5 The Water Layer Trick .....  | 13 |
| 6 Thermocline: A Transition Zone .....                                     | 15 |
| 7 The Ocean’s Smallest Creatures .....                                     | 16 |
| 8 The Fisherman .....  | 18 |
| 9 And Yet It Moves .....   | 19 |
| 10 A Fabulous Team .....   | 20 |

# 1. INTRODUCTION

Follow the Glider enables students and teachers to follow the course of ocean gliders in almost real time, examine past missions, understand the data provided by these autonomous underwater vehicles, and recognize the importance of coastal research for developing predictive models and facing phenomena such as climate change. Follow the Glider is a multilingual tool developed in the Balearic Islands and aimed at European school children, as well as anyone with interest in this technology.

This educational tool was developed by CEFAS (Centre for Environment, Fisheries & Aquaculture Science), IMEDEA (Mediterranean Institute for Advanced Studies, CSIC-UIB), and SOCIB (Balearic Islands Coastal Observing and Forecasting System) as part of the FP7-JERICO European project, and is based on the glider monitoring tool that is available at [www.socib.es](http://www.socib.es). The contents, videos, and graphs, as well as a glider monitoring tool adapted for student use, are available at [www.followtheglider.com](http://www.followtheglider.com)

The JERICO European project aims to develop a network to coordinate the activities of different European coastal observatories, share experiences, and set up an organizational structure that will guarantee a regular, ongoing, and sustainable supply of environmental information and marine environment products in European coastal areas. In order to support the marine environment and biodiversity, understand climate change, and make better predictions as to its impact, facilitating sustainable use of marine resources. For this purpose, it is essential for the project to promote awareness of coastal research among children. This was how Follow the Glider was born.

The Mediterranean Institute for Advanced Studies (IMEDEA) is a research center jointly governed by the Spanish National Research Council (CSIC) and the University of the Balearic Islands (UIB). This institute develops scientific and technical interdisciplinary research in the area of natural resources. Its framework is the ocean and coastal areas, including islands. Currently, IMEDEA's activity is centered on the effects of global change on these ecosystems and how to achieve an integrated and sustainable management of coastal areas.

ICTS SOCIB is a Coastal Ocean Observing and Forecasting System located in the Balearic Islands. SOCIB is a multi-platform distributed and integrated system that provides streams of oceanographic data and modelling services to support operational oceanography in a European and international framework, therefore also contributing to the needs of marine and coastal research in a global change context. SOCIB's objectives also include specific efforts in education, scientific culture, dissemination, and communication to the general public.

# 2. PROJECT DESCRIPTION

## 2.2 TARGET AUDIENCE

This project aims to provide teaching materials for students aged 10 to 16 and offer an introduction to coastal and marine research in the Mediterranean Sea.

The set of educational resources offered here strives to give students a better understanding of what environmental or marine research involves, while also providing them with an opportunity to turn the information they receive into a tool for acquiring knowledge in different subjects from their curriculum. Although in the conceptual basis for the science curriculum subjects are drawn from disciplines such as physics, chemistry, biology, and geology, these are combined in connection with areas of work and study that call for a cross-curricular approach, such as the environment, climate, or the universe.

The teaching materials provided here are a complementary resource within a broader exploration of gliders and coastal research, and include a series of activities that have been conceived to facilitate reflective learning and active student participation.

In addition to the option of monitoring gliders' activities, the website provides visual explanations of how these devices work and how to interpret data such as salinity, temperature, and the amount of chlorophyll and oxygen in the seawater. Teachers will find a specific area aimed at helping them use the tool in a directed way using classroom activities.

The activities are aimed at a wide range of students, and have been developed considering the diversity of personal skills and socio-cultural backgrounds. The activities involve varying degrees of difficulty, but can be undertaken by any group, regardless of its nature. In any case, teachers will always be the ones to determine the appropriateness for the needs of each specific group, and can make whatever alterations they see fit for each setting.



## 2.2 BASIC SKILLS

The basic curriculum skills addressed in this project are the following:

### **Literacy**

The scientific and technological language used here is specialized language that contains terminology referring to oceanography, laboratory concepts, fieldwork, methods, and procedures. Understanding this terminology is one of the aims of the activity.

### **Math**

The procedures for researching and analyzing the data provided by gliders require knowledge of how to interpret graphs and representations, and using mathematical models.

### **Knowledge of and Interaction with the Physical World**

This skill involves students learning about scientific work, specifically the coastal research work carried out in the Balearic Islands.

### **Information Processing and Digital Skills**

The website helps students work on procedures related to seeking and processing information.

### **Society and Citizenship**

This project's contribution involves giving relevance to the procedural contents of coastal research, emphasizing the role of science in society.

### **Arts and Culture**

Observation, intuition, and creative skills are linked to science and the arts. These skills can be addressed in depth through hands-on activities related to the concepts at hand. Learning specific terminology broadens students' cultural horizons, while their interest in their environment and closest physical surroundings also involves learning more about their own culture.

### **Learning to Learn**

The ability to solve problems develops this basic skill. It puts students to the test, raising questions about their environment for which they will have to come up with well thought-out answers and share them with their fellow students.

### **Autonomy and Personal Initiative**

Scientific activities reinforce problem-solving skills and the development of one's own criteria.

## 2.3. OVERALL OBJECTIVES

- Help students learn what ocean gliders are and their importance for ocean research.
- Enable students to monitor the gliders that SOCIB currently has in operation in the Balearic Sea.
- Learn to interpret the information provided by gliders.
- Raise awareness of coastal and ocean research among students.
- Integrate environmental knowledge as a basic element for students' overall education.
- Implement strategies that enable individual work and active, responsible collaboration in cooperative learning.
- Raise awareness of the need to protect the environment, supporting sustainable use and an appreciation of nature.
- Provide tools for teachers, whose role is key for mediating the teaching–learning process.
- Foster scientific vocation.

## 2.4. METHODOLOGY

It is important to use the appropriate methodology, the one closest to the most broadly accepted approaches in science education, such as the acknowledgement of prior ideas and the value attached to acquiring new knowledge.

Students must have an active role throughout the entire process, and should see cooperative work as the best way to solve scientific problems.

We recommend beginning the activities by reflecting on the need to learn about the marine environment, both for the conservation of its ecosystems and for a sustainable use of its resources. Next, we present gliders as a tool for researching coastal and ocean water, showing students what they are and how they work. Lastly, students monitor the gliders' courses, drawing conclusions based on the provided data. All of this is completed with specific activities related to interesting aspects of gliders and the marine ecosystem.

### **Description of How the Tool Is Used**

Follow the Glider enables us to monitor the gliders that SOCIB and IMEDEA currently have on missions in the Balearic Sea.

The tool shows where the gliders are in almost–real time, as well as their course and the data they have collected on the missions they have completed. With this information, activities can be performed over time, following a glider's course; data from previous missions can be analyzed as well.

The website offers information about what gliders are and how to interpret some of the data they collect. Bearing in mind that gliders provide a huge amount of information about a variety of parameters, we have selected four that strike us as particularly sig-

nificant and especially relevant for observing the ocean. Among the physical parameters, Follow the Glider offers information about water salinity and temperature. In terms of biochemical parameters, students will be able to examine chlorophyll and oxygen data.

## 2.5. CONTENTS

### **Concepts of Oceanography**

Explanation and practice of basic concepts such as density, salinity, temperature, buoyancy and stratification. Description of phenomena such as upwelling, the thermocline and the movement of ocean currents.

### **The Marine Environment**

Conservation of ecosystems and sustainable use of resources.

### **Scientific Knowledge**

Acknowledging the role of scientific knowledge in technological development and in people's lives; valuing the contributions of the natural sciences to address the needs of human beings and improve their living conditions, participating in their conservation, protection, and improvement.

Using information technologies as reference instruments. Interpreting data and information about nature and using that information to increase our insight into the natural environment.

Presentation of ICTS SOCIB. Introducing the ICTS SOCIB as a multi-platform system in Operational Oceanography, Marine Technology and Sustainability in the Balearic Islands, which offers support to operational oceanography at the European and international framework system, obtaining a coastal and ocean management based in science.

### **Gliders and Their Role in Research**

What gliders are and how they work. Structure, functions, and uses.

### **Interpreting Data and Drawing Conclusions**

Measurement parameters. Practical applications.

## 3. ACTIVITIES

Follow the Glider offers a series of activities aimed at different grade groups, ranging from ages 10 to 16. Teachers will choose the activities they consider most appropriate given their students' prior knowledge and interests.

### 3.1 OBJECTIVES OF THE ACTIVITIES

#### **Conceptual Objectives**

- Learn what ocean gliders are and how important their role is in coastal and ocean research.

- Correctly interpret the information provided by gliders.
- Learn about the current status of Balearic coastal research.

### **Procedural Objectives**

- Analyze the data collected by gliders and interpret them correctly.
- Explore prior knowledge of the subject as well as recently acquired knowledge.
- Generate hypotheses and draw conclusions.

### **Attitude Objectives**

- Show an interest in scientific research.
- Be aware of the need to protect the environment.
- Develop an analytical and critical sense that leads students to participate in efforts and campaigns aimed at improving the environment.

## **3.2 CLASSROOM MATERIALS**

The teaching approach involves offering suggestions for work that can be used partially or entirely. In turn, these can be a source of inspiration for new ideas.

Resources are offered so that, taking into consideration basic aspects such as the nature of the subject matter, the setting, their own skills, and the students' skills, teachers can use additional materials as they see fit.

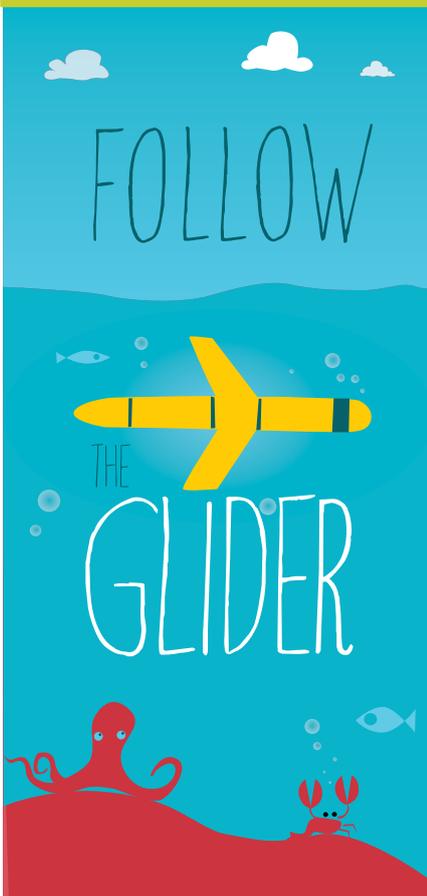
The ultimate aim is to get students to learn in a reflective, critical way, reinforcing their problem solving skills. Therefore, they have to engage in the process actively.

Teachers must promote participation and help support it. The role of students must be active, participating in their own learning process.

## 4. ASSESSMENT

We view assessment as a stage that provides an opportunity to stop and think about the performed activities and their results.

Our objective is to have feedback from our users in order to improve certain aspects and assess the participants' degree of satisfaction. To do so, we invite you to visit [www.followtheglider.com](http://www.followtheglider.com) and fill in the assessment questionnaire.



## ACTIVITIES TEACHER'S GUIDE

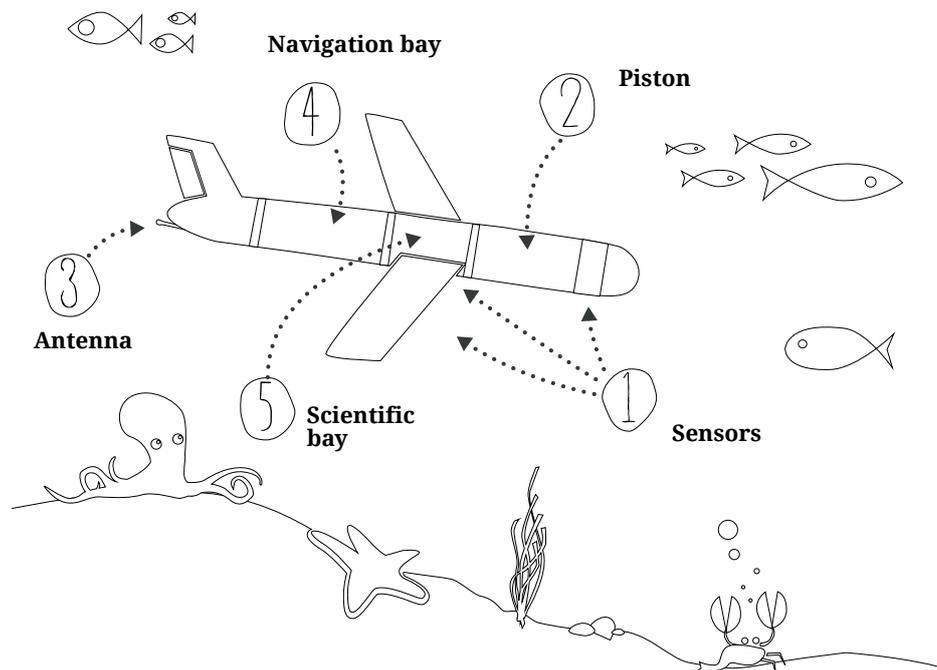
Before they begin any of the activities, students should be given a guided explanation of the theoretical content of the Follow the Glider book; they could also watch the videos and explore the online glider monitoring tool. For the explanation, the teacher can use the Follow the Glider Power Point presentation.

Next, the teacher will choose the activities he or she considers most appropriate for the students' grade and interest level.

|                           |  |
|---------------------------|--|
| <b>GRADE LEVEL</b>        | Ages 10–12   |
| <b>DESCRIPTION</b>        | Students will find out more about gliders in an entertaining activity, consolidating the knowledge they have just acquired about what gliders are. At the end of exercise, we recommend that teachers walk their students through the <a href="http://www.followtheglider.com">www.followtheglider.com</a> website and the online monitoring tool, choosing one of the missions and analyzing aspects such as salinity, temperature, chlorophyll, and oxygen, according to the students' grade and interest level. |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Identify the parts of a glider.</li> <li>• Develop an interest in oceanographic concepts.</li> <li>• Learn about the glider monitoring tool at <a href="http://www.followtheglider.com">www.followtheglider.com</a></li> <li>• Interpret the information provided by the glider.</li> </ul>   |
| <b>MATERIALS</b>          | <ul style="list-style-type: none"> <li>• Colored pencils</li> <li>• Interactive whiteboard or a computer with an Internet connection and a projector</li> </ul>  |
| <b>SUGGESTED APPROACH</b> | Students will work individually coloring the illustration, and they can work as a team to identify the parts of a glider. The monitoring activity should be led by the teacher, whose questions will engage students and get them to think about the data provided by the glider.  |
| <b>SUGGESTIONS</b>        | Visit <a href="http://www.followtheglider.com">www.followtheglider.com</a>   |

**SOLUTIONS**

1. Sensors
2. Piston
3. Antenna
4. Navigation bay
5. Scientific bay



# 2 YOUR GLIDER MISSION

|                           |   |
|---------------------------|---|
| <b>GRADE LEVEL</b>        | Ages 12–16  |
| <b>DESCRIPTION</b>        | The students become glider pilots, and, as such, they will have to solve problems and make decisions about its operation. Students will also act as scientific researchers, analyzing the data that the gliders collect.  |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Apply the knowledge acquired about how gliders work and the parameters they analyze.</li> <li>• Interpret the information provided by the glider.</li> <li>• Understand basic concepts of oceanography.</li> <li>• Encourage analytical thought, reasoning, and decision-making.</li> <li>• Spark interest in scientific methods.</li> </ul> |
| <b>MATERIALS</b>          | <ul style="list-style-type: none"> <li>• Interactive whiteboard or computer with an Internet connection and a projector</li> <li>• Pen or pencil</li> </ul>   |
| <b>SUGGESTED APPROACH</b> | Students can work individually or in small groups. If they choose to work in groups, it is important to stress the value of fostering discussion among students, encouraging them all to participate and highlighting teamwork and joint decision making.   |
| <b>SUGGESTIONS</b>        | <ul style="list-style-type: none"> <li>• Visit <a href="http://www.followtheglider.com">www.followtheglider.com</a></li> <li>• Watch the micro-videos suggested in the activity while answering the survey questions.</li> </ul>  |

## SOLUTIONS

- a
- b
- b
- b
- b
- LOOK UP THE ANSWERS IN “How do we read the data we receive from a glider?”
- The more salt there is in the water, the heavier it becomes (it’s denser). Since it’s heavier, it goes down to the bottom. That’s why deep water is saltier (red) than water near the surface (blue).
- The water near the surface tends to be warmer than deep water because sunlight heats it up. However, if the glider moves through an area where it’s been raining or it’s very cold, the surface water may also be very cold, so it’s marked in blue on the graph. In fact, one of the things that can cool the sea down is a major storm.
- a
- Mechanical failure. Collisions with boats, fishing nets, or buoys. Battery failure. Communication failures due to the glider or to the satellites. Low-density waters that don’t allow the glider to come back up to the surface. Molluscs or remoras that don’t let the glider come back up to the surface.
- Forecasting the movements of currents, eddies, etc., and making forecast models like the ones that are used for the weather. They enable us to: know where an oil spill is might spread; know how the oceans are reacting to climate change; predict how severe winter storms affect the sea.

|                           |  |
|---------------------------|--|
| <b>GRADE LEVEL</b>        | Ages 12–18   |
| <b>DESCRIPTION</b>        | The student builds a glider, comes up with hypotheses about its buoyancy, and experiments with it in a fish tank.  |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Introduce the concepts of density and buoyancy to students.</li> <li>• Help students understand how gliders work.</li> <li>• Apply knowledge of density and buoyancy to the ways gliders move.</li> <li>• Reinforce analytical skills.</li> </ul>   |
| <b>MATERIALS</b>          | <ul style="list-style-type: none"> <li>• Interactive whiteboard or computer with an Internet connection and a projector</li> <li>• Large fish tank with fresh water, coarse salt, kitchen scale, two 60cc syringes, Plexiglas, scissors, saw, hot glue or another strong glue, yellow and black electrical tape, and a large measuring cup.</li> </ul>   |
| <b>SUGGESTED APPROACH</b> | Students can work in groups to build their gliders, come up with hypotheses, and conduct their experiments. One session may not be enough time for them to build their gliders and try them out. Teachers could plan to break the activity into two sessions, one for building the gliders and the other for experiment with the models. The teacher should evaluate students' skills beforehand in order to decide whether to plan for one or two sessions. |
| <b>SUGGESTIONS</b>        | <ul style="list-style-type: none"> <li>• Visit <a href="http://coseenow.net/files/2010/08/15-Ocean-Robots.pdf">http://coseenow.net/files/2010/08/15-Ocean-Robots.pdf</a></li> <li>• Visit <a href="http://www.followtheglider.com">www.followtheglider.com</a></li> </ul>  |

**SOLUTIONS**

*Activity written by Kate Florio, Liberty Science Center.*

- 6** The glider that was filled with saltwater is denser. Since the water it contains is denser than fresh water, the glider sinks in the fish tank.

On real glider missions the piston fills up or empties out a chamber with saltwater in order to make the glider go up or down in the water column.

# 4 THE AMAZING STORY OF THE FLOATING EGG AND THE COLORED ICE CUBES

|                           |  |
|---------------------------|--|
| <b>GRADE LEVEL</b>        | Ages 10–12   |
| <b>DESCRIPTION</b>        | Students will perform two simple experiments about the density of objects. They will come up with working hypotheses and think about the results they obtain.  |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Introduce the concepts of density, salinity, and temperature to students.</li> <li>• Relate these concepts to how gliders work.</li> <li>• Encourage searching for information and reinforce analytical skills.</li> </ul>  |
| <b>MATERIALS</b>          | <p>Interactive whiteboard or computer with an Internet connection and a projector</p> <p>Two large clear glasses, salt, water, and two raw eggs.</p> <p>Fish tank or large, deep glass container, food coloring, ice cube tray, salt.</p>  |
| <b>SUGGESTED APPROACH</b> | <p>Students can work individually or in small groups. They should take notes about the hypotheses they come up with, the results of their experiments, and their conclusions.</p> <p>For the ice cube experiment, the teacher can make the ice cubes in advance. Into one half of the tray, pour food-colored water. Using a different color, pour very salty water into the other half of the tray. Freeze overnight.</p> |

## SOLUTIONS

### EXPERIMENT 1: THE EGG THAT FLOATS... OR DOESN'T

- 3 The water that's in saltwater floats, because saltwater is denser than fresh water.
- 4 The formula for water is  $H_2O$ , which means two atoms of hydrogen and one of oxygen. Salt is composed of sodium chloride. Therefore, instead of containing only hydrogen and oxygen, saltwater also has atoms of sodium and chloride. And because there are more particles in saltwater than in fresh water, it is denser.
- 5 To go down, a glider increases its density by filling up with seawater. To go up, it empties the water out, reducing its density.

### EXPERIMENT 2: THE COLORED ICE CUBES

- 4 In both cases, the colored ice cubes will sink in the fish tank water. That's because the fish tank water is warmer than the ice cubes: cold water is denser than warm water, so all the ice cubes will sink in the tap water.

However, the water in the salty ice cubes sinks even faster than the fresh water cubes. That's because salt makes the density of the ice cubes even greater.

**Fresh water ice cubes:** they are denser than the fish tank water because of their temperature (they are colder).

**Saltwater ice cubes** are denser due to their temperature (they are colder) and their salinity.

# 5 THE WATER LAYER TRICK

|                    |  |
|--------------------|--|
| <b>GRADE LEVEL</b> | Ages 10–16   |
| <b>DESCRIPTION</b> | Students will create masses of water with different densities according to their temperature and salinity, and then will observe their stratification when they mix them together in the same container. Stratification is what occurs in ocean, and it is one of the things visible with glider's data.   |
| <b>OBJECTIVES</b>  | <ul style="list-style-type: none"> <li>• Understand the concepts of density, salinity, and temperature.</li> <li>• Learn the concept of stratification.</li> <li>• Relate the experiment to how gliders work.</li> <li>• Encourage generating hypotheses, observation, and analytical skills.</li> <li>• Understand the scientific information provided in a newspaper.</li> <li>• Understand basic concepts of oceanography.</li> </ul>   |
| <b>MATERIALS</b>   | <ul style="list-style-type: none"> <li>• Interactive whiteboard or computer with an Internet connection and a projector</li> <li>• Rectangular fish tank with a divider panel</li> <li>• Bottle of water with dissolved salt (about 75 grams of salt dissolved in 1 liter of water)</li> <li>• Food coloring in two different colors</li> <li>• Ice</li> <li>• Measuring cups</li> </ul> <p>* If these materials were not available, the experiment could be done with basic household items, as you can see in the following video:<br/> <a href="https://www.youtube.com/watch?v=a9KwKVnlsio">https://www.youtube.com/watch?v=a9KwKVnlsio</a></p> <p><b>The required materials for this version are:</b></p> <ul style="list-style-type: none"> <li>• Four identical glass jars</li> <li>• Two bottles of water (one hot and one cold)</li> <li>• Two small pieces of construction paper</li> <li>• Food coloring in two different colors</li> </ul> <p>* Another even simpler alternative is:<br/> <a href="https://www.youtube.com/watch?v=6RMLG1jjMSs">https://www.youtube.com/watch?v=6RMLG1jjMSs</a></p> <p><b>For this one, the required materials are:</b></p> <ul style="list-style-type: none"> <li>• Two glass jars</li> <li>• Salt</li> <li>• Food coloring</li> <li>• Rectangular plastic container (food storage container)</li> <li>• Tap water</li> </ul> |

## SUGGESTED APPROACH

Before performing the experiment, students will generate a hypothesis based on the knowledge they have acquired about density, salinity, temperature, and stratification. Next, the teacher will conduct the experiment with help from the students, who will end up drawing conclusions from what they have experienced. Last, the students will apply those conclusions to the conditions in the sea as well as to the data collected by the glider.

## SUGGESTIONS

- Before you start, review the page on density, buoyancy, and salinity.
- Visit [www.followtheglider.com](http://www.followtheglider.com)

## SOLUTIONS

### EXPERIMENT 1

- 4 Saltwater is denser than fresh water.
- 5 Since it is denser, the saltwater settles at the bottom of the tank, and the fresh water rises to the top. In between, a thin layer develops: that is the thermocline..

### EXPERIMENT 2

- 3 Cold water is denser than warm water
- 4 Since it is denser, the cold water settles at the bottom of the tank, and the warm water rises to the top. In between, a thin layer develops: that is the thermocline



# 6 THERMOCLINE: A TRANSITION ZONE

|                           |  |
|---------------------------|--|
| <b>GRADE LEVEL</b>        | Ages 10–16   |
| <b>DESCRIPTION</b>        | Students will learn what happens within the thermocline: the layer of water that separates two other masses of water with different densities. The thermocline is the subject of a huge amount of research because of how important its consequences are. The teacher will ask the students questions, and they will have to provide the answers based on the knowledge they have acquired about density, salinity, temperature, and stratification. |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Understand the concepts of density, salinity, temperature, and stratification.</li> <li>• Relate the experiment to the way gliders work.</li> <li>• Encourage generating hypotheses, observation, and analytical skills.</li> <li>• Understand basic concepts of oceanography.</li> </ul>   |
| <b>MATERIALS</b>          | Interactive whiteboard or computer with an Internet connection and a projector<br>Pen or pencil  |
| <b>SUGGESTED APPROACH</b> | We recommend planning this activity as a continuation of Activity 5. If the teacher prefers to plan it separately, we suggest playing a video that shows the experiment from Activity 5, as well as its illustrations. Students can work in pairs, in small groups, or individually. The teacher should encourage discussing the answers as part of the group debate.  |
| <b>SUGGESTIONS</b>        | <ul style="list-style-type: none"> <li>• Before you start, review the page on density, buoyancy, and salinity, as well as the information about stratification from Activity 5.</li> <li>• Visit <a href="http://www.followtheglider.com">www.followtheglider.com</a></li> </ul>   |

## SOLUTIONS

1. It's summertime. The thermocline is very strong because the difference in temperature between the surface water and the deep water is greater.
2. We say that the thermocline is a border because it is the layer that separates the more dense water from the less dense water. It is hard for oxygen and nutrients to cross this border, so if they're at the bottom, they are unable to rise up to the surface water.
3. Storms cool down the surface of the ocean, so the water becomes denser and sinks. The water also gets stirred up, the thermocline breaks, and the waters mix.
4. The thermocline is strongest in summer. That is the time when the water near the surface runs out of oxygen and nutrients; the nutrients at the bottom cannot cross the thermocline to get up to the surface. Later on, in the fall, when the waters mix, the oxygen and nutrients rise up; the water near the surface is enriched and provides food for many species. \*See the graph in the STUDENT BOOK.

|                           |   |
|---------------------------|---|
| <b>GRADE LEVEL</b>        | Ages 10–16  |
| <b>DESCRIPTION</b>        | Students will learn about plankton and how a glider can measure certain biochemical parameters, such as the concentration of oxygen and chlorophyll, which can provide information about the amount of phytoplankton there are in the areas it travels through. There will be a strong emphasis on the need to protect plankton in order to ensure the existence of all the other species in the ocean. |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Provide knowledge about plankton.</li> <li>• Understand biochemical parameters measured by gliders, such as the concentration of oxygen and chlorophyll.</li> <li>• Stress the need to protect the balance of the marine ecosystem.</li> </ul>   |
| <b>MATERIALS</b>          | <ul style="list-style-type: none"> <li>• Interactive whiteboard or computer with an Internet connection and a projector</li> <li>• Pen or pencil</li> </ul>   |
| <b>SUGGESTED APPROACH</b> | We recommend planning this activity jointly with Activity 8 (Let's Go Fishing). However, this activity can also be done on its own, with students working individually or in small groups.  |
| <b>SUGGESTIONS</b>        | Visit <a href="http://www.followtheglider.com">www.followtheglider.com</a> , specifically the "What it measures" section.   |

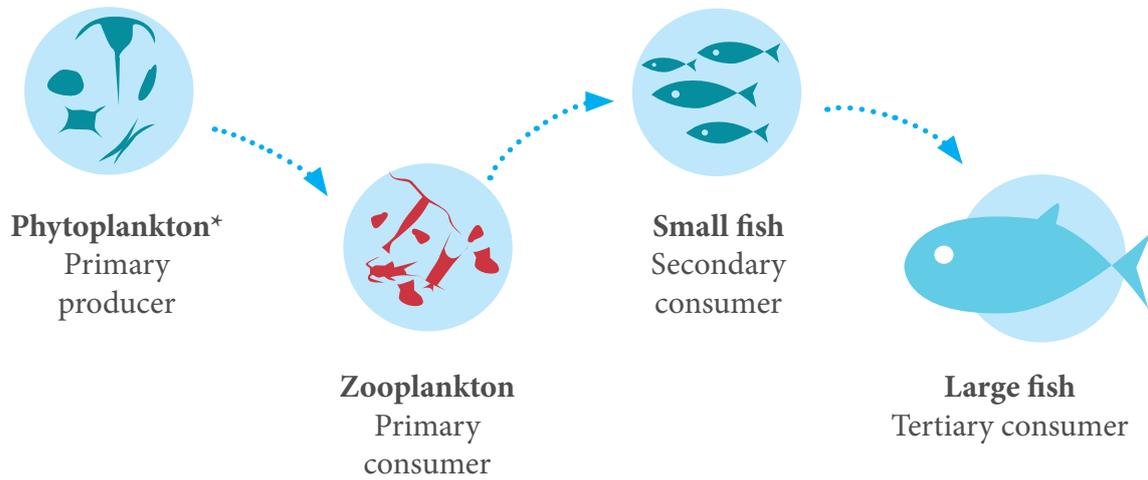
### SOLUCIONES

1. One very simple thing to do is to look at its color. Sometimes seawater looks greenish. Chlorophyll is green, so that green color in the water may be an indication of a large presence of chlorophyll, and hence of phytoplankton.
2. Phytoplankton are considered primary producers because they are the base of the food chain. They transform sunlight into energy, which allows them to grow. In turn, they become food for other species, which become their consumers.
3. Phytoplankton are referred to as the ocean's lungs, because when they photosynthesize they release oxygen. They are the source of 50% of the oxygen in the atmosphere. Without photosynthesis, the global balance would be broken, because a shortage of oxygen would have terrible consequences for the preservation of life on Earth.
4. The organisms that form phytoplankton are very light because if they weigh less, they don't sink. If they sank, they wouldn't have access to sunlight and couldn't survive.
5. The teacher can find reference material for interpreting these graphs at [www.followtheglider.com](http://www.followtheglider.com), under the "What it measures" section.
6. Gliders can provide us with data that help us learn about the abundance or scarcity of phytoplankton. These data enable us to analyze the causes and, if necessary, take measures to ensure their balance and survival.
7. The oil would form a layer on the surface of the ocean that would block sunlight and the exchange of gases with the atmosphere. The phytoplankton would be unable to photosynthesize, and therefore would die. The other species that feed on phyto-

plankton would also suffer the consequences, as part of a chain reaction. Although the effect on larger animals may not be death, they may suffer poisoning and illnesses due to the toxic components in the oil spill.

8. The greatest threat of marine pollution, and perhaps the least known, is the disappearance of phytoplankton, the base of all food chains and the regulator of atmospheric CO<sub>2</sub>, absorbing carbon from the atmosphere and bringing it into the food chain. The organisms that make up phytoplankton are

very sensitive to pollution. In the Southern Hemisphere, for example, an alarming drop in phytoplankton production has been observed. This is due to an increase in ultraviolet radiation as a consequence of the depletion of the ozone layer in recent decades. This is one of the examples of how global environmental problems are closely interconnected and feed into each other.



|                           |   |
|---------------------------|---|
| <b>GRADE LEVEL</b>        | Ages 12–16, especially around age 13  |
| <b>DESCRIPTION</b>        | Students play the role of fishermen and try out a practical application of what they have learned about the thermocline and plankton to find out where they can find most fish.   |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Understand the concepts of density, salinity, temperature, and stratification.</li> <li>• Broaden their knowledge of plankton.</li> <li>• Interpret biochemical parameters such as concentrations of oxygen and chlorophyll.</li> <li>• Relate their experience in the activity to how gliders work</li> <li>• Encourage generating hypotheses, observation, and analytical skills.</li> <li>• Understand basic concepts of oceanography.</li> </ul> |
| <b>MATERIALS</b>          | <ul style="list-style-type: none"> <li>• Interactive whiteboard or computer with an Internet connection and a projector</li> <li>• Pen or pencil</li> </ul>   |
| <b>SUGGESTED APPROACH</b> | We recommend planning this activity jointly with Activity 7 (The Ocean’s Smallest Creatures) or 6 (Thermocline: A Border). However, the teacher may choose to do the activity on its own, referring to the theoretical information from the units mentioned above.  |
| <b>SUGGESTIONS</b>        | <ul style="list-style-type: none"> <li>• Before you begin, review the concepts of density, salinity, temperature, thermocline, and plankton.</li> <li>• Visit <a href="http://www.followtheglider.com">www.followtheglider.com</a></li> </ul>   |

## SOLUTIONS

1. Phytoplankton are the plankton that photosynthesize; they are mostly microscopic algae. These organisms weight very little, and this enables them to stay near the surface and receive sunlight, which is essential for them to photosynthesize and transform that sunlight into food. To absorb the sun’s energy, they need chlorophyll, and in doing so, they release oxygen. Gliders can collect data about chlorophyll and oxygen concentrations, and therefore tell us whether there is more or less phytoplankton in a given area. Phytoplankton is considered a primary producer and is a source of food for tiny organisms, and other very large ones as well, such as certain whale species. The teacher can show the students an illustration of the food chain from the previous activity.
2. Phytoplankton need nutrients and sunlight. There are more nutrients in the cold bottom water. However, there is only sunlight near the surface. The area where these two factors meet would offer the appropriate setting for a greater presence of phytoplankton.
3. Gliders can’t give us direct data about phytoplankton, but they can give us data about chlorophyll, temperature, and oxygen concentrations, which together help us determine where there is more phytoplankton.
4. The area where the surface water near the sunlight meets the deep, nutrient-rich water is called the thermocline. The point of the activity is to have students relate the temperature and chlorophyll graphs and reach this conclusion on their own.
5. Supposedly, a situation with riled-up waters would be good for fishing because wind on the surface or storms can help break the thermocline, allowing for the deep, nutrient-rich water to flow upward. This, in turn, leads to a proliferation of phytoplankton, which all the other species feed on.
6. Yes, because of their high concentration of nutrients.

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|---------------------------|---|
| <b>GRADE LEVEL</b>        | Ages 12–16  |
| <b>DESCRIPTION</b>        | Students will discover surface and deep ocean currents, as well as the consequences that a change in this system of currents would have and the ways in which gliders can help us monitor this phenomenon.  |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Identify surface and deep ocean currents.</li> <li>• Relate the concepts of density, salinity, temperature, and stratification.</li> <li>• Think about climate change.</li> <li>• Understand the importance of gliders as monitors of ocean currents.</li> <li>• Encourage generating hypotheses, observation, and analytical skills.</li> </ul> |
| <b>MATERIALS</b>          | <ul style="list-style-type: none"> <li>• Interactive whiteboard or computer with an Internet connection and a projector</li> <li>• Long rectangular container (for example, a baking pan)</li> <li>• Drinking straws</li> <li>• Water</li> <li>• Black pepper</li> </ul>  |
| <b>SUGGESTED APPROACH</b> | Some of the questions involve applying the concepts of temperature, salinity, density and stratification addressed in previous activities. If these activities have not been done in the classroom, the teacher should suggest reading the information provided in previous pages and help students find the answers.   |
| <b>SUGGESTIONS</b>        | <ul style="list-style-type: none"> <li>• Before you begin, review the concepts of salinity, temperature, density, stratification, etc.</li> <li>• Visit <a href="http://www.followthegliders.com">www.followthegliders.com</a></li> </ul>   |

## SOLUTIONS

1. The water will start moving clockwise in a circle. That is how currents move, creating ocean gyres.
2. At the Poles, cold currents are formed, pushing cold water towards the Equator and helping to cool the Tropics. This water pushes out the bodies of water in the Tropics, which in turn move up towards the north, carrying heat toward the Poles. This helps to make the coast in the north less cold and to make the coast in the south less warm. That is why ocean currents are known as the Earth's thermostat.
3. If there were a major thaw in the area around Greenland, water would be less salty and therefore not dense enough to sink to great depths. Therefore, it would not be replaced by the warm current coming up from the Equator. In other words, the circulation system would come to a standstill. One of the first consequences would be that the cold water from the Poles would not cool off the coasts in the Tropics, and the warm water from the Tropics would not warm up the northern coasts. This could lead to a severe change in climate. It would also affect the exchange of nutrients between deep water and surface water, and therefore the entire marine ecosystem.
4. Gliders can become our spies in the ocean. The information they give us about temperature and salinity enables us to be alert and detect any changes that may threaten the current balance.

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| <b>GRADE LEVEL</b>        | Ages 10–16   |
| <b>DESCRIPTION</b>        | The activity suggests that students discover the people behind everything we have told them about in former activities. The technicians and researchers at the SOCIB will show what they do and convey their motivation. Students will reflect on these profiles, find out which they identify with most, and realize the amount of people it takes to carry out large-scale projects. Students will also be introduced to other technological resources used for coastal observation.   |
| <b>OBJECTIVES</b>         | <ul style="list-style-type: none"> <li>• Stimulate scientific vocations.</li> <li>• Provide further knowledge about how gliders work and their scientific applications.</li> <li>• Find out about other technological resources used by SOCIB.</li> <li>• Realize the value of the research performed by SOCIB.</li> </ul>   |
| <b>MATERIALS</b>          | <ul style="list-style-type: none"> <li>• Interactive whiteboard or computer with an Internet connection and a projector</li> <li>• Pen or pencil</li> </ul>  |
| <b>SUGGESTED APPROACH</b> | Teachers can relate this activity to some of the other ones that focused on how gliders work. In this case, it is important to not repeat the videos that students already watched in previous activities. Most of the questions in this activity are open-ended, and aim to elicit an emotional connection between the students and the contents we are communicating. It is essential for the teacher to convey how exciting and relevant the tasks and elements in the activity are, so as to motivate scientific vocations. If the teacher identifies especially motivated students, we suggest that he or she follow up on their curiosity and interest, guiding them to pursue it further, especially in the case of high school students who need orientation for their future careers. |
| <b>SUGGESTIONS</b>        | <ul style="list-style-type: none"> <li>• Visit <a href="http://www.followthegliders.com">www.followthegliders.com</a></li> <li>• Visit <a href="http://www.socib.es">www.socib.es</a></li> </ul>   |

### SOLUTIONS

1. High-frequency (HF) radar provides real-time data about the surface current in the Ibiza Channel.
2. The coastal research vessel allow us to research the ocean and monitor some variables in real time, in order to increase scientific knowledge of the Western Mediterranean.
3. They are surface drifters, autonomous platforms used for observing and predicting ocean currents.
4. They provide information such as air and ocean temperature, sea level, atmospheric pressure, salinity, wind speed, current speed, and wave height.
5. SOCIB collects satellite data and generates images of areas such as the Western Mediterranean and the Balearic Islands. They use these data to map ocean surface temperature, topography, currents, and chlorophyll content, among other factors.
6. The Data Centre is the core of SOCIB. Through it, SOCIB is developing and implementing a general data management system to guarantee international standards, quality assurance and inter-operability.
7. To develop predictive models, such as weather forecast models. These can help us know where an oil spill is going to move and enable us to contain it. It also can tell us how the oceans are reacting to climate change, how winter storms affect the ocean, and how to take better care of our Marine Protected Areas.



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