Kids as Airborne Mission Scientists

Lesson plan overview: How do I Plan a Remote Sensing Mission?

FRAME	INFORM	EXPLORE	TRY	SUPPORT
Students examine remote sensing images of the Kailua Bay, Oahu and begin to think about considerations for planning a remote sensing mission.	Students participate in activities to develop their understanding of the concepts of swath and spatial resolution and learn the attributes of high and low spatial resolution.	Students participate in activities to develop their understanding of the concepts of temporal resolution	Students use their new knowledge while making the decisions necessary to create a plan for the remote sensing mission over Kailua Bay, Oahu.	This is support material for the teacher including ideas to promote student reflection, sample answers to activities, and extension ideas.

Lesson Context: To apply the tools of remote sensing to real-world situations, students need to participate in the actual planning of a remote sensing mission. The goal of this lesson is for students to plan a remote sensing mission to evaluate the state of the Kailua Bay coral reefs. Based on their understanding of the concepts of swath, spatial resolution, and temporal resolution, students will make the decisions necessary to create a plan. The activity in this lesson will work as supporting knowledge for when they will collect and analyze actual remote sensing data.

Key Science Concepts:

- The concept of swath
- The concepts of resolution: spatial resolution and temporal resolution

Links to teacher background information:

- The concept of swath
  http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_2_e.html)
- Spatial resolution
  http://observe.arc.nasa.gov/nasa/education/reference/resolve/resolve.html)
- Spatial resolution, pixel size, and scale
  http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_3_e.html)
- Temporal resolution
  http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_6_e.html)

Problems Addressed in this lesson:

- What is the difference between spatial resolution and temporal resolution?

- What decisions need to be made when planning a remote sensing mission?

Activity Bursts:

- Investigating the different levels of spatial resolution: What are we looking for
- Relationship between resolution and pixel: How well can a Satellite see?
- Sensing changes over time (temporal resolution): The only thing constant is change
- Planning a remote sensing mission: **Activity sheets: Planning a mission (PRSM-2, 2A, 2B).** (See Activity sheet: Planning a remote sensing mission below)

Links to other resources:

Lesson	Teacher	Student
FRAME	Map of coral reefs around the world. Click on second image and zoom in on Hawaii. Then scroll down for a number of available remote sensing images of Hawaii. http://seawifs.gsfc.nasa.gov/cgibrs/reefs.pl	
	Satellite image of the western portion of Oahu http://eo1.gsfc.nasa.gov/Imagery/060401Oahu.jpg	Satellite image of the western portion of Oahu http://eo1.gsfc.nasa.gov/Imagery/060401Oahu.jpg
	Remote sensing image of the island of Oahu taken from the Space Shuttle http://earth.jsc.nasa.gov/lores.cgi?PHOTO=STS026-041-007	Remote sensing image of the island of Oahu taken from the Space Shuttle http://earth.jsc.nasa.gov/lores.cgi?PHOTO=STS026-041-007
	Map of the Oahu outlining Kailua Bay http://www.soest.hawaii.edu/GG/STUDENTS/ebitari/Research/Oahu_map.jpg	Map of Oahu http://satftp.soest.hawaii.edu/space/hawaii/maps/Oahu_map.758x554.gif
	Image maps of Kailua Bay http://www.soest.hawaii.edu/GG/STUDENTS/ebitari/Research/Image_maps.html	Image maps of Kailua Bay http://www.soest.hawaii.edu/GG/STUDENTS/ebitari/Research/Image_maps.html
INFORM	The concept of swath http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_2_e.html	The concept of swath http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_2_e.html

	What are we looking for http://imagers.gsfc.nasa.gov/teachersite/RS2_1.html	What are we looking for http://imagers.gsfc.nasa.gov/teachersite/RS2_1.html
	Four pictures of the train http://imagers.gsfc.nasa.gov/teachersite/RS2_1_1.html	Four pictures of the train http://imagers.gsfc.nasa.gov/teachersite/RS2_1_1.html
	Howe well can a Satellite see? http://octopus.gma.org/surfing/sensing seeing.html	Howe well can a Satellite see? http://octopus.gma.org/surfing/sensing seeing.html
	Spatial resolution http://observe.arc.nasa.gov/nasa/education/reference/resolve/resolve.html	Spatial resolution http://observe.arc.nasa.gov/nasa/education/reference/resolve/resolve.html
	Spatial resolution, pixel, and scale http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_3_e.html	Spatial resolution, pixel, and scale http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_3_e.html
	The only thing constant is change http://geo.arc.nasa.gov/sge/jskiles/top-down/only_constant/only_constant.html	The only thing constant is change http://geo.arc.nasa.gov/sge/jskiles/top-down/only_constant/only_constant.html
EXPLORE	Sensing change in your neighborhood http://octopus.gma.org/surfing/sensing/color.html	Sensing change in your neighborhood http://octopus.gma.org/surfing/sensing/color.html
	Temporal resolution http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_6_e.html	Temporal resolution http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_6_e.html
TRY	The various images of Oahu from space http://satftp.soest.hawaii.edu/space/hawaii/navnew/images/images.oahu.html	The various images of Oahu from space http://satftp.soest.hawaii.edu/space/hawaii/navnew/images/images.oahu.html

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How do I Plan a Remote Sensing Mission?

Related subject area: Science

Overall problem: Should activities be restricted around the coral reefs in Kailua Bay to insure their lasting protection?

Relationship of problem in this lesson to overall problem: At this point, students have developed a fairly complex understanding of remote sensing elements and processes, a precise definition of remote sensing, and have gained an understanding of the EM spectrum and how remote sensing can help evaluate the state of the coral reefs in Kailua Bay. The problem in this lesson is to construct a plan for using the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) remote sensing instrument to locate coral reefs in Kailua Bay. To do this, they will need to learn about a few additional key concepts related to the use of remote sensing instrumentation, e.g., temporal and spatial resolution and swath.

Estimated time required: 4 class periods.

Student outcomes/objectives:

- Students will be able describe the meaning of swath.
- Students will be able to describe the difference between temporal resolution and spatial resolution.
- Students will be able to distinguish between airborne remote sensing and satellite remote sensing.
- Students will be about to understand how ground truthing helps to validate airborne & satellite remote sensing image.
- Students will be able to make a remote sensing decision based on concepts that need to be considered when they are planning for a coral reefs mission.

Prerequisite skills or knowledge:

- Definitional knowledge of remote sensing including elements and process of remote sensing and the fundamentals of the EM spectrum
- Ability to work in teams
- Basic understanding of problem solving
- Basic reading skills
- Basic presentation skills

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How do I Plan a Remote Sensing Mission?

(Continued)

Teacher preparation:

- Print Student Journal / Activity sheets for these activities.
- Secure internet computers and projection equipment.
- Bookmark student web sites on student machines (if not available, print and copy student problem scenario web site).

Student reflection and assessment: Student reflection activities | Assessment

Education standards supported by this lesson:

National Science Education Standards | Project 2061 Benchmarks

National Standards for School Mathematics | National Technology Standards | National Geography Standards

Cross-curricular connections to support National Education Standards for this lesson:

math | technology | geography

Teacher activities	Student activities
FRAME the lesson by explaining to the students that they will be developing a remote sensing mission plan. To do this they will need to consider the purpose of the mission and the data they will need to collect. **Stimulate** students' interest and get them to begin to think about considerations for planning a remote sensing mission by	Sample student responses: • It is an island because of its features, size, etc. It is surrounded by water. • We might get this picture from aircraft, kites, balloons, satellites, etc. • Remote sensing is a process of obtaining information without coming into direct

projecting either remote sensing image of the Oahu #1 or #2

Ask the students to describe what they see in the picture, why they think it is an island, and how they think the images were produced, i.e., review the working definition of remote sensing.

Direct the students to especially look at the light blue area surrounding the island. What do they think it represents?

Teacher note: You may want to either project these images to the class, bookmark them for students to look at during this brief discussion, or print color copies of the pictures. Image #1 is quite large and requires scrolling.

Prompt students to look at the map of Oahu and compare it with the remote sensing image and ask:

- Where is Kailua Bay located on the island of Oahu?

contact with the object being observed.

- It looks like a picture of an island. In #1 I can see land, areas of green, areas of brown, water. In #2 I can see much more detail. I can see mountains, valleys, the waves crashing against the shore, agricultural areas (brown).

- The light blue area represents shallower water, where coral reefs may reside.

- Kailua Bay is toward the east side of the island.

Teacher activities	Student activities

INFORM students that in order to plan a remote sensing mission they need to learn about spatial and temporal resolution and swath. They will be learning about the concepts of swath and resolution by participating in activities.
 	
Ask students to list what they know about remote sensing. Give them a few minutes to list their responses.
 	
Prompt students to think about other factors they may need to consider before beginning the actual remote sensing
	Student activity:
	
	• Students create a list of what they know about remote sensing, which might include:
	    ○ Remote sensing is gathering data on things without touching them.
	    ○ Elements of remote sensing include energy sources, transmission of data, remote sensing instrument, and data processing.

mission.

Prompt students to take a piece of paper, roll it into a tube and look at the black/white board in the classroom.

- Energy is given off from a source that is gathered and interpreted by a remote sensing instrument and turned in to an image that scientists can interpret.
- Aircraft, satellites, balloons; etc can collect remote sensing data.
- Remote sensing instruments can detect both visible and infrared EM radiation from which images can be produced.
- Remote sensing instruments can collect data that is from heat sources, gases, etc.
- Remote sensing instruments gather data throughout the EM spectrum.

Teacher note: You may want to use remote sensing image of the Oahu #1or #2 for this activity. If you do not have projection capabilities you may want to sketch an object on the black/white board.

Sample student responses:

- For example, the size of the area being sensed, the location of the area being sensed.

Ask students while looking through the tube, how many passes across the black/white board will they need to make to see the entire blackboard.

Student activity:

Students participate in swath activity demonstration and record their definition of swath on **Activity sheet: Defining the terms (PRSM-1).**

Describe the concept of swath (PN: change URL, http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_2_e.html) in remote sensing (See 5th paragraph on this web page).

Sample student responses:

- Swath is what the RS instrument "sees."
- Understanding the swath of the instrument helps to plan flight path needed to gather the appropriate data for the mission.

Prompt students to write a definition of swath. See **Activity sheet: Defining the terms (PRSM-1).**

Ask students why the swath is important in remote sensing.

Student activity:

- Students participate in short discussion on spatial resolution.

Prompt students to look at the What are we looking for site that shows different levels of spatial resolution.

- Reveal one picture at a time and have students compare and contrast the pictures that were taken of the same objects but at different spatial resolutions.

Ask the students:

- What are the similarities?
- What are the differences?
- What would you be able to describe using image #1 that you couldn't describe using image #4?
- What could you describe using image #4 that you couldn't describe using image #1?

Teacher note: You may want to have the students view the images in reverse order to the way they are presented at the site. In this way their interest may be piqued as they try to identify the object that is revealed in the image with the highest resolution.

Introduce the relationship between resolution and pixel (picture element) by participating in the activity: How well can a Satellite see?

Ask students how remote sensing images will be seen differently based on spatial resolution based on what they learned by doing the "How Well Can A Satellite See?" activity.

Prompt students to write **a definition of spatial resolution**. See **Activity sheet: Defining the terms (PRSM-1).**

Debrief the students by asking them to identify advantages and disadvantages to low and high spatial resolution. This discussion might be enhanced by asking

- Review the four pictures of the train set taken from different heights.
- Compare and contrast the pictures.

Sample student responses:

- The images are all of the same thing.
- You can see much more detail in picture #1 but a bigger area in picture #4.
- In image #1 I could describe the train, its color and features. I can't see those features in image #4.
- In image #4 I can see the whole landscape and see how the area is laid out. I can't see much except the train in image #1.

Student activity:

- Students participate in the activity: How well can a Satellite see?

Sample student response:

- The picture I had drawn did not look as clear when I did it using the graph paper with the larger squares on it. I had to pick one color from a few blocks and so I lost some of the detail in the picture.

Student activity:

Students record their definition of spatial resolution on the **Activity sheet: Defining the terms (PRSM-1).**

them for examples of situations when one might be preferable.

Optional activity: An interesting and fun exercise is to have the students see if they can locate Kailua Bay on a remote Sensing Image of Oahu #1 with the aid of the map of Oahu

For the location of Kailua Bay, see the map of Oahu

Teacher note:

- Before teaching this activity, teachers should bookmark each of the image websites in advance.

- It is recommended that teachers print images from the websites in advance if computers and/or a projector is not available in the classroom.

Teacher resources:

- Spatial resolution, http://observe.arc.nasa.gov/nasa/education/reference/resolve/resolve.html)
- Spatial resolution, pixel size, and scale http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_3_e.html)

Sample student responses to debrief:

- In **low** spatial resolution, we can see large (gross characteristics) features in a larger ground area, but we can't see the fine details of these features.
- In **high** spatial resolution, we can see smaller details of the features. However, the higher the resolution, the less total ground area can be seen.

Teacher activities	Student activities
EXPLORE temporal resolution and participate in a temporal resolution activity. **Ask** students how remote sensing could be used to recognize changes on the earth.	Sample student responses: • Remote sensing images can be gathered over time to monitor the Earth and show how features change. • Remote sensing enables scientists to

Prompt students to participate in the activity: The only thing constant is change During this activity students will have the opportunity to "sense" changes over time. Activities 1 and activity 3 are highly recommended for helping students understand temporal resolution.

monitor changes on Earth at regular time intervals.

Student activity:

- Students participate in the activity: The only thing constant is change.

Optional Activity: Have students sense the changes in their school's neighborhood by taking pictures from the same spot at different times, either during a single day or over a series of days. Compare the different sets of photos and have students talk about how their neighborhood has changed over time. For detailed information see the 2nd activity of Sensing change in your neighborhood.

Teacher Note: Teachers who use the optional activity should be prepared to view this activity as long-term. It may take time to take and develop photos. Thus, it is recommended that students begin to take photos a week or so before this lesson. Then, they can analyze the pictures and develop a concept of temporal resolution during this lesson.

Prompt students to write a definition of temporal resolution. See **Activity sheet: Defining the terms (PRSM-1).**

Student activity:

Students record their definition of temporal resolution on the **Activity sheet: Defining the terms (PRSM-1).**

Debrief the students by asking how many times they think they will need to fly over Kailua Bay to locate and evaluate the changes of the coral reefs over time? Ask them to justify their answer.

Sample student responses to debrief:

- Several times, since they are looking at the changes in the state of the reefs over time.

Students may indicate multiple times if they apply swath and resolution concepts, e.g., multiple passes is seeking *high* resolution images of a *large* area.

Teacher resources

Temporal resolution
http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/chapter2/chapter2_6_e.html)

Teacher activities	**Student activities**
TRY using new knowledge while making the decisions necessary to create a plan for the remote sensing mission over Kailua Bay. **Break** students into several groups and direct each group to look at various images of Oahu **Teacher note:** • These images are not current images of Kailua Bay. We will investigate coral reefs in the "Analyzing data" lesson by using more current (1998-2000) images. • For the location of Kailua Bay on the island of Oahu refer once again to the map of Oahu. **Ask** students: • How would you classify these images in terms of spatial and temporal resolution? **Prompt** students to look at different images over Kailua Bay that were taken by different remote sensing instruments and ask them to record the answers on **the Activity Sheet: Comparing Remote Sensing images(PRSM-2)** • DMSV (Airborne) images with links to ground truth images *DMSV image showing location of Ground Truth Image* http://www.higp.hawaii.edu/kaams/lpreef/cr_analyze/image%20files/ground-truthimagesm.htm)	Student activity: • View the various images of Oahu. Concentrate especially on trying to find Kailua Bay (remember some images may not have Kailua Bay, and in that case where is Kailua Bay relative to the image) Sample student responses: • The spatial resolution is different in each image. • The images are of different areas and therefore may not show change over time since we aren't looking at the same place each time. • Students record their investigation on the **the Activity Sheet: Comparing Remote Sensing images(PRSM-2)** • Students make decisions for a remote sensing mission on the **Activity sheets: Planning a mission (PRSM-3)**. • Students share their remote sensing plans. Students complete the **Activity sheet: Reflection page (PRSM-3)** in their student journal.

- Airborne images

  Aviris image mosaic

- Satellite images

  Landsat mosaic

Prompt each group develop a plan for their remote sensing missions using the **Activity sheets: Planning a mission (PRSM-3)**.

Prompt groups to present their plans to the class.

Classmates assess and provide feedback to each group's plan.

Remind students to complete the **Activity sheet: Reflection page (PRSM-3)** in their student journal.

Summarize the lesson and introduce the next lesson, "Collecting and Analyzing data."

Student reflection activities:

- Prompt students to record what types of resolution problems they would need to consider, if they were planning a remote sensing mission.
    - Spatial resolution: high resolution and low resolution.
    - Temporal resolution: how many times will you fly
- Prompt students to make their own decisions for remote sensing mission.

Assessment:

- Students define and develop an understanding of: swath, spatial resolution, and temporal resolution.
- Students differentiate between temporal resolution and spatial resolution.
- Students differentiate between high spatial resolution and low spatial resolution.

Ideas for math lesson connections:

- The students determine a sensor's maximum spatial resolution in terms of the size of the area viewed by multiplying the instantaneous field of view (IFOV) by the distance from the ground to the sensor. (See diagram and explanation, 2.3 Spatial Resolution, Pixel Size, and Scale, in the CCRS on-line remote sensing tutorial
- Students practice skills using ratios and scale related to resolution and using digital images, photographs, and maps.

Related National Education Math Standards:

- Number and operations
- Geometry
- Measurement
- Representation

Ideas for geography lesson connections:

- Students investigate the Hawaiian Islands. For example, the students might create a report describing the location, climate, history, culture, and geography of the island.
- Students learn how remote sensing images are produced by engaging in the "How does the spacecraft send us data?" activity.

Related National Education Geography Standards:

- Places and Regions (#4)
- The World in Spatial Terms (#1, 2, & 3)

Ideas for technology lesson connections:

- Students discuss the tradeoffs associated with high and low spatial resolution.
- Students consider ethical issues associated with satellites and other remote sensing platforms being used for nonscientific purposes.

Related National Education Science Technology Standards:

- Nature of Technology (#3) Relationships among technologies and the connections between technology and other fields.
- Technology and Society (#4) The cultural, social, economic, and political effects of technology
- The Designed World (#17) Information and communication technologies

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Activity sheet: Defining the terms (PRSM-1) answer key

1. Swath - *ANSWER: the sensor "sees" a certain portion of the Earth's surface. The area imaged on the surface, is referred to as the swath.*

2. **Spatial resolution** - *ANSWER: describes how much detail in an image is visible to the human eye.*

ANSWER:

- *In low spatial resolution, we can see large (gross characteristics) features in a larger ground area, but we can't see the fine details of these features.*
- *In high spatial resolution, we can see smaller details of the features. However, the higher the resolution, the less total ground area can be seen.*

3. Temporal resolution - *ANSWER: The frequency (number of repeat observations in a given length of time) of observations of the same area of the Earth's surface during a given period of time.*

Activity sheet: Comparing ground truth images, airborne, & satellite remote sensing images (PRSM-2) answer key

- Where were these images taken?

The ground truth images were taken with an underwater camera by scuba divers on the ocean floor in Kailua Bay, Oahu.

The airborne multi-spectral image was taken over a section of Kailua Bay.

The airborne AVIRIS image was taken over Kaneohe Bay and Kailua Bay. We then zoomed into our study area of Kailua Bay.

The Landsat satellite image was taken over the entire island of Oahu. We then zoomed into our study area of Kailua Bay.

- What are the similarities?

They are all images that include Kailua Bay. The sensors that record the images all measure reflected sunlight off the Earth's surface (and the ocean floor down to depths of about 30 meters).

- What are the differences?

They are different in terms of spatial resolution. We could see much more detail in the ground truth images (underwater photographs) compared to the airborne and satellite images. Ground truth images have the highest spatial resolution. The multi-spectral airborne images have the next highest spatial resolution (1 square meter per pixel). The AVIRIS airborne image has a 20 meter spatial resolution (400 square meters per pixel). The Landsat satellite image has 30 meter spatial resolution (900 square meters per pixel), the lowest of the three types of images.

- What is the reason that these images are different?

The reason that these images are different is because the ground truth images are collected in the water, the multi-spectral and AVIRIS images are collected from airplanes, and the Landsat image is collected from a satellite.

- What would you be able to describe using ground truth images?

In ground truth images, we could see details on specific locations in Kailua Bay. We could see detail about the coral reef habitat such as lush coral gardens, green algae fields, sand ripples on the ocean floor, branching coral colonies, a coral "bomb" and even some fish. We couldn't see this sort of detail in the airborne or satellite image.

- What would you be able to describe using airborne and satellite images?

In the airborne multi-spectral image, we could see large-scale geological features such as small islands (Flat Island) the meandering sand channel, sand fields, islands in the

Bay, shape of the coastline and Kailua town. We could also see the overall texture of the reef.

In the airborne AVIRIS image, we could see both Kailua Bay, adjacent Kaneohe Bay, and the surrounding towns. We could also see small islands (Flat Island, the Mokolua Islands, and Coconut Island). There are lots of clouds in the image which is one of the reasons why they are flying another mission.

In the Landsat satellite image, we could see the whole landscape of Oahu and how the area is laid out. We could see things such as cities, mountain ranges, highways, agricultural fields, volcanic craters, white caps on the North shore (big surf), the airport but couldn't see the detail images in specific location because the resolution of the Landsat data is so coarse.

- Why do you think ground truthing is necessary to plan the remote sensing mission?

The ground truth images allows us to assist in the classification(i.e. distinguishing sand from coral) of the airborne and satellite remote sensing images (we will discuss the classification maps in more detail in lesson 11). If we do not have any ground truth images (underwater photographs), we would have a more difficult time distinguishing between different features (i.e. high versus low percentage of coral cover) within the airborne or satellite image. Ground truthing provides a validation for the classification of airborne and satellite images.

Activity sheet: Planning a remote sensing mission (PRSM-3) answer key

Mission statement

You are a member of an airborne mission scientist team. Your team's role is to locate and evaluate the state of the reefs in Kailua Bay on Oahu. Your team has access to AVIRIS as your remote sensing instrument and NASA aircraft at Dryden Flight Research Center in California. Before starting your mission, you need to present your remote sensing plan to other scientists at NASA. So, what do you need to consider in your remote sensing mission plan? Use what you know about remote sensing and the questions below to create a mission plan.

1. The process of remote sensing data collection:

What steps will you take to collect data for the remote sensing mission?

Step 1: Confirm the use of AVIRIS as the remote sensing instrument (example)

Step 2: Choose the appropriate NASA aircraft for housing the AVIRIS

Step 3: Create a flight plan that provides the data required to locate and evaluate the state of coral reefs are in Kailua Bay including, altitude, flight path, time of flight, etc.

Step 4: Prepare aircraft, instruments, and crew, Take off from NASA Dryden center

Step 5: Fly over Kailua Bay on Oahu.

Step 6: Collect the remote sensing images and return to Dryden, make interim landings as required

2. The types of data (remote sensing image):

1) What kinds of remote sensing images will you collect and why will you collect those images?

ANSWER:

- *Visible images: To see the features of the coastal environment, including the coral reefs.*

2) Which remotes sensing images will you collect and why do you think those images are necessary?

Remote sensing images	**Do I need these Images?**	**Why do I need this image?**
Ground truth images	*Yes*	***To have a record of what we have seen on the ground. We can use the ground truth data in conjunction with the airborne and satellite data to apply what we've seen in a particular area to a larger spatial area.***
Airborne remote sensing images	*Yes*	*To be able to discern larger scale geological features.*
Satellite remote sensing images	*Yes*	***To see how the location of Kailua Bay fits into the larger context of Oahu.***

3. The method of data collection:

Spatial resolution: What spatial resolution are you looking for in your images (high or low) and why?

High resolution: (Yes No) circle one (ANSWER: YES)

Why?:

ANSWER:

- *I will collect high-resolution images since I need detailed images of the coral reefs. The high- resolution images provide detailed information about specific location of the coral reefs given the features of the coastal environment.*

Low resolution: (Yes No) circle one (ANSWER: YES)

Why?:

ANSWER:

- *I will collect low-resolution images since I need an entire view of Oahu, especially on the east side (Kailua Bay). The low-resolution images provide the information on the location of Kailua Bay and puts the size of the bay in perspective with the size of the island.*

Temporal resolution and the swath: Are you looking at changes in the state of the reefs over time?

Changes over time: (Yes No) circle one (ANSWER: YES)

Why?:

ANSWER:

- *The request for this mission was to look at the state of the reefs in Kailua Bay. In order to assess the state of the reefs, we must be able to compare the state of the reefs in the past versus the present.*

Why might you fly over Kailua Bay more than once for this mission?

ANSWER:

- *Because the swath of the instrument may not cover the entire area of Kailua Bay.*

Use your responses to the questions on this worksheet to create a plan for conducting a remote sensing mission over Kailua Bay. Be sure to state the mission objective and a list the criteria for the mission including types of images you will collect and the spatial and temporal resolution requirements. You should be prepared to describe why each of the mission requirements is necessary for addressing the mission objective.