USING AN INTERNET MAP SERVER AND COASTAL REMOTE SENSING FOR EDUCATION

by

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Abstract: An Internet Map Server (IMS) web site was constructed with the goal of helping middle- through high-school students learn about ocean processes. This IMS was developed in conjunction with the activities of the Science & Math Investigative Learning Experience (SMILE) program, and for eventual use with the Oregon Coastal Atlas, an existing IMS site that allows a diverse audience of coastal users to access information about the Oregon coast. The main objective was to create educational lessons making use of a simple IMS site to allow students with basic computer skills to learn about large-scale ocean processes from actual ocean satellite imagery. This site features remotely sensed ocean images showing physical parameters and includes data from biological surveys conducted during the U.S. GLOBEC (Global Ocean Ecosystem Dynamics) cruise off the Oregon Coast in the summer of 2000. The satellite imagery was selected from different time periods to show students key seasonal trends and differences in physical conditions that occur off the Pacific Coast of Oregon and Northern California. Evaluation of the project has shown that the use of an IMS site allows students who have no prior training or access to GIS software to effectively view and understand the meaning of real ocean data and to perform simple analysis without the need for extensive data processing or software training.

1. INTRODUCTION

1.1 Background

> *By the year 2000, all students will leave grades 4, 8, and 12 having demonstrated competency over challenging subject matter including…geography, and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our Nation's modern economy.*
>
> – Goals 2000: Educate America Act Section 102 (GESP, 1994)

In our increasingly global society, geographic knowledge, spatial thinking, and natural resource management are becoming more important in our society. The United States has taken action to improve the state of geographic education in its schools as evidenced by the above passage from an act passed by Congress. This act of Congress united the geography K-12 education community, which in 1994 formed The Geography Education Standards Project (GESP). The standards were produced under the sponsorship and collaboration of the major U.S. geography organizations: the American

Geographical Society, the Association of American Geographers, the National Council for Geographic Education, and the National Geographic Society. This working group's effort resulted in the publishing of *Geography for Life,* a comprehensive set of standards for geographic education in the K-12 age group (GESP 1994). The GESP outlines five sets of geographic skills that all students should possess upon completion of high school. These include:

1. Asking Geographic Questions
2. Acquiring Geographic Information
3. Organizing Geographic Information
4. Analyzing Geographic Information
5. Answering Geographic Questions (GESP 1994)

One of the recommendations that the GESP outlines is a focus on the further integration of Geographic Information Systems (GIS) in education (GESP 1994). Geographic Information Systems and remotely sensed images from satellites can both be used to help students better understand Earth systems (e.g., Walsh 1988), as well as obtain geographic skills described by the GESP. Recently, efforts to include oceanography concepts in secondary education have multiplied, although overall oceanography education in U.S. secondary schools is still quite limited.

With the advent of GIS software, society has experienced an exponential increase in the ability to collect and analyze spatially referenced data (Bednarz and Ludwig 1997, Kemp et. al. 1992, O'Dea 2002). Geographic education in the secondary schools can be greatly enhanced with the use of GIS, as these programs help students to learn about the real-world applications of geographic concepts (Goodchild and Kemp 1992, White and Simms 1993, Linn 1997, Meyer et al 1999, Audet and Ludwig 2000, ESRI 2005).

The role of GIS in the classroom has been envisioned as a tool which will help introduce and reinforce important spatial topics (Gatrell, 2001). The role GIS takes in schools ranges from simple digital atlas applications to the advanced projects that require data gathering, spatial queries, and modeling (Green 151, 2001, Alibrandi, 2002, Audet and Paris 1997, ESRI 2005). Funding for technology implementation in secondary education has recently come from both federal and private sources (Bednarz and Ludwig 1997). A growing number of scholars and educators recognize that GIS software has become simpler to use and its benefits to the student warrant further introduction in secondary schooling (Goodchild and Kemp 1992).

GIS education has made great progress in secondary school implementation, but research in this arena is still limited (Kerski 2001, Wiegand 2001, Patterson et. al 2003). An exception is the study of Kerski (2001) which looks extensively at the use of GIS in secondary schools nationwide. His findings reveal that only about 2% of American high schools have adopted GIS software, and of the teachers who use GIS, only 20% use it in more than one lesson in more than one class (Kerski, 2001). His findings also show that GIS was used twice as often by science teachers as by geography teachers (Kerski, 2001). Similar studies also note a low GIS adoption in secondary schools (Meyer, et al., Bednarz & Ludwig 1997, Keiper 1998).

One of the many difficulties with implementing desktop GIS software is the time investment required before a user feels comfortable using the software. Yet even more time must be invested by a K-12 teacher, who must first learn the software and then prepare to teach it to students. Some of the barriers identified by Kerski (2001) to the effective use of desktop GIS for secondary school education include: lack of time for developing GIS lessons in addition to the standard curriculum, little support for training, lack of training geared toward educators, and the perceived complexity of software. Other barriers include limited access to hardware and software, and limited direction as to how GIS can help teach geographic concepts in an educational setting (Green 2001, Meyer at. al. 1999). As mentioned above, another significant difficulty that must be overcome by teachers is the initial time investment needed to instruct students in the basic use of GIS software before the software can be used to enhance a curriculum topic (Meyer 1999, Baker 2005, Audet & Paris 1997). Wilder et al. (2003) also found this to be the case after conducting a GIS professional-style workshop for teachers that consisted of two 15-day intensive workshops conducted over two summers in addition to two 2-day intensive in-service trainings during each of the following winters.

Teachers also need to gain experience in data acquisition, processing and management in order to use GIS software, and this presents an additional barrier to classroom use of GIS. Baker (2005) noted even though data are widely available, and in many cases free, significant barriers still exist, including lack of data for specific educational topics and technical data processing issues.

Due to the technical demands of data acquisition and processing, remote sensing imagery has seen even more limited use in secondary education (Kirman, 1997). Becoming too focused on individual techniques in the study of geography remains a concern; however, the advent of new technologies has brought about the most exciting and interesting aspects of sub-disciplines in geography (Kent 2000). NASA has created an interactive web site for younger students to learn about remote sensing at URL: http://imagers.gsfc.nasa.gov/

Shrinking budgets and increased demands on funding in public school districts have changed priorities in computer access. School purchasing trends are shifting from stand-alone desktop models to networked terminals, which have more limited client-side peripheral input options. These terminals are less expensive than stand-alone desktop models and are controlled from a central location, usually a school district's office. This solution uses inexpensive hardware and reduces the information technology staff required to maintain the centralized equipment. One of the downsides is that it limits the teacher's ability to use custom software because it has to be loaded off-site (Gray, L. E., personal communication 5/6/05). GIS software can be very expensive and hardware-intensive, which will likely be incompatible or cumbersome in this type of centralized network environment due to software design.

Even with advances in software usability, teachers and students rarely require the full power of a GIS desktop package (O'Dea 2001). Describing GIS use in schools, Fitzpatrick and McGuire (2001) suggest that "…the vast majority of tasks that schools wish to accomplish can be handled with a reasonable number of basic operations" and students and teachers "should not be concerned with learning immediately 'all there is' ".

Although there are many obstacles to successfully implementing desktop GIS software in K-12 education, those teachers who have succeeded see it as a very positive experience for students and a valuable tool for integrating geography, science, technology, and problem solving skills (ESRI 1998, Meyer et al 1999, Green 2001, Kerski 2000, Alibrandi 2002, Baker and White 2003, and West 2003).

Considering the difficulties that teachers have to overcome when trying to integrate GIS into lessons, some geographers have advocated using Internet map service (IMS) web sites to introduce GIS to a wider range of teachers and students (Crawford et al. 1999, Green 2001, O'Dea 2002, Larkin 2004, Baker and White 2003, Baker 2005). An IMS web site functions like a simple GIS by allowing a user to view preprocessed data in selectable layers at different scales, with basic queries and searches that can be performed through a web browser. The IMS is accessible by any computer with Internet access and is excellent for education applications because only the basic GIS operations are accessible via the IMS interface, thus providing a way to integrate a simple GIS lesson into a curriculum.

1.2 Previous Work and Examples of Other IMS Sites

The National Geographic Society's Sustainable Seas Expeditions (URL: http://www.nationalgeographic.com/seas/), Channel Islands National Marine Sanctuary (CIMS) and Center for Image Processing in Education (CIPE) (URL: http://www.cinms.nos.noaa.gov/edu/main.html), and Environmental Systems Research Incorporated (ESRI) (URL: http://www.esri.com/industries/k-12/index.html) have previously developed educational materials with a GIS and marine focus. Researchers at the University of Kansas K-12 GIS community (URL: http://kangis.org/), in collaboration with others, have developed a number of IMS sites for education that can be accessed via the web though the PathFinder Science page (URL:http://pathfinderscience.net/).

At Oregon State University, O'Dea (2001), and Larkin (2004) both designed and implemented IMS sites for use in education. O'Dea designed an IMS site for teachers in the Seattle/Tacoma region of Washington State. This site was designed as an atlas of the local community with base map information (cites, roads, boundaries) combined with physical geography layers, so that area science classes could use the atlas to learn more about the area and enhance science field studies. Larkin (2004) designed and implemented an IMS site incorporating data from ship-borne multibeam sonar surveys collected in 2001 to aid students and the public in American Samoa in learning about marine benthic habitats in seven areas surrounding the main island of Tutuila.

1.3 Project Goals

The goal of this project was to develop materials and methods to increase K-12 student exposure to GIS, remote sensing, and oceanography concepts, focusing locally in Oregon and the Northwest. This project is unique in that it combined satellite remote sensing data with ocean research data that were sampled in an ecosystem approach from the smallest plankton to large animals. No such internet site or educational lessons with this kind of cross-disciplinary approach exist in the Oregon region for an educational audience. Although many students in Oregon live very near the coastal zone, marine sciences and oceanography are very briefly covered in traditional K-12 curricula. Some of the larger, more urban school districts are usually able to fund very limited course work in marine science but the more rural schools in Oregon and the Northwest have always had more difficulty funding specialty courses. This project aims to get students excited about learning about oceanography, remote sensing, and GIS using local coastal examples that students in Oregon could relate to.

Two primary research questions addressed were:

1. Can an IMS site be used effectively to teach students at the high-school level about remote sensing, large-scale oceanography concepts, and biological interactions?
2. What are some of the impediments to successful implementation of an IMS and possible implementation solutions?

In order to answer the above research questions, the following steps were taken:

1. Design an IMS web site, the Oregon Coast Marine Viewer (OCMV), using ocean remote sensing and oceanography data that are user-friendly to teachers and students;
2. Develop educational modules to complement the site;
3. Introduce teachers to GIS, remote sensing, and oceanography and how to use the IMS site in a series of workshops: one in the summer to introduce ideas, and one in the winter to introduce the working OCMV site and specific IMS lessons;
4. Obtain feedback to improve the site and identify impediments to successful IMS integration;

In order to help students learn about remotely sensed images, an IMS site was constructed that contained sea surface temperature (SST), ocean chlorophyll (ocean color), and biological data from the U.S. GLOBEC (Global Ocean Ecosystem Dynamics) cruise in 2002.

A goal that has emerged recently in the oceanographic community is to promote the use of remote sensing, GIS, and oceanography by students who have been traditionally underrepresented and underserved by the science programs at local rural schools. To this end the Science Math Integrated Learning Experiences Program (SMILE) was a key collaborator in the facilitation of this project. The SMILE Program has been active on the OSU Campus for 17 years seeking to carry out is mission of enhancing science and math learning for underrepresented students in mostly rural schools in Oregon by providing hands-on activities at weekly after-school SMILE club meetings. The eventual goal of the SMILE Programs efforts are to help guide students from K-12 on a path to study science and math at the college level by fostering an interest early on in their education. More information about the SMILE Program at OSU can be found at their web site, URL: http://smile.oregonstate.edu.

The IMS site that was constructed for this project was made specifically for activities pertaining to the SMILE Program after-school club meeting, and the teachers that the author interacted with during this project were all SMILE Program teachers. The SMILE Program provides lesson material for a portion of the yearly activities drawing heavily from current projects, and working collaborations with researchers on the OSU campus. Twice a year SMILE Program teachers are invited to OSU for training and staff development pertaining to the upcoming activities to be presented in SMILE after school activities. The presentation of the lesson plans to the teachers for this project took place at SMILE workshops in August 2004 and January 2005.

2. METHODS

In order to meet the objective of creating an IMS site with an oceanography and remote sensing content, the ArcIMS software developed by Environmental Systems Research Institute (ESRI) was used to create GIS functionality over the web and build a web site which allows the user to manipulate the map service (more information on ArcIMS can be found at URL: http://www.esri.com/software/arcgis/arcims/index.html). As discussed previously, ArcIMS web sites have been designed with success specifically for the K-12 audience. The relatively gentle learning curve of ArcIMS was a large factor in the selection of ArcIMS as the software chosen to design the project web site.

2.1 Data Acquisition and Processing

Once the IMS design program was selected and the author began to learn how to use ArcIMS, oceanographic and remote sensing data was collected for the content of the site. The next sections will outline methods of data acquisition and processing, followed by procedures used to create and customize the IMS web site.

2.1.1 Remote Sensing Data

The remotely sensed data used in the OCMV came from a variety of sources. The data for the Pacific Ocean SST was from a NOAA satellite equipped with an Advanced Very High Resolution Radiometer (AVHRR) sensor. Each image is from a single pass at a 1-km resolution, with absolute temperature derived from multichannel algorithms. These images can be accessed via file transfer protocol (FTP) download at the U.S. GLOBEC NE Pacific Project Satellite Data Archive, hosted by the College of Oceanographic and Atmospheric Sciences at Oregon State University. (URL: http://coho.coas.oregonstate.edu/#globec). The raw satellite data were first processed by Ocean Imaging of San Diego, California, and translated into image files. The SST images used for the IMS site showed the coast of Northern California, Oregon and Washington. They are stored in the directory under the following section: N.E. Pacific, North Region NOAA 12/14 AVHRR Ch 4, 5. To get the clearest images possible, care was taken in selecting images for the IMS site from days that had very few clouds. In order for the entire range of ocean surface temperatures to be captured year-round, the sensor collects temperatures ranging from 0 to 22.5°C. The raw satellite data are then processed into images that display the collected range. The SST images used in the Oregon Coastal Marine Viewer (OCMV) were taken from June 13, and August 2, 2000.

The ocean chlorophyll (ocean color) images came from the Sea-viewing Wide Field Sensor (SeaWiFS). Unlike the SST images, which were from a single satellite pass, the ocean color images were constructed from processing images over an 8-day period. These composite images were created using methods developed by Dr. Andrew Thomas at the Satellite Oceanography Data Laboratory at the University of Maine (URL: http://wavy.umeoce.maine.edu/). The SeaWiFS images show values of chlorophyll concentration that represent milligrams of chlorophyll per cubic meter with a resolution of 4km, along the Pacific coast ranging from Washington to northern California.

The data for both AVHRR and SeaWiFS came in a simple byte array format with the land areas blacked out. The files were taken into the remote sensing program ENVI for conversion to an image in the TIFF format (Appendix B). Once the images were saved in a TIFF format, the images were imported into ArcGIS and georeferenced manually, matching up distinctive shoreline features from the image to a shapefile of the northwest states.

2.1.2 Mammal and Birds Data Collection

The bird and mammal data were both collected from observers aboard the Research Vessel (R/V) *Roger Revelle* (Figure 1), an oceanography research ship owned by the Scripps Institution of Oceanography at the University of California at San Diego. The birds and mammal data was collected from the deck of the ship using high-powered binoculars that had an estimated range of 6 nautical miles during clear weather (Figure 2). The full procedures for sampling and processing these data are described on the U.S. GLOBEC web site (URL: http://globec.whoi.edu/jg/dir/globec/nep/ccs/).

Figure 1. R/V Roger Revelle (Photo: Scripps)

Figure2. 25x150 Binoculars for Bird and Mammal counts (Photo U.S. GLOBEC)

The data were made available on the U.S. GLOBEC data archive gateway in a flat file text format at http://globec.whoi.edu/jg/dir/globec/nep/ccs/ . The data were copied from the web page and pasted into a Microsoft Excel file for simplification and sub-sampling. The Excel sheet was then converted to a shapefile in ArcGIS for use in the IMS site. The information collected by the observers that were used in the IMS site for the bird and mammal data included the date, latitude and longitude, the number spotted, the common name, and the scientific name.

2.1.3 Plankton Data Collection

In order to collect plankton data on an ocean research vessel, a very fine mesh net is deployed off the stern of the boat and then towed through the water to collect plankton. The system used for the U.S. GLOBEC sampling was a MOCNESS plankton net system (Multiple Opening/Closing Net and Environmental Sampling System). The plankton data were collected on the R/V New Horizon, owned by the Scripps Institution.

The net consists of a metal frame that has a system of nets with canisters at the rear to collect drifting plankton. When initially deployed, the nets are all in the closed position. When the ship has maneuvered into the desired area for sampling, and the net is at the correct depth, one of the nets is raised into the open position to collect a sample. After the first sample has been taken and the net is closed, the net for the second sample can be opened according to the planned depth and location.

After collection is complete, the samples are preserved, species identified and data recorded.

Figure 3. R/V New Horizon departing Hatfield Marine Science Center, Newport, Oregon, July 31, 2000. The plankton net, which is black in color, can be seen stored at the stern of the ship. (Photo Courtesy of U.S. GLOBEC)

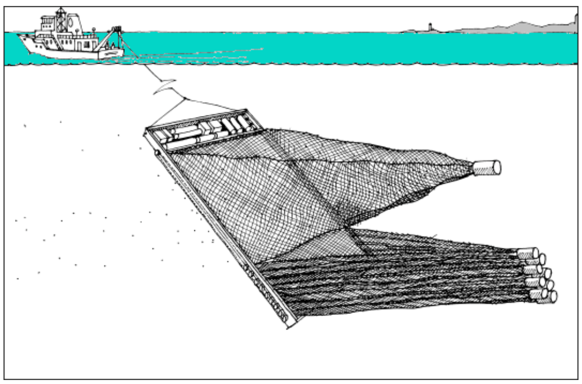


Figure 4. A diagram of the MOCNESS plankton net system used on the U.S. GLOBEC cruise. (Illustration courtesy U.S. GLOBEC)

The plankton data were also accessed from the U.S. GLOBEC project web site. The data were in the same format as the bird and mammal data, and the same data conversion process described in the previous section was used. Of the plankton data collected, the IMS site used only the date, latitude and longitude, the abundance of plankton in meters cubed, the depth the sample was collected, and the scientific name of each species.

2.2 Basic IMS Site Operation

The ArcIMS application functions in a client-server relationship where the client is a computer running a web browser connected to the internet. The client views the web site hosted by an ArcIMS server. When the client makes a selection on the web site, called a request, the ArcIMS-enabled server processes the request and returns the information the client requested for viewing. An IMS site is a web site that is connected to a spatial server that references GIS data. The client makes a section of the data either by selecting a layer of data or by using the navigation tools to select an area. Once the section is processed by the client's computer, it is sent as a request to the ArcIMS spatial server. When the IMS receives the spatial request, it processes the data of the type requested in the area specified. The spatial server then generates an image of the user's request and sends the image back to the client's web browser, which prompts it to reload the web page and show the newly generated image. This process makes the transfer of data, in this case an image, to the client's computer much faster than if the client had to download and process the GIS data on the local machine. The IMS site was constructed using ArcIMS Author, ArcIMS Designer, ArcIMS Administrator, and hand editing of XML, HTML, and Java files.

2.3 Creation of the Web Site

The ArcIMS author program allows the user to create an Arc Extensible Language file (AXL), which is based on the Extensible Markup Language (XML) file format. An XML file is designed to describe how data are used in an application; in this case, the Axl file defines which GIS data in this IMS site are used and how they are displayed.

At the beginning of the AXL file, the boundaries of the initial map displayed at start-up are defined, along with the text font, size, and style. The <SHAPESPACE> tag defines the path to the location where the vector files are stored. The <IMAGESPACE> tag defines where the grids are stored. After these preliminary parameters, the rest of the Axl file uses the <LAYER> tag to define which layers are displayed in the IMS, and how they are displayed. Similar to basic HTML, an Axl file has a beginning tag <LAYER>, and an ending tag </LAYER>, the forward slash denoting the end of data related to a single layer. The LAYER tag's argument "type" defines whether the layer is an image, a shapefile, coverage file or an SDE layer (see sample markup below in Figure 5). The "name" argument establishes the layer name as it will appear in the web site. "Visible", either true or false, defines at start-up of the web site whether the layer is turned on and visible. "ID" defines the position of the layer among the other layers listed. Layer 0 shows up at the bottom of the list and the highest number (in the case of OCMV, 8) is the first layer that shows up, although in the AXL file the list must start from 0 at the top of the file. The dataset tag <DATASET … /> (which does not require an opening tag) defines the name of the file. In the following example, the file named is sstjn13, and the type is an image (or grid). The workspace, in this case jai_ws-0, defines the alias for the path name of the storage file for all the images that were defined at the top of the Axl file under the <IMAGESPACE> tag.

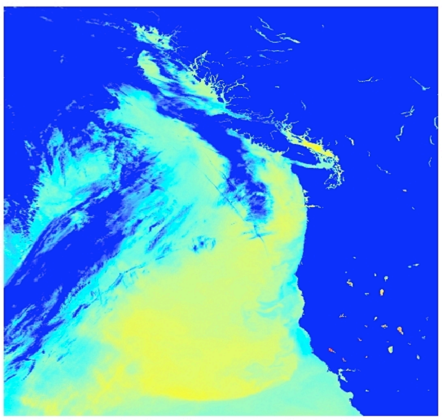
```
<LAYER type="image" name="Sea Surface Temperature June 13 2000" visible="false" id="0">
   <DATASET name="sstjn13" type="image" workspace="jai_ws-0" />
```

Figure 5. See the Appendix B for a more detailed example of code that was written for the OCMV web site

After the AXL file is created and the mapping service that calls the GIS data into the web site is created, the rest of the web site with which the user interacts needs to be created. This part of the web site can be generated with ArcIMS Designer either in Java or HTML. The Designer sets up the web page layout and design and allows the creator to select which GIS tools are available for the user of the IMS site. ArcIMS Designer is a good tool for getting the web site set up; however, some additional customization is usually required to enhance the default layout options. Customization will be described in more depth below (Section 2.6).

2.4 Technical IMS/R-S Grids

A grid is a file that contains a range of values representing measurements in a row and column arrangement, similar to a spreadsheet. In the case of OCMV, because display was a key concern so as not to confuse those not familiar with remote sensing images, great care was taken to pick a color range that accurately portrayed the values of SST and ocean color. Grid files are not natively handled by the ArcIMS Author program; rather, the web site designer must add appropriate lines of code into the Axl file for them to work properly. One line of code must first define the workspace that the grid resides in, following ESRI naming conventions (file/path name no longer than 8 characters; no spaces or special characters). Unlike a vector file, which usually only requires a few different color options, a grid needs to have a color palette that accurately highlights the data values that are important. For example, with summer SST images off the coast of Oregon, if a linear color palette was applied to the entire range of values 0-255, the image would display only 2-3 colors (Figure 6 and 7). This is because the summer temperatures off the coast of Oregon tend to vary between 10 and 17 degrees Celsius. The colors can be stretched to match the data more accurately, with the unused temperature ranges of 0 to 9° C and 17 to 25° C assigned to the extremes of the color range. This will leave the rest of the color range to show the subtle variations in temperature off the coast that are important to understanding large-scale ocean dynamics such as upwelling.



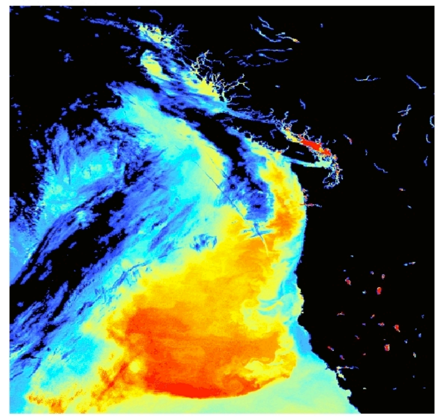


Figure 6 & 7. The image on the left has a default classification for the color ramp and does not show the color variation in the SST. The image on the right used a Quantile classification with 32 classes.

2.5 Image Display in an IMS

After arguments are added to the layer tag, which describes where the grid data are stored, the grid values have to be assigned a range of colors in order to be displayed correctly. Since the ArcIMS Author program does not have the capability to do this, the value ranges must be determined manually and manually assigned a representative color using the Red Green Blue (RGB) color system. To determine the best range of colors, the images were loaded into ArcGIS and then were given a Quantile classification, a command which can be found under the Properties menu. Under the Quantile classification options, the highest number of available classes (32) was selected. The Quantile classification divides the full range of values (here, temperature and ocean color readings) into smaller ranges, each range containing an equal number of observations (Figure 8).

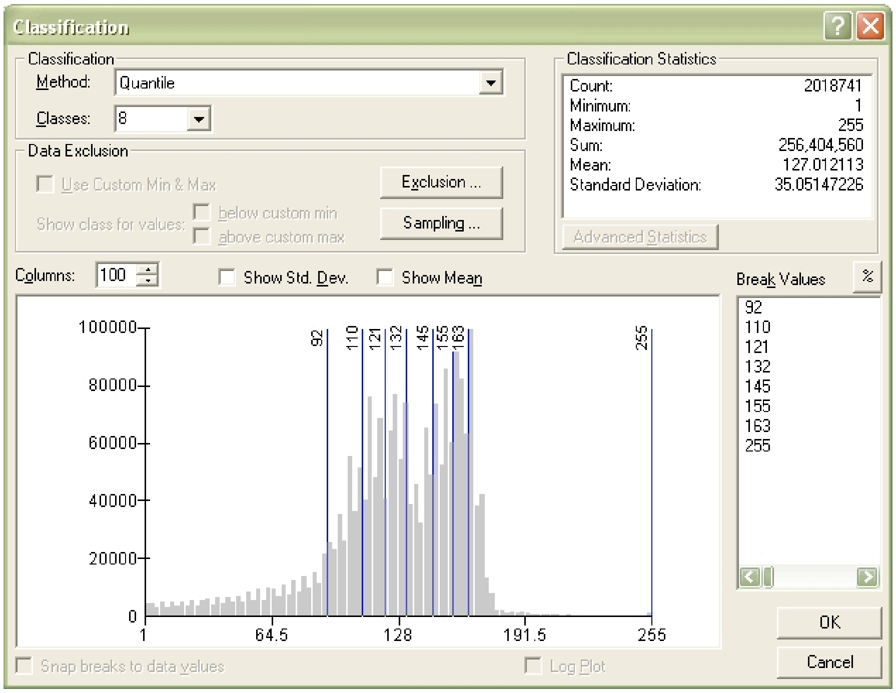


Figure 8. A quantile classification of sea surface temperature (SST). This example classification has eight classes for clarity.

The Quantile classification is good at representing linearly distributed data, although some distortion in cartographic representation can occur. This distortion can be reduced by increasing the number of classes (ESRI 2004). This classification scheme showed the variance in the temperature the best because it grouped the highest and lowest values (of which there were few) into a small number of classes, leaving the remaining available class ranges to represent the bulk of the data values.

Once the image was classified, a default color ramp from red to light blue was applied. Each class of values was then assigned a color, for which the RGB number was determined and entered into a spreadsheet for organizational purposes. The following example shows the lowest three ranges and their corresponding color definitions as they would be defined in an AXL file:

```
<RASTER_RENDERER>
<RASTER_RANGE lower="0" upper="1" color="0,0,0" equality="all" />
<RASTER_RANGE lower="1.00001" upper="23" color="33,44,255" equality="all" />
<RASTER_RANGE lower="23.00001" upper="48" color="46,70,255" equality="all" />
```

In the last line of the above markup, the range of values is defined (23-48) and the color is defined in RGB as “46, 70, 225”, a light blue color. Since each image has a range of values from 0 to 255, each range of colors must be defined in the same way; an image with 32 classes must define the range and color for each class (Appendix B).

2.6 Data Simplification

In the first version of the OCMV web site, the biological data layers (Birds, Mammals, Plankton) contained all the data from the 2000 U.S. GLOBEC cruise off the coast of Oregon and Northern California. To a user not familiar with viewing GIS data, viewing more than one data layer at a time was quite overwhelming. It was decided by the author, SMILE and COAS collaborators, that a subset of each data biological data type should be used in order to simplify the data display.

The research cruise followed a zigzag track up and down the coastline. A northern and a southern ship track were selected so that the two areas would be visually separated. One area was chosen according to an area of higher phytoplankton productivity (around Cape Blanco, near Coos Bay, Oregon) and the second section was of lower productivity, to illustrate variability in the area. Once the areas were chosen, the data collected from these areas were copied and pasted into a new shapefile that was used for the final version of the OCMV web site (Figure 9 and 10).

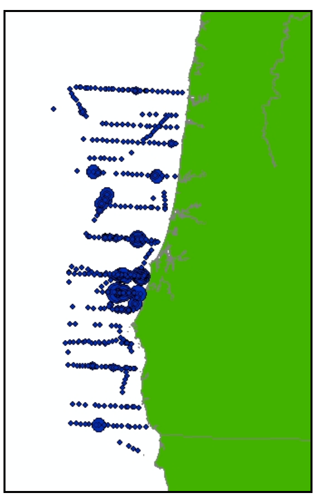
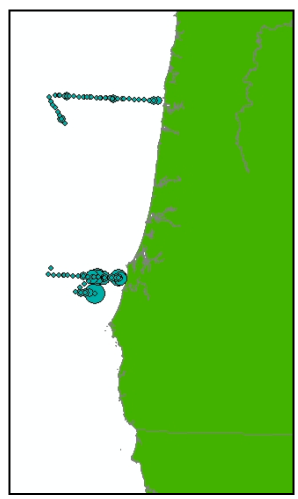


Figure 9 & 10 The figure on the left is the complete set of bird data from June/July. The figure on the left is the simplified version used in the OCMV web site.



In order to make the shapefile attribute tables easier to interpret by teachers and students, the species codes were replaced with the full species names. Also, extraneous data columns present in the data's original form but not required for the lessons were removed.

2.7 Web Site Customization

2.7.1 Buttons

The default buttons for navigation and other functionalities in the ArcIMS viewer are very small and use some icons that people unfamiliar with ESRI software, especially school children or high school students, would not recognize. In order to make the site more user-friendly, the small default buttons were replaced with larger buttons to draw the user's attention, and the icons were replaced with text labels so that the buttons would me more intuitive to novice users (Figure 11).

Figure 11. An image of a button that is not currently selected, and a button that is currently selected.

2.7.2 Layout

The layout of the site was modified from the default to make the site more easily used by students. On the right side of the site layout, two large tabs were placed at the top of the side banner so the users could select between viewing the layers and the legend. The default setup to toggle between the legend and layers is a small icon on the tool bar on the opposite side of the page, which was not as intuitive as the changes that I made for the OCMV (Figure 12).

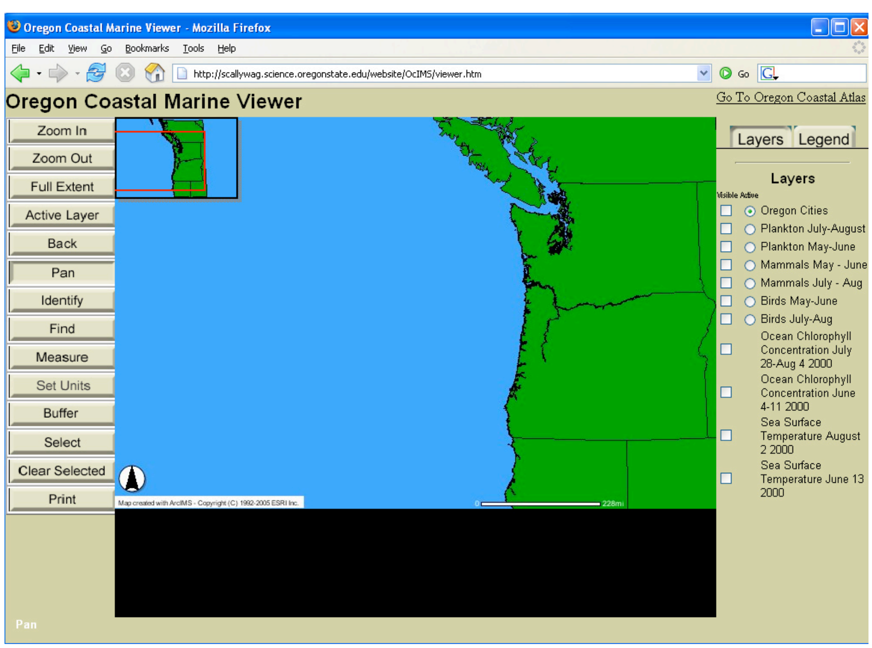
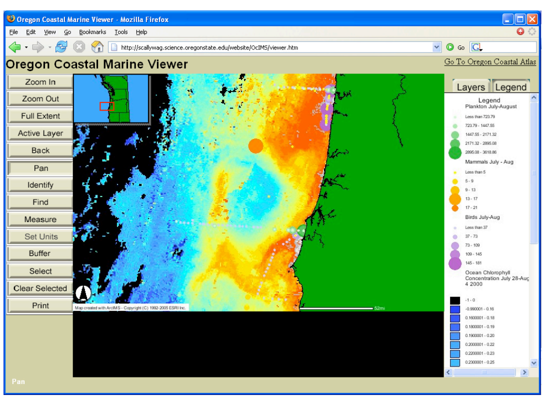


Figure 12 The OCMV web site at start up.

A link to the Oregon Coastal Atlas was added for reference to other information about coastal management as well as links to GIS data. A link to the electronic versions of the teacher manuals and student worksheets were also provided via an external page of the OCMV.

2.8 Site Design Considerations

The site was designed specifically for the novice user of both web browsers and IMS sites. As mentioned before, audience considerations were made regarding data processing, color selection and web site design, with the goal of making the site easily understandable to students and teachers. Data were simplified so that multiple layers would not be visually overwhelming when viewed at the same time. Data tables were simplified by removing extraneous codes and columns of data that were not pertinent to the lesson. The species codes used in the biological data types (plankton, birds, mammals) by the scientists were replaced with species names to improve readability (see Appendix B for Java Script file modifications). Colors were selected with the goal of providing the most contrast between the satellite imagery and other data types. Symbols for representing the biological data were made to vary in shape and color so that it was easy to distinguish classes. The satellite color palettes were chosen from known web-safe colors, tested, and modified to show up well though a web browser (Figure 13 and 14).



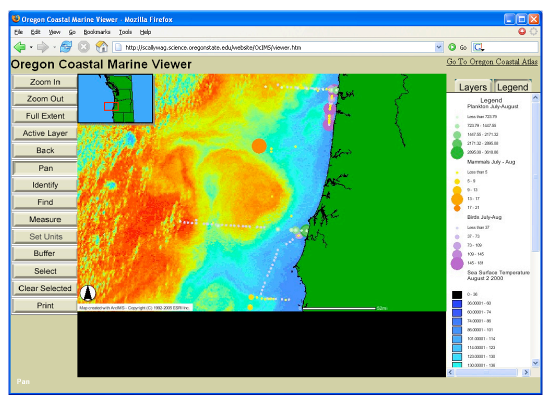


Figure 13 & 14. Two examples of color schemes chosen for the display of SST images from the OCMV. The image on the left is from late June 13, 2000, the image on the right is from August 2, 2000.

The layout was organized so that the most frequently used tools would show up on the top of the page. The background layer was colored blue, and the state layer controls were hidden, to give the interface a familiar map-like appearance at all times. A cities layer was added to give a land reference for the ocean data. A toggle for the layers and the legend was added at the top of the right hand side of the page to aid in usability. The small default icons were replaced with large text buttons so users could read the functions of the buttons.

2.9 Workshop Preparation

For the SMILE teacher workshop, lesson plans were constructed and background material on both GIS and remote sensing was prepared. This was to help the teachers learn about how to use the IMS site and to provide some background knowledge in GIS, remote sensing, and how the IMS works. The lessons were designed to give a logical progression of instructions for navigating the site (Appendix A). The main goal behind the lessons was to aid the students in learning about how maps are made, basic GIS concepts, remote sensing image resolution and visualization, relationships between costal upwelling, SST, ocean color, and biota.

The first lesson the SMILE students were exposed to was Mapping Your School and Resolution (Appendix A). This lesson was intended to introduce cartography concepts to students by having them make their own maps. The next step was to introduce the concepts of resolution and classification, by having the students simulate the process of making a digital image from the maps they created using a transparent grid. The students were then led though another classification with a different grid size to create an image of higher resolution. This introductory lesson was intended to make the students better understand the IMS site and the concept of resolution in satellite imagery.

The second lesson, and the first that used the IMS site, takes the students through understanding the sea surface temperature grids and comparing the early-summer and late-summer images to get familiar with the concept of coastal upwelling. The lesson then progresses to an investigation of the SeaWiFS images for the students to learn about the concentration of chlorophyll and phytoplankton around the upwelling areas. The final step takes the students through the biological data and shows the correlations between the ship-sampled phytoplankton and the SeaWiFS images, followed by the relations between the bird and mammal data with the SeaWiFS and SST images (Appendix A).

The third lesson was designed to build upon the second lesson, using the temperature and ocean color images to compare some field-sampled data. The students looked at the plankton net tow data in conjunction with the SeaWIFS images from the same time period. The students were then instructed to look at the bird and mammal data and then to select a species in one of the data tables and do an internet search for a picture of that species. Finally, students viewed the bird and mammal data with the SST and SeaWiFS images to look at correlations between the areas of upwelling and high photosynthesis and aggregation of animals.

3. RESULTS / DISCUSSION

One of the benefits of using an IMS site is that the students can explore the data in many different scales much more easily than using static computer images or paper print-outs. It is very easy for other data to be overlaid with the remote sensing imagery to view commonalities. Searching within the data is also possible, as the IMS site allows the user to either select a search by location or attribute. Once a selection is made, the map is dynamically updated to show the selection in a new color. This makes it possible to search for a specific attribute and see were it is located.

If set up correctly with inexperienced users in mind, an IMS site can be very simple to use, which is a key consideration when trying to teach students how to use a piece of technology. The OCMV was designed to contain only the GIS operations and functionality that was discussed in the lesson plans so as not to overwhelm the users with excessive options or functionalities that were not required for the student worksheet. As mentioned before, the layout was altered to highlight key functionality in the legend/layers section, and to make the button controls more descriptive.

When working with spatial data in a GIS project, preprocessing the data can be demanding and time consuming. Although constructing an IMS site is time consuming and technical in nature, a person with extensive GIS training will be responsible for the data processing. Once the site is set up, the teachers and students do not have to spend time processing data and can immediately begin the more interesting lessons using the GIS functionality of the site.

There was a wide range of comments made by teachers after they were introduced to the site and lessons at a winter workshop run by the SMILE program. Much of the feedback was very positive, including the praise of integrated technology in the classroom as aligning with district educational goals, and general enthusiasm for the material presented in the site. Some concern was voiced by teachers who anticipated a lack of availability of the necessary computer access, which is a common problem in budget-strapped school districts.

From observations at the SMILE winter workshop, as well as written comments provided by workshop attendees, some of the teachers who were not as computer literate felt overwhelmed by the volume of information provided both as background material for teachers and as lesson material for students. Given only two hours to introduce GIS and remote sensing, and to work though the lessons for the IMS site, it is understandable that a few teachers felt this way. A couple of the teachers felt that they would need some extra time to work though the site on their own after the workshop to be able to instruct the students. The lessons were constructed with the intent that any teacher could download the background information and lessons and be able to teach a class how to use the IMS effectively to learn about ocean processes off the coast.

Unfortunately, due to time constraints and difficultly in contacting teachers the number of teachers interviewed after using the IMS site was limited. In talking to one of the teachers briefly about the site and the lessons after he used them in the classroom, one of the main problems was getting the whole classroom on the web site at the same time. This was most likely due to the server side of the site becoming overwhelmed by multiple connections while processing large datasets. Another teacher who ran into similar roadblocks used a central computer attached to a projector and had students take turns navigating the web site which was projected on the wall for others to view. This outcome was disappointing because the project's intent was to have all students in the SMILE clubs navigate the web site independently as a desktop GIS software user would.

In discussing the web site layout, the teachers commented that it seemed it was easy to use and the students picked up its navigation quickly. Preparatory time outside of the two-hour workshop was limited for the teachers to feel comfortable with teaching the lessons and navigating the site. Although there were some problems in getting multiple web browsers to access the web site at the same time with a single computer, the client requests were processed in a reasonable time.

Due to time constraints in presenting the lessons and volume of new information, one teacher commented that the students may not have picked up the concepts of upwelling because of limited time spent the teachers were able to spend explaining the process. This raises an excellent point regarding the utility of this kind of site for educational proposes. Although the design of the site was aimed at illustrating the ocean processes is the best manner possible and careful thought was put into its user-friendly design, students still need to have a good understanding of the process at work for the site to be successful in showing the process at work. This could be accomplished with a more extensive series of web pages patterned after a textbook lesson, taking students though each step of the upwelling cycle off the west coast. However, it is the author's opinion that more success would be had with teachers introducing the basic concepts of oceanography and then helping to facilitate discussion on the patterns and processes the OCMV displays.

4. CONCLUSIONS

An IMS site is a suitable way to make a GIS lesson accessible to a wide audience without requiring the teachers to learn the technical nuances of operating GIS software. It is also more accessible to a range of computer platforms, provided they have access to the internet. Once a site is constructed, it is fairly easy for an IMS administrator to add current information to the site. Fitzpatrick and Maguire (2001) report that many teachers and students only use the basic functionality of GIS software, so the extra features that full versions of ArcGIS would offer might never be used by students. Since only a basic set of tools is required for the majority of lessons and students, an IMS is a good choice because it easily provides basic GIS tools. The IMS site must be assembled by a knowledgeable GIS user and thus all the data management is handled in the beginning before the site becomes available to the public. This greatly reduces the amount of time that a teacher would otherwise have to spend uploading desktop GIS software and data, processing data, and learning the software in order to teach a simple introduction to GIS. Reducing the initial time investment required of the teacher could make the difference between including a lesson about GIS or not, especially considering the technology barriers the teacher might face.

Another benefit of using an IMS site is that teachers can spend more time teaching *with* GIS rather than devoting many hours teaching *about* GIS, so that students can effectively use GIS for learning (Thompson et al., 1997). By centralizing the computing resources and preprocessing the data, the initial investment can benefit many educators many times over without requiring them to reinvest time for setup or maintenance.

An IMS does have limitations, some of which may be overcome with future advances in technology. One of the limitations of a basic IMS setup is the user's inability to input data. New advances have created a collaborative web-mapping experience, where students are in charge of collecting data in a standard format that can then be submitted to a web database through a standard web form. In such a project, the user-collected data can then be displayed in an IMS web site. However, the standard setup for an IMS does not allow user-collected data to be added. If an IMS web site is enabled with Web Mapping Services (WMS), it can pull information from other WMS-enabled

IMS sites, allowing the use of many more data sets that have already been processed for an IMS site.

Since IMS sites operate though the Internet, all the problems that prevent the Internet from operating smoothly can degrade the user's experience. Some of these include lag time for processing large data sets, slow connection rates, network speed, IMS server connection ability, client hardware speed, and general internet traffic. All these factors can coincide, resulting in low web page loading time. If it takes a long time for requests to the server to be processed and returned, it may be hard for students to remain interested.

Server hardware capacity can be a large issue. IMS sites require significant processing power to query spatial datasets, and a smaller server that only allows a few simultaneous connections may not work well when an entire classroom attempts to use the web site simultaneously. If the site fails to function smoothly, it can be a major stumbling block to a successful experience.

This project was unique in that it combined data that were technical in nature in the form of remotely sensed data from ocean observing satellites, observations, and samples collected aboard research vessels off the Oregon coast. The data was simplified and a web site designed for ease of navigation by teachers and students was created. Although only a few teachers were available to be interviewed about the students' interaction with the web site, those who were contacted remarked that although there were some problems, it seemed that students were generally able to navigate the web site and learn more about the processes off the Oregon coast using the IMS site. Due to a lack of time the students had to spend on the lessons, it appears that this project affirmed some of the findings of Fitzpatrick and Maguire (2001) and others, that efforts to integrate GIS into education rarely succeed in teaching students to utilize the full power that GIS software has to offer.

This project helped identify some of the problems associated with using complex and technical datasets in an educational IMS lesson setting and would serve as an example to follow if other researchers or educators were interested in creating a similar project. This project is also unique in that collaboration between Pacific Ocean researchers and outreach educators was able to bringing current research and complex datasets to local students to learn from.

4.1 Suggestions for Future Work

Due to time constraints and data issues, there was an important data set that was unable to be incorporated into the final version of the OCMV. In addition to the other biological samples that were included, fish sampling trawls were also performed in conjunction with the other U.S. GLOBEC research cruises. These data were not available via the U.S. GLOBEC data porthole at the time of site construction and were not included, but it would have been another good piece of the ecosystem to present to students due to fisheries' importance in the Pacific Northwest region. Although the data were available through other channels, it was decided in conjunction with the collaborators to omit the fisheries data to retain simplicity in navigation.

At the present time there is very little documentation on how to optimize the speed of user request processing. An area of research that would be beneficial to enhancing IMS site operation would be to test load times for web pages in areas identified below. These tests could be carried out by altering the ArcIMS set up or through changes in data processing and management.

1. For complex vector files, generate a number of simplified files that load at different scales
2. Simplify data tables to include only the necessary sections of information
3. For images sent back to the client, compare load times for higher/lower resolution files for the larger view
4. Break up large image catalogs into separate folders
5. Make use of the scale-dependent render options for labels and data files
6. Upon initially loading the site, keep the visible layers to a minimum
7. Identify troublesome layers via web site benchmarking testing
8. Identify most popular layers via benchmarking tests
9. Examine the potential improvement in request processing times realized by using ArcSDE to store large data files. ArcSDE is a new database connection used for this purpose; an appropriate study would be to compare the load times between small and large data layers, with and without ArcSDE.

(List adapted from Deaver, Blair 2005. Presentation titled: Tuning your ArcIMS site. Personal Communication at GIS in Action Conference, March 28-29, Portland, Oregon.)

If this information was gathered and implemented to make the web server run more efficiently, user experiences with the IMS site would be more positive.

A new ESRI web interface called ArcExplorer Web (AEW) version (URL: http://www.esri.com/software/arcexplorer/about/arcexplorer-web.html) could be a very useful tool for educators looking to integrate many different kinds of data without the necessary processing. The Web version of ArcExplorer allows any data from an ArcIMS server or WMS-enabled map server to be added to a simple web GIS interface, and does not require any special downloading or plugins. There are direct links to add data from the Geography Network (URL: http://www.geographynetwork.com/), a worldwide hub for GIS-related data published on the internet. This functionality allows students and teachers to use GIS data in an atlas style or when combined with data for a more specific purpose, like the OCMV, to add ancillary data to enhance the study of a specific data set. Although fairly simple for experienced GIS software users to navigate, some time would be required for teachers to become familiar with navigating the AEW interface and to learn to efficiently locate desired data in the Geography Network web site.

Web-based GIS database applications have only recently appeared. These applications enable users to update or add data to an IMS application over the web without having to physically log on to the IMS server. As these applications become more widespread and easier to use, applications could be designed for educational purposes to allow students and teachers the possibility of entering their own data without having to go through an intermediary to get data published. Some internet mapping sites with data submission forms have been developed for educational purposes; however, data entry is limited to a standard web-based form with preset options (e.g. URL: http://pathfinderscience.net/winterbird/index.cfm). One of interesting benefits of web sites of this nature is that data collected by students all over the nation can be viewed in one location, fostering students' interest in investigating geographic data on a large scale. With universal access to the web, the possibilities for collaboration between schools nationally and internationally can become a reality.

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Appendix A

Teacher Guides and Student Handouts

The SMILE Program
August Teachers' Workshop, 2004

Mapping your School and Resolution

Adapted from "Odyssey for the Eyes" Globe 2003

Purpose: To help students learn to think spatially by mapping a familiar area. To introduce students to the concept of resolution, an important concept in interpreting satellite images of earth.

Overview: Students will make a map of school grounds and use two different grid overlays to make a "digital image" of their maps. The two different size grids will illustrate the differences in resolution that are obtained from the same map.

Materials Needed:

<u>OUTSIDE</u>: Navigational compass, clipboard (clear plastic bag if it's raining to cover clipboard), regular pencil.

<u>INSIDE</u> Colored pencils, rulers, plain paper, 2 paper grids (one of each size), 2 transparent grids (one of each size), USGS 7.5' Quadrangle map that includes the town, aerial photo coverage map.

Part One

1. Have students divide the school grounds into four quadrants:
   (If your school has very large grounds, define a border inside the school grounds as the edge of the quadrants so as not to spend too much time making the map).

2. Teams of students will be responsible for making a map of one quadrant (Things to include: school outline, doors, windows, trees, hedges, cars, school, parking lots, sidewalks, fire hydrants, mailboxes, etc.)

3. Have the teams take a pencil and clipboard outside and make a map of their quadrant with North at the top of the paper. Remind students to include a compass rose and a key on their map. Before everyone leaves, use the navigational compass to determine which direction is north.

4. When all teams are finished with their map, bring them inside and have them compare the maps they made. What are the differences? (some examples will be differences in scale, the amount of detail, and the accuracy of each map)

Part Two

5. Get back into teams again and have them place the large grid transparency over their map.

6. When everyone has a large transparency on top, talk about classification of land cover—ex. buildings, parking lots, trees, shrubs, grass, sidewalks, and other important point features. (see classification explanation below)

7. One student in the team is in charge of listing, row by row, each individual cell (with transparency labeled A–Z and 1–50) and assigning it a classification color; another student is in charge of coloring in the appropriate cell with the correct classified color on the grid paper that matches the transparency.

8. Repeat with the smaller grid cell transparency and have a different pair from the same team make the new map.

9. Briefly talk about the differences between the large grid cells/small grid cells. (see explanation below)

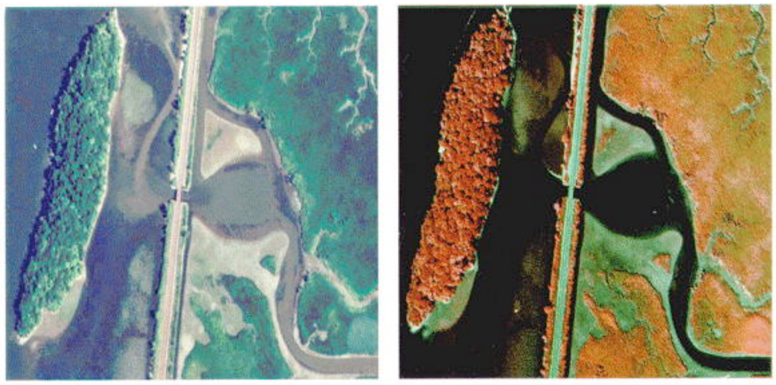
10. Show USGS Topographic Map of town as an example of a well-made map and as another way of representing the area.

11. Show the aerial photos taken over the school and town, yet another way of representing the school grounds and town.

12. Discuss scale for all (student maps, USGS, aerial photo)

Classification explanation:

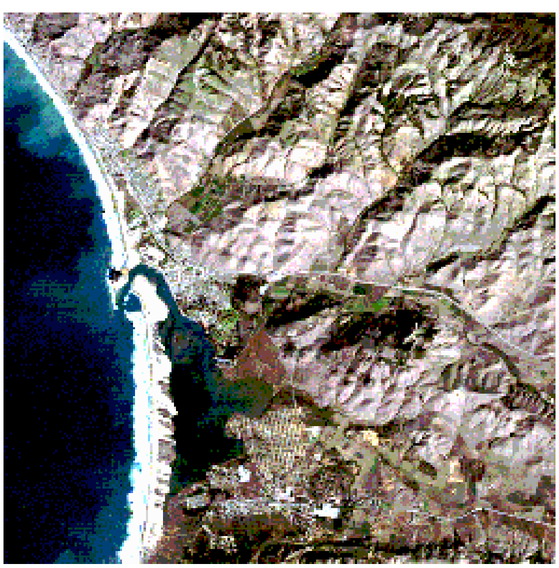
A raw satellite image is a digital file which contains a series of grid cells that have a corresponding digital number. A computer program is then used to view the digital image and the user (or by default the program) selects a color scheme to display the image. Depending on what wavelength of energy the sensor is designed to collect the images of the same area may look totally different. A sensor that collects wavelengths of visible light will produce images that will look similar to a color photograph. A sensor that collects wavelengths in the Near Infrared (often called NIR) spectrum will show plants and vegetation as bright features because plants reflect a high amount of light in the NIR spectrum.



a. b.

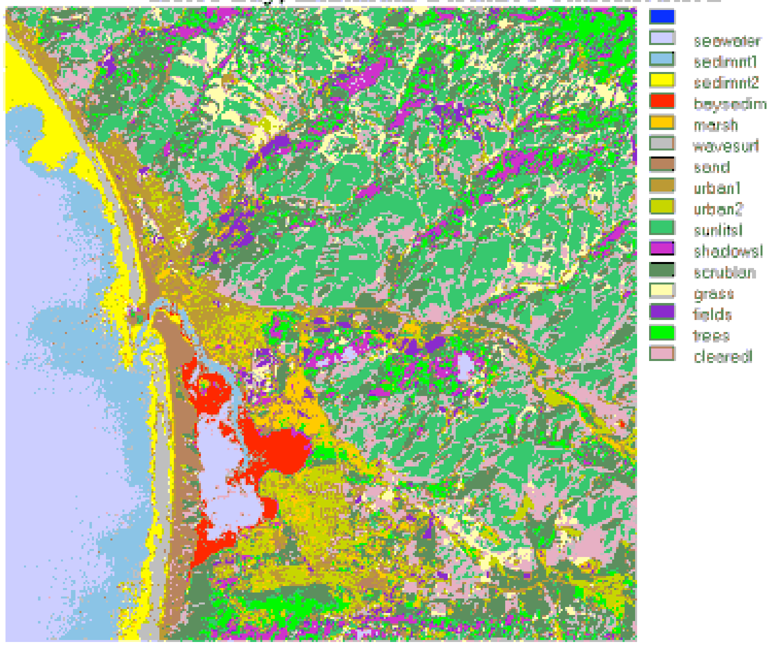
The picture on the left is a true color image. The one on the right is a near infrared (NIR) photo. Vegetation reflects a high amount of NIR light. Thus, the film that is sensitive to this wavelength of light shows bright red where the vegetation is healthy.

In order to better make scientific observations from satellite images, the images are classified according to their grid cell value. Since each object absorbs, reflects, and emits energy differently it is then possible to classify an image using known reflectance differences. An example of a classification might be a NIR image of a forest that is near an urban area. The different plant species would reflect differently as would the urban roads and streets. In this scenario logical group categories might include: Douglas fir, maple, alder, shrubs, grasslands, urban. An image of this nature might then help foresters analyze total area of Douglas fir trees, and if a series of images from different years were available, changes over time could be calculated, as long as the previous classifications used the same values for group categorization.



The image to the left is Band 1, 2 and 3 of an image taken from a Thematic Mapper (TM) sensor, which shows a view of Morro Bay, California. The image colors are fairly close to true color.

Morro Bay, Minimum Distance Classification



This image is the same view as the previous image, but has been classified from all 7 bands of TM into categories that are more useful for a geographic analysis.

Concepts for Discussion

The digitized version… how well does it represent your map?

What are the differences between the small grid cell and large grid cell coverage?

A smaller grid size results in images that have more detail; however, it takes longer to collect, process and store these files. With more detail, the number of pixel values that one image contains increases significantly.

A larger grid size results in smaller images which can be collected much faster and do not take as much processing or storage; however, they have much lower resolution than an image with a smaller grid size.

What is the appropriate resolution for your study?

One example: an urban planner would require images with a high level of detail because small differences in property lines and potential actions/hazards/development from one property can affect adjacent property owners.

Another example: In the ocean, conditions are constantly changing, so a high resolution image of an area would only be valid for a brief snapshot in time. Researchers may be interested in a particular phenomena but capturing such fine-scale interactions many times would be very difficult to capture and analyze due to the dynamic nature of the ocean. Ocean researchers are more interested in learning about large-scale ocean processes. Over an expanse such as an ocean where conditions are constantly changing, lower resolutions are sufficient for large-scale research.

Mixed pixel problem: when there are two different types of land cover in one cell, which one wins?

In the exercise students lay a grid on top of the image and classify it according to a few classes. When two different features both occupy the same grid cell a decision must be made as to which feature "wins" the cell. By default most programs assign the feature that has the largest percentage as the value of that cell. The resulting pixel is often referred to as a "mixel" because, although in digital form it represents only one value, in the real world the pixel represents a mix of two or more features.

A good example would be where a coast line defines the difference between land and water. Where the water takes over more of the cell, small areas of beach will be classified as water, and vice versa in areas of sand/rock that take up more than 50% of the cell.

What would happen if we took the large grid image and tried to make an accurate measurement from it to use on a smaller scale?

Due the mixed pixel problem, an image that was made with a very large pixel resolution (for example, one image pixel = 1km x 1km on the ground) should not be used to investigate an area where fine-scale measurements need to be made. For example, consider a case where property boundaries need to be determined near a river. Due to the irregularities in a river edge, an image with a low resolution would not be suitable for this purpose due to the relatively large number of pixels that would represent only land where there actually was some river and vice versa. A higher resolution image would contain proportionally fewer such pixels and produce a more accurate map.

The SMILE Program
January Teachers' Workshop, 2005

A Quick Introduction to GIS
For
Using the Oregon Coastal Marine Viewer

Introduction: In this next series of lessons, we will explore some large-scale ocean processes, using satellite images coupled with data that was collected from a research ship during cruises conducted by the U.S. GLOBEC project. Our region of study is the Pacific Ocean, off the coast of Oregon.

In order to view both the satellite imagery and the biological data collected from the research vessel at the same time we will be using an Internet Map Service (IMS), which is a web site that is powered by a Geographic Information System.

What is a GIS? As stated before, a GIS is a Geographic Information System. A GIS is a computer system that stores information that has a geographic location. Since this is a geographic system, all the data that GIS programs deal with have to have a geographic component. An information system is one that organizes data so that it can be searched by the user and so that relationships can be formed from one data set to another.

All the data stored in a GIS has a geographical location and therefore users can perform spatial studies. How far is it from the fire station downtown to your school? How much area is within the city limits of your town? These are both spatial questions that you could answer using a GIS tool. The data in a GIS is stored in a spreadsheet format. From the information stored there, and in other files, the software can draw a map on the screen. This allows the user not only to store, edit, and make spatial studies, but to view the data in a dynamic environment.

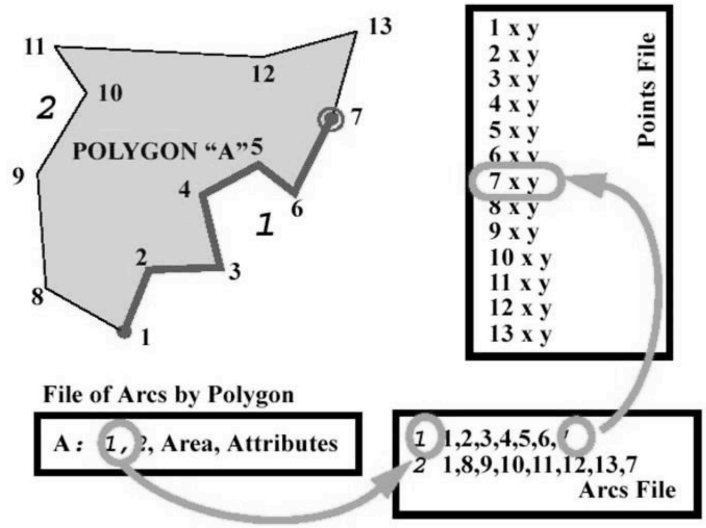
Another key characteristic of a GIS is the ability to make highly accurate and detailed maps. Since the software can store and display data, the next logical function is to make a map of the data.

How is Data stored in a GIS?

Data are stored in four basic methods: points, lines, areas, and in a grid (or raster). A point is just that: a point with location coordinates and some accompanying information (usually called an attribute). For example, one point in the bird data represents all birds (species of birds are not specified) sighted from a specific location on a specific date.

Lines are simply two points that are connected by a segment. In the GIS world they are called arcs. In the data, the line would be stored as two points and an arc connecting them with the associated attributes stored in a table form. When a user selects the line in the software they can view the attributes to see what the line is representing. Is this road a main highway or just a dirt road?

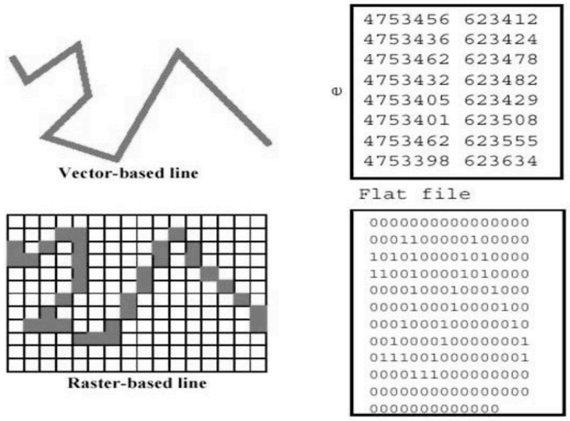
An area is stored by polygons that are a series of points that are connected by arcs in a closed position. Like lines and areas, a table stores the points and lines along with the attributes.



This polygon "A" has two line segments, 1 and 2. Line 2 is made up of points (or nodes) 1–7, which are all have a location defined in the points file.

Points, lines, and areas are called vector data because they all define a feature with a point and a line, similar to a vector in classical physics.

A grid is just as it sounds: a series of square cells that have a value associated with each cell. A grid is also called a raster, from the Latin root meaning "rake." Grid files usually represent larger areas and use different values to show different features (ex. For an image of 1km each cell represents an area of 1km x 1km). Each cell will have a value that represents an attribute, for example, a lake may have the value of 10 where a bare soil area may have a value of 2. Grids are commonly used for areas where a continuous gradient of some attribute is being displayed. An example of this we will see is temperature. The satellite data we are using has a range from 0-25.5 degrees Celsius. A cell-sized area of the ocean that has been determined by the sensor to have a temperature of 18 degrees C will have a value of 180 (for 18.0 degrees C; this is the way computers store image formats. We will talk more about this later.)



This example shows how a GIS would store a line in either a grid (or raster) or as a line (vector).

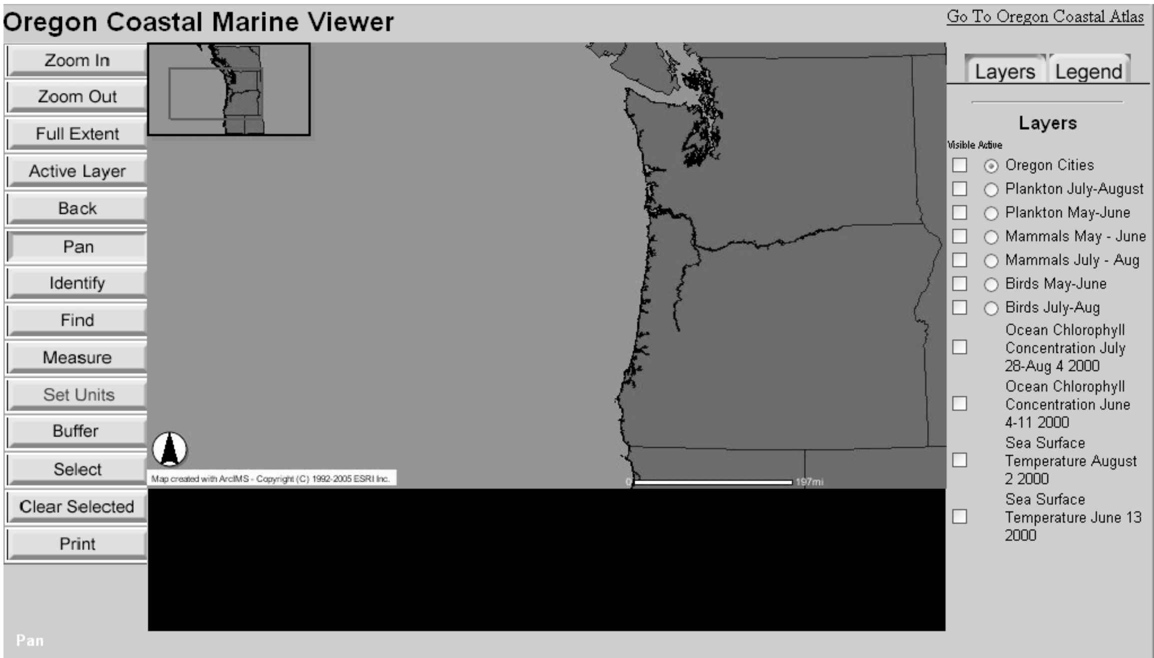
The real power of a GIS is that multiple layers of data can be viewed at the same time. This allows the user to see patterns and answer spatial questions that rely on many different geographical data sets.

What is an IMS?

For these two lessons, we will not be using a typical GIS software program because they require advanced training and many hours of practice. Advances in internet technology have aided in the development of Internet Map Services (IMS), a new method to allow wider audiences to view data in the same way that a professional GIS user can. The benefits of using an IMS are that the user can view data, do simple spatial analysis, and print a map of the information they are interested in by using a web-based browser.

Let's Get Started!

OK, first bring up the IMS site from the web site: http://scallywag.science.oregonstate.edu/web site/OcIMS/viewer.htm. The first thing you will notice is a large map located in the center with a smaller view in the upper left-hand corner. The main map is the working map and the one in the top left corner is the overview map, which shows the zoomed-in area of the working map. Now let's look at the right panel. This is the Layers and Legend Panel—it acts like a Table of Contents.



As mentioned earlier, the true power of a GIS is to be able to look at multiple layers of data at the same time. The right-hand side is where the layers the user selects become visible or invisible. This is also where the user selects which layer becomes "active." Only active layers can be manipulated.

On the left side of the window you will see a number of buttons that have text in the center. This area is the tool bar, and by selecting these buttons we can make the IMS perform different tasks.
Helpful hint: only click one layer on and off at a time. Your selections will not display properly if you click other buttons while the working map image reloads.

ZOOM IN

The Zoom In button allows the user to drag a rectangle around and select an area you want to look at more closely.

ZOOM OUT

The Zoom Out button allows the user to draw a box, expanding the area of view on the screen.

FULL EXTENT

The Full Extent button will reset the map to its default size.

ACTIVE LAYER

Pressing Active Layer changes the size and location of the working map to show all the data in the active layer.

BACK

The Back button returns to the most recently viewed area of the map. This is a handy button if you accidentally click some where you didn't mean to or if you want to go right back to the last placer you were looking at without having to scroll around.

PAN

The Pan button allows the user to move around the working map at the current scale you are using.

IDENTIFY

The Identity tool is used to learn about the data behind map features. When you click on a point, line or area the data in the spreadsheet table becomes visible in the information window and allows the user to view all the attributes of a single point or points.

FIND

The Find tool allows you to search for data by typing in a value of an attribute that you know. Let's say you used the identify tool and found out in the mammal data that one of the data points represents a humpback whale. If you are interested in seeing where the other humpback whales were sited you can type humpback whale into the box under the find command and the appropriate data points will automatically be highlighted.

BUFFER

The buffer tool is a great tool for answering spatial questions. For example let's say that we know during the winter months a certain species of bird flies less than 2 miles from its nest to find food. If we did a survey and found a bird's nest, we could then buffer the nest at two miles and an area on the map would be highlighted at a 2 mile radius from that point. We can also buffer line and areas. If the 50 ft on either side of a railroad track is owned by a railroad, we can determine how much area that would take up. The same would happen if you buffered an area polygon.

SELECT

This tool only works on the layer that is set to the active layer; you can choose the active layer using the button located next to the layer button. Once you have selected the active layer you want, use the select tool to drag a box around the point(s) that you would like to select. If a point or a number of points are selected, the first 25 records will show up in the information frame located underneath the main map window.

MEASURE

The Measure tool allows the user to draw points connected by segments that automatically calculate distance. In the upper left-hand corner, a total distance of the line you construct will be displayed, along with the length of the next segment if you clicked where the pointer arrow is resting.

SET UNITS

When the Set Unit button is selected, a menu appears allowing the user to choose the units the map and measure tool will display. By default the units of Oregon Coastal Marine Viewer are set to miles.

CLEAR SELECTION

If a selection or action is made with the identity, selection, buffer, or measure tool, the Clear Selection tool will remove that selection.

PRINT

This button will print a copy of the current view of the map.

Example IMS Sites:

The Oregon Coastal Atlas: http://www.coastalatlas.net/maps/index.php

This IMS site was developed for Oregon Coastal Managers. It has many options to add data layers. Aerial photos, shaded terrain, roads, cities, and many other data can be added to the view.

Terra Server: http://terraserver-usa.com/default.aspx

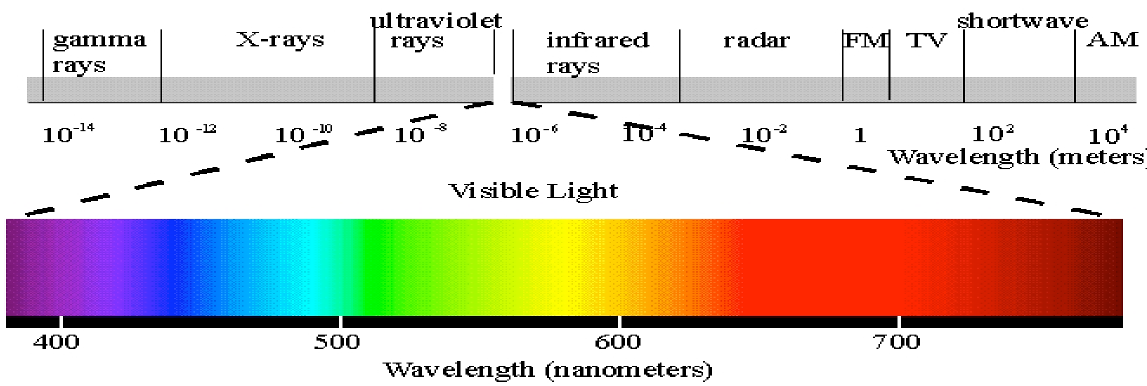
In this site you can type in an address and see an aerial photograph of anywhere in the USA. Although it looks different than the IMS site we have looked at, it is still running GIS software in the background to help it work properly.

The SMILE Program
January Teachers' Workshop, 2005

A Quick Review of Remote Sensing

In Mapping Your School we talked about satellite remote sensing. Now that we are able to look at actual data from a satellite, we need to learn more about how satellites work so we can understand what they show us.

The satellite sensors in our case are an Advanced Very High Resolution Radiometer (AVHRR), which provided our Sea Surface Temperature; and a Sea-viewing Wide Field-of-View Sensor (SeaWiFS), which provided our chlorophyll data. These sensors collect brightness values in the electromagnetic spectrum, in "bands" both inside and outside the visible spectrum. In the electromagnetic spectrum, visible light is in the approximate range of 700–400 nm (nanometers).

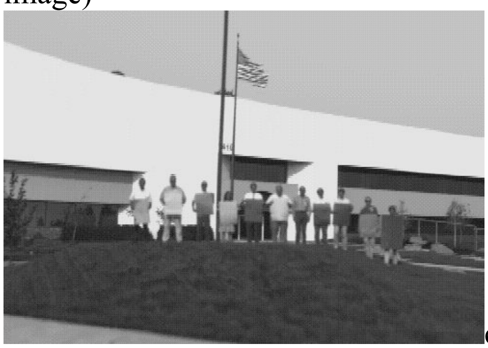


The electromagnetic spectrum with the visible light section enlarged.

Although humans are not able to see outside of the visible spectrum, scientists and engineers have been able to construct sensors that detect wavelengths of light we are unable to see with the human eye. It is also possible to build a sensor that detects many different ranges of light (called bands) such as 200–300 nm, or 300–400 nm. Plants are very good reflectors of near infrared light, which is in the 1000nm range. A sensor detecting this 1000nm range of light can be used to make an image that will be a good way to assess vegetation on a global scale.

Example images of bands collected by the SeaWiFS Sensor

Bands 6, 5, 3: R, B, G (Bands 6, 5, and 3 have been combined to make a true color image)



ch1

ch2

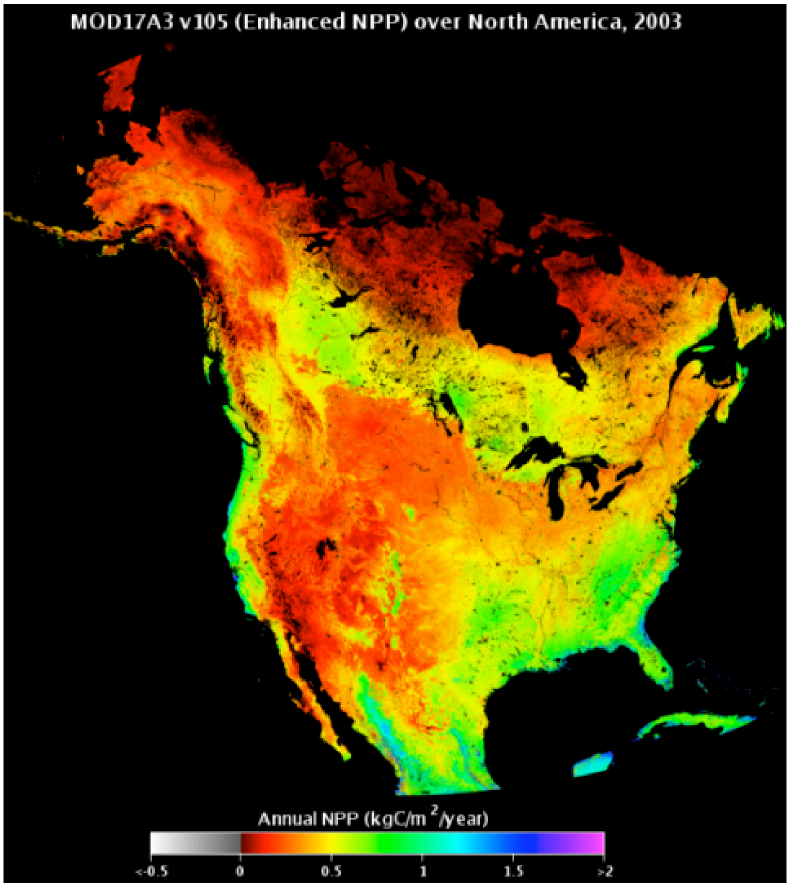
ch3

ch4

ch6

ch7

All these images were taken by the SeaWiFS sensor. The black and white images are some of the bands that the sensor collects data in. Each band picks up the colored cards being held by the scientists differently. The data from each different band can reveal something different about the area that is scanned by the sensor.

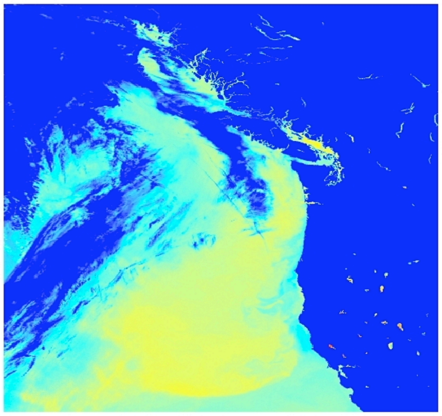
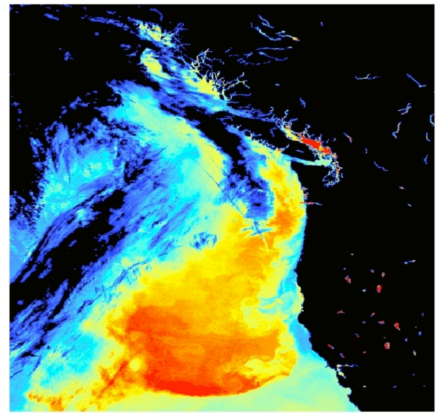


This is an Image from Moderate Resolution Imaging Spectroradiometer [MODIS] that collected NIR radiation reflected from plants. The colors were then applied to the image so that higher areas of production are in green and blue. Lower values of production are in red and orange.

A satellite collects information in a band (ex. 200–400nm) and then gives each pixel a brightness value on a scale from 0 to 255, because for many years that was the maximum number of color values that a computer monitor could display.

Contrast Stretching:

In the case of the sea surface temperature data, we need to apply a contrast stretch to the image in order to make the image a useful display. In the Sea Surface example, the values 0–255 have been designated to represent 0^{o} C to 25.5^{o} C. Therefore, a value of 180 would equal 18.0^{o} C. The ocean right off the Oregon coast during the summer (which is the time period the data in the IMS is from) does not include all the values from that scale. Most of the values are clumped between 2^{o}C and 15^{o}C. If we tried to show these values with a color range that gave a color to each value from 0–255, we wouldn't see the interesting variation in the data just off our coast.

The image on the left has not been stretched and because most of the variation in temperature is in a small range it does not show up well. In the right image, the color range has been stretched over a smaller range of values where most of the data in this image occurs.

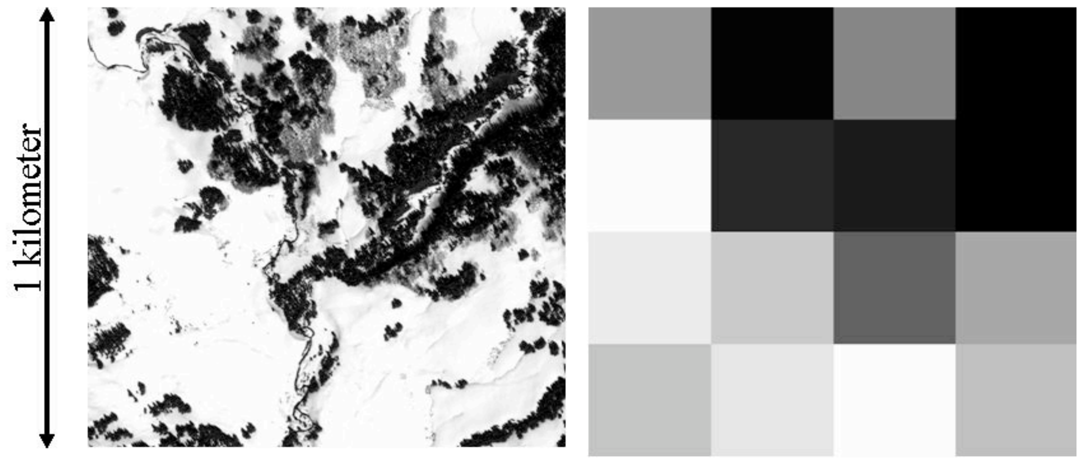
When we perform a contrast stretch, we reassign the color range so that the entire color variation occurs within the range of 2–15° C, where almost all the data appear. This avoids using several colors as placeholders for data ranges that will not be displayed on the map.
Here, contrast stretching brings out the subtle variations in temperature that are most interesting to view, and can show us important areas in the ocean for production of plant and animal life (more on this later).

The SST images in the IMS site have been contrast-stretched. If you look in the legend, you will notice that the range of values for each image is slightly different. August has a range from 3.6 to 20.2, while June has a range from 2.3 to 14.7.

What is the appropriate resolution for your study?

Resolution is the amount of area on the ground that one cell in a grid represents. A one-meter resolution grid, as shown below, has a much higher level of detail because each cells value was collected from a 1 m x 1 m area on the ground. In the other image, each grid cell was collected from an area 250 m x 250 m on the ground.

IKONOS image of Gunnison River Basin, CO



1 meter resolution 250 meter resolution

What is the appropriate resolution for a study? One example: an urban planner would require images with a high level of detail because small differences in property lines and potential actions/hazards/development from one property can affect adjacent property owners.

Another example: In the ocean, conditions are constantly changing, so a high resolution image of an area would only be valid for a brief snapshot in time. Researchers may be interested in a particular phenomena but capturing such fine-scale interactions many times would be very difficult to capture and analyze due to the dynamic nature of the ocean. Ocean researchers are more interested in learning about large-scale ocean processes. Over an expanse such as an ocean where conditions are constantly changing, lower resolutions are sufficient for large-scale research.

How do we know that what the satellite is telling us is accurate?

To be sure that the satellite is collecting accurate data, we need to compare its output to readings from a reliable source. This process is called ground truthing. It is an important process because all instruments have varying amounts of error associated with their measurements. In order to ground truth a sensor, scientists must collect data on the ground and compare it to satellite images of the same period of time. In this way, they can calibrate what the sensor is recording.

The plankton layers for June and August were both collected by a research ship towing a fine mesh bag through the water to collect samples. The data was collected at a number of depths, which is very important because a satellite sensor can only see the surface of the water and a few meters below the surface.

At the present time, GIS software is just now beginning to be able to handle data collected in 3-D. The IMS software is a simpler version of the full-strength GIS software and is not able to handle 3-D data. As a result of this limitation, the 3-D plankton layer is compressed into a 2-D layer, where some data points will be stacked on top of each other because samples were taken at varying depths from the same point on the ocean surface.

If a data point is selected from this layer, the data table associated with that point will show the data from several depths.

By looking at the numbers in the data table, we can begin to get an idea at what depths the samples were taken, and the associated abundance of phytoplankton, but a vertical profile would be a more useful tool for looking at this data set.

For additional Remote Sensing Information see the following links:

SeaWiFS (Chlorophyll concentration)**:**
http://SeaWiFS.gsfc.nasa.gov/SEAWIFS/TEACHERS/ This site has some very good material on the SeaWiFS sensor.

http://SeaWiFS.gsfc.nasa.gov/SEAWIFS/IMAGES/GROUP2.html
This a good set of images to understand the idea of how a sensor collects data in bands. This page includes the images shown on page 2, plus several others.

AVHRR (Sea Surface Temperature) http://edc.usgs.gov/guides/avhrr.html
This page has additional information on AVHRR.

U.S. GLOBEC http://globec.oce.orst.edu/groups/nep/outreach/tas/index.html
This portion of the main U.S. GLOBEC site has a daily log written by John Hercher, a high school science teacher from South Salem. It profiles what it's like to work aboard a research ship and includes video clips from some of the scientists who were collecting the data that we have seen in the IMS site.

GIS, Satellite Remote Sensing, and Oceanography
Part 1
The SMILE Program
Teacher Handout

1. Intro to GIS
    a. What is a GIS?
        1. Geographic Information System
        2. Storage system for data that has a geographic component
        3. A tool that allows you to search data with both text and by geographic area.
        4. A tool for making spatial studies **(Class brainstorm Spatial Questions)**
        5. A computer map-making program
    b. Point, Lines, Areas, Layers
        1.Points (how stored)
        2. Lines (how stored)
        3. Area (how stored)
        4. Idea of data layers
            Data Layers allow us to look at many types of data at the same time and make spatial studies possible.
    c. What is an IMS?
        a. A GIS accessible via the internet
        b. Display for data/info to the public in a dynamic environment
            1. User controls data viewed
            2. A way of making simple GIS maps via Internet
        c. All data pre-processed for the user
            1. In some sites users can add data
            2. In some sites users cannot add data.

To start, bring up the IMS site from the web site:

http://scallywag.science.oregonstate.edu/web site/OcIMS/viewer.htm

The first thing you will notice is a large map located in the center with a smaller view in the upper left-hand corner. The main map is the working map and the one in the top left corner is the overview map, showing the zoomed-in area of the working map.

Look at the right panel. This is the Layers and Legend Panel; it acts like a Table of Contents. Here you can click on and off the layers of data you would like to see.

Follow these steps to practice using some of the tools in the tool bar on the left side of the site:

First turn on the layer that is named OREGON CITIES
(Make sure it's selected with the active layer button right next to the Visible Column)

Next select the **Zoom In** tool.

Draw a rectangle around your city.
If you can't see the labels of your city zoom in farther.

Next hit the **Active Layer** button
If you get lost you can hit the Active Layer button and you will see all the Oregon Cities (or whichever layer is set to active) at a good scale for viewing.

Press the **Full Extent** button
This tool zooms the view all the way out so you can see the entire map and all the data.

Next select the **Pan** tool
This tool allows you to move around the map without zooming in or out.

Pan from your town to the coast

Zoom Out so you can see your town and the coast at the same time

Then click on the **Measure** tool
Measure the distance from your town to the coast.

Now click the **Set Units** tool:
Change the option to *Kilometers* then press the other **Set Units** button inside the gray window.

Again **Measure** the distance from the Coast to your town and you will see how many kilometers it is to the ocean.

Turn on the **June Mammals** layer

Zoom in to a small number of the mammal points, press the **Select** button and draw a box around one of the point.
A data table will show up in the information window under the current map view.

Scroll down the list to a mammal you're interested in, copy the animal's name by highlighting the text and copy from the edit menu or press **Ctrl + c**.

Now press the **Find** button and paste by right clicking or pressing **Ctrl + v** (the name must be typed in the box exactly as it appears in the information window, ex: Dalls_porpoise) You should now see all the places highlighted where your animal was sited on the research cruise.
The **Identify** tool has the same features as Select except it works for a single point.

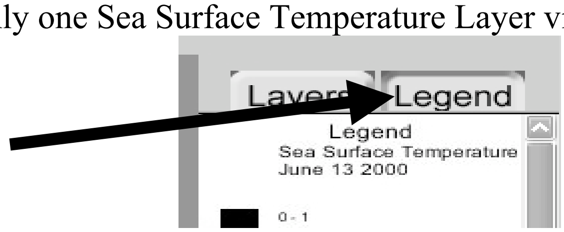
Zoom into a few points and then select the Identify tool. After selecting one of the points the data table will show up. If you scroll to the bottom of the data table there is a link to more records if more than 25 are in the data table.

If you hit the **Clear Selection** button all your previously highlighted points will now become unselected.

Looking at the Sea Surface Temperature (SST) images:

Click on the June SST image, turn it off and then look at the August SST image.

With only one Sea Surface Temperature Layer visible click the **Legend** tab.



Complete the following:
In the space below write the numbers for each image at the beginning of the legend (For Low write the first number > 1 for High write the first number < 255)

June:	**Low**	23	**August:** **Low**	36
	High	151	**High**	202

Discussion Question: What are some of the differences between the two sea surface temperature maps?

In the June image you should see that most of the water just off the coast is bright red to yellow showing that it is fairly warm (comparatively off the Oregon coast) as compared to the water farther up the coast off the shore of British Columbia and Washington.

In the August image you should be able to see a more defined band of cold water directly off the coast of Oregon. This is especially pronounced off the southern Oregon coast.

The values for SST in June are lower 2.3 ° – 15.1° Celsius, compared to August 3.6 ° - 20.2 °. These images look similar due to Contrast stretching. We only have limited numbers of colors to use so between the images different values have the same color to highlight were the differences in temperature exist.

Discussion Question: Why is the cold water coming up to the surface close to the coast?

The winds are the major driving force behind the differences during the summer. The winds that blow push the warmer water from the surface (heated by the intense sun during the summer months) off shore. The resulting effect brings up cold water from the ocean floor. This process is called Upwelling, or Cold Water Upwelling.

Next look at the Ocean Color or Chlorophyll concentration.

This data has been processed to show the concentration of chlorophyll in milligrams per cubic meter at a resolution of 4km.

Discussion Question: How might we verify that what the satellite is telling us is accurate?

To be sure that the satellite is collecting accurate data, we need to compare its output to readings from a reliable source. This process is called ground truthing. It is an important process because all instruments have varying amounts of error associated with their measurements. In order to ground truth a sensor, scientists must collect data on the ground and compare it to satellite images of the same period of time. In this way, they can calibrate what the sensor is recording.

The plankton layers for June and August were both collected by a research ship towing a fine mesh bag through the water to collect samples. The data was collected at a number of depths, which is very important because a satellite sensor can only see the surface of the water and a few meters below the surface.

Click on the June Ocean Color image study it and then switch to the August Ocean Color image.

Click on the plankton Layer for June and the Ocean Color image for June

Click all layers off

Click on the plankton Layer for August and the Ocean Color image for August

Discussion Question: What is the appropriate resolution for your study?

The SST images have a resolution of 1 Km (the size of this image is 3.3MB)
The Ocean Color Images have a resolution of 4Km.

In the ocean, conditions are constantly changing; a high-resolution image (1m) of an area would only be valid for a brief moment in time. Researchers may be interested in a particular phenomena but capturing such fine scale interactions multiple times would be very difficult to capture and analyze due to the dynamic nature of the ocean (not to mention the huge amount of storage space require for high resolution data!). Ocean researchers are more interested in learning about large-scale ocean processes. Over an expanse such as an ocean where conditions are constantly changing, lower resolutions are sufficient for large-scale research.

GIS, Satellite Remote Sensing, and Oceanography
Part 2

The SMILE Program
Teacher Handout

The last lesson looked at some of the seasonal changes in Sea Surface Temperature (SST), and Ocean Chlorophyll (or Color). This lesson addresses more about plankton and other biology connections.

Look at the biological data:

First click on the ocean color for the early summer months, in this case June

Click on the first Birds Layer for June:

The larger and more darkly colored circles represent higher bird concentrations.

Click the select tool and highlight some of the birds.

Written Questions: In the space below write you answer

What species of birds are in this area?

Where are the birds located?

Write down three common names in the space below

Then type a name into Google and click on the Images tab at the top

Google should show you a picture of the bird sited.

Before moving on, click off the birds layer, then click on the mammal data for June.

Repeat the same process for the August images
First look at the Birds, then the Mammals

To review: look back at the SST from both periods then at the Chlorophyll for both periods

Discussion Question: Phytoplankton are very small plants, so they need light and water to grow. Why then does the phytoplankton grow best close to or just off shore? What else to they need to grow?

If we look back at the sea surface temperature we notice that the cold water that is upwelling is where the phytoplankton grow best. Why is this? With the circulation of the ocean off the coast, cold water from the bottom of the ocean is brought up to the surface. Along with the colder water come nutrients from decaying animals and plants in the ocean. The key component that is missing in other places in the ocean for growing abundant phytoplankton is nutrients.

The change in quantities of nutrients off the coast varies from low productivity in the winter, to high productivity in the summer due to no upwelling in the winter to large upwelling circulation in the summer. Since phytoplankton is at the bottom of the food chain it is the "grass" of the ocean that other larger animals eat. As the phytoplankton grow in large numbers, other larger animals move in to take advantage of a good food resource.

Discussion Question: Why are we interested in measuring chlorophyll?

Since we can not physically measure phytoplankton directly via satellite, the chlorophyll data provide a good stand-in for phytoplankton concentration. Chlorophyll is the main pigment in plants that is responsible for photosynthesis, a plant's process of turning sunlight and nutrients into energy. Chlorophyll reflects near infrared wavelengths of light (around 1000nm), which can be detected by satellite sensors. Since phytoplankton is the most abundant plant in the ocean, the areas in the SeaWiFS images where the highest concentrations of chlorophyll are visible correlate to high concentrations of phytoplankton.

Discussion Question: Why is phytoplankton important in a larger sense?

Phytoplankton is the main food source in the ocean so it follows that where the phytoplankton grows so do the larger organisms in the ocean. If too large a phytoplankton bloom occurs this can be bad because the plankton use a lot of oxygen in the water. If the phytoplankton population grow too large the oxygen levels can be driven down to levels so low that other sea creatures animals can not get enough oxygen.

Discussion Question: What eats phytoplankton?

Zooplanktons, which are tiny animals, eat phytoplankton. Small fish and other sea creatures eat zooplankton, and so on up the food chain.

Discussion Question: Where are the bird and mammals most often sighted?

The birds and mammals are still for the most part in the same areas that have higher concentrations of phytoplankton. This is again because the small animals eat zooplankton, which eats the phytoplankton. The big animals of course eat the smaller animals so they are going to move to where the food is abundant.

Click the Ocean Color, the birds for June on, the Mammals on, and the phytoplankton,

Then do the same for the August data

Discussion Question:

What are some of the large assumptions we are using when we look at the data in the IMS and make connections?

1. **All the data was taken on the same day at the same time**.
   What is really going on: The SST is from one day with the fewest clouds. The Ocean color image is a composite of 8 days worth of data. The largest value in each cell from 8 days was then used to make a composite image of ocean color. In order to make viewing easier the biological data was divided into to two time periods, for example: the Bird Layer for June is made up of dates from 2^{nd}–4^{th}, 7^{th}–8^{th}, 12^{th}.

2. **In a static map display as in the case of the IMS we tend to not think about the points as mobile**.
   Birds and mammals are definitely very mobile, and if the data are taken over several days, what are the chances the surveyors are counting the same birds in different locations? How would we account for that?

3. **Same Colors, Different Values!**
   We only have so many colors to make a scale from and still make it easy to read. In the SST images, if we used the same colors over the same values for both images, we wouldn't be able to see the temperature variation. For example, the color red on the first image may start at 15° C, while on the second image it could start at 19°. When looking back and forth between the two we may think the same color is the same value but this may not be the case.

4. **The real world is 3-D; maps are flat.**
   In the 2-D map view, especially with ocean data, we are not dealing with the 3^{rd} dimension, which is much more expansive than just the surface of the ocean. All the data we looked at in this site maps well in 2-D—and that is why it was selected for

use in this project—but there are many more important relationships at work under the surface of the ocean.

5. **It is easy when looking at a map to assume that all the data was collected without errors and in the same way**.

This is not always the case. There may have been some equipment failure, or in a visual survey for Birds or Mammals how do you account for differences in data collectors actions?

Examples of possible variations between different sets of data: one could have been collected during the day the other at night. Similar types of dataset may be been collected using different methods, one may have used an old method and another a new method. For visual surveys fog could have impaired long-distance viewing for minutes or hours during a sampling period, which would cause variation within a dataset

On the same map we tend to think that all the data are homogenous but this is not always the case. We need to look into the metadata (data about data; i.e., information about how the data was collected, including methods used and irregularities in collection) to see how it was collected and ask questions about potential problems with making comparisons between the data. One chlorophyll layer may have been collected in a band from 990 to 1110 nm and another may have been from 1000 to 1120 nm.

GIS, Satellite Remote Sensing, and Oceanography
Part 1
The SMILE Program
Student Sheet

To start, bring up the IMS site from the web site:

http://scallywag.science.oregonstate.edu/web site/OcIMS/viewer.htm

The first thing you will notice is a large map located in the center with a smaller view in the upper left-hand corner. The main map is the working map and the one in the top left corner is the overview map, showing the zoomed-in area of the working map.

Look at the right panel. This is the Layers and Legend Panel; it acts like a Table of Contents. Here you can click on and off the layers of data you would like to see.

Follow these steps to practice using some of the tools in the tool bar on the left side of the site:

First turn on the layer that is named OREGON CITIES
(Make sure it's selected with the active layer button right next to the Visible Column)

Next select the **Zoom In** tool.

Draw a rectangle around your city.
If you can't see the labels of your city zoom in further.

Next press the **Active Layer** button
If you get lost you can hit the Active Layer button and you will see all the Oregon Cities (or whichever layer is set to active) at a good scale for viewing.

Press the **Full Extent** button
This tool zooms the view all the way out so you can see the entire map and all the data.

Next select the **Pan** tool
This tool allows you to move around the map without zooming in or out.

Pan from your town to the coast

Zoom Out so you can see your town and the coast at the same time

Then click on the **Measure** tool

Measure the distance from your town to the coast.

Now click the **Set Units** tool: Change the option to *Kilometers* then press the other **Set Units** button inside the gray window.

Again **Measure** the distance from the Coast to your town and you will see how many kilometers it is to the ocean.

Turn on the Mammals layer

Zoom in to a small number of the mammal points, press the **Select** button and draw a box around one of the points.

A data table will show up in the information window under the current map view.

Scroll down the list to a mammal you're interested in, copy the animal's name by highlighting the text and copy from the edit menu or by pressing **Ctrl + c**.

Now press the **Find** button and paste by right-clicking or pressing Ctrl + v (the name must be typed in the box exactly as it appears in the information window, ex: Dalls_porpoise).

You should now see all the places highlighted where your animal was sited on the research cruise.

The **Identify** tool has the same features as Select except it works for a single point.

Zoom into a few points and then select the Identify tool. After selecting one of the points the data table will show up. If you scroll to the bottom of the data table there is a link to more records if there are more than 25.

If you hit the **Clear Selection** button, all your previously highlighted points will now become unselected.

Looking at the Sea Surface Temperature (SST) images:

Click on the June SST image, turn it off and then look at the Aug SST image.

With only one Sea Surface Temperature Layer visible, click the **Legend** tab.

Complete the following:
In the space below write the numbers for each image at the beginning of the legend (For Low write the first number > 1 for High write the first number < 255)

June: Low _____		**August:**	**Low** ____
High ______			**High** ____

Discussion Question: What are some of the differences between the two sea surface temperature maps?

Discussion Question: Why is the cold water coming up to the surface close to the coast?

Next look at the Ocean Color or Chlorophyll concentration.

This data has been processed to show the concentration of chlorophyll in milligrams per cubic meter at a resolution of 4km.

Discussion Question: How might we verify that what the satellite is telling us is accurate?

Click on the June Ocean Color image, study it, and then switch to the August Ocean Color image.

Click on the plankton layer for June and the Ocean Color image for June

Click all layers off

Click on the plankton layer for August and the Ocean Color image for August

Discussion Question: What is the appropriate resolution for your study?

The SST images have a resolution of 1 km (the size of this image is 3.3MB)
The Ocean Color Images have a resolution of 4km.

GIS, Satellite Remote Sensing, and Oceanography
Part 2
The SMILE Program
Student Sheet

The last lesson looked at some of the seasonal changes in Sea Surface Temperature (SST), and Ocean Chlorophyll (or Color). This lesson addresses more about plankton and other biology connections.

Look at the biological data:

First click on the ocean color layer for the early summer months, in this case June.

Click on the first Birds Layer for June:

The larger and more darkly colored circles represent higher bird concentrations.

Click the select tool and highlight some of the birds.

Written Questions: In the space below write you answer

What species of birds are in this area?

Where are the birds located?

Write down three common names in the space below

Then type a name into Google and click on the Images tab at the top

Google should show you a picture of the bird sighted

Before moving on, click off the birds layer, then click on the mammal data for June.

Repeat the same process for the August images

First look at the Birds, then the Mammals

To review: look back at the SST from both periods then at the Chlorophyll for both periods

Discussion Question: Phytoplankton are very small plants, so they need light and water to grow. Why then does the phytoplankton grow best close to or just off shore? What else to they need to grow?

Discussion Question: Why are we interested in measuring chlorophyll?

Discussion Question: Why is phytoplankton important in a larger sense?

Discussion Question: What eats phytoplankton?

Discussion Question: Where are the bird and mammals most often sighted?

Click the Ocean Color, the birds for June on, the Mammals on, and the phytoplankton on.

Then do the same for the August data.

Discussion Question: When data are viewed in a map and we make conclusions based on that data we see, what kinds of assumptions are made about the data? (Hint: think about collection, and conditions)

Appendix B

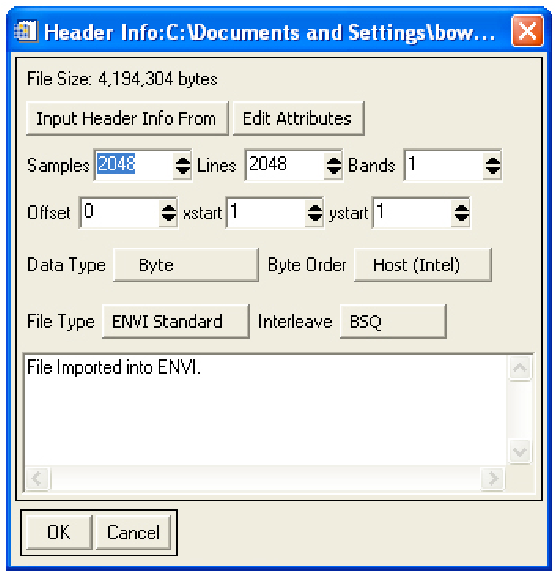
AXL, Java Script, and HTML Files for OCMV web site

Creating a TIFF Image from a Raw Binary File
from the U.S. GLOBEC AVHRR SST FTP site

1. First download desired image from FTP://pisco.coas.oregonstate.edu/ebc/globec/

2. Unzip the file. this is an example file name after unzipping: n0016802_8531_n15.gbc

3. Open ENVI, under the **FILE** menu select Open Image File.
The **Header Information** window will open automatically.

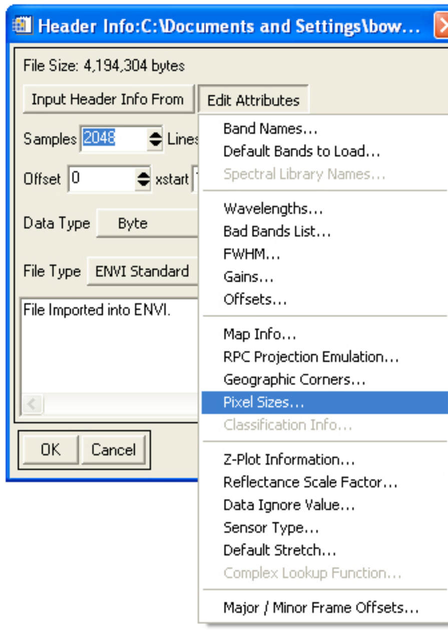


From the metadata document located at URL:
http://coho.coas.oregonstate.edu/globec/AAGBCREADME.TXT

The images from the Northern section that were used were 2028 Samples by 2048 Lines, this is a single band image so the Band is 1. Fill in the header file with the appropriate Samples, Lines and Bands for the desired image.

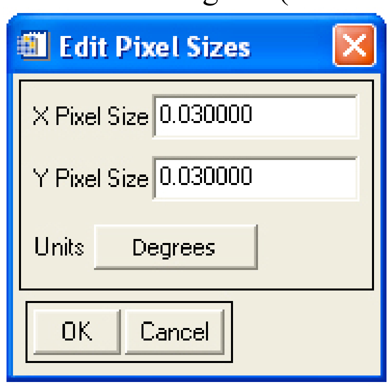
4. Before closing the header info file window: click on the **Edit Attributes** button.

5. Click on the **Pixel Sizes** selection.



6. From the image metadata information on the SST AVHRR images the pixel s are defined as representing 0.03 degrees of latitude and longitude.

7. Fill in the numbers and set the **Units** to degrees (default is meters).



8. The image should display correctly, if not check the metadata and the header information to make sure they both match. Now to save as a TIFF file.

Under the **FILE** menu select the **Save File As** selection and select the TIFF/GeoTIFF option. Navigate the file to the folder you want and name the file.

9. In ArcGIS the TIFF can now be georeferenced using the Georeference tool.

AXL FILE for OCMV

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          <RANGE lower="109" upper="145" label="109 - 145">
            <SIMPLEMARKERSYMBOL color="182,112,209" width="20" />
          </RANGE>
          <RANGE lower="145" upper="181" label="145 - 181">
            <SIMPLEMARKERSYMBOL color="174,81,194" width="25" />
          </RANGE>
        </VALUEMAPRENDERER>
      </LAYER>
      <LAYER type="featureclass" name="Birds May-June" visible="false" id="5">
        <DATASET name="Bird_May_June_sub" type="point" workspace="shp_ws-14" />
        <VALUEMAPRENDERER lookupfield="NUMBER">
          <RANGE lower="1" upper="291" label="Less than 291">
        <SIMPLEMARKERSYMBOL color="255,175,175" width="5" />
</RANGE>
          <RANGE lower="291" upper="581" label="291 - 581">
        <SIMPLEMARKERSYMBOL color="255,150,150" width="10" />
          </RANGE>
          <RANGE lower="581" upper="871" label="581 - 871">
            <SIMPLEMARKERSYMBOL color="255,124,124" width="15" />
          </RANGE>
          <RANGE lower="871" upper="1161" label="871 - 1161">
            <SIMPLEMARKERSYMBOL color="255,99,99" width="20" />
          </RANGE>
          <RANGE lower="1161" upper="1452" label="1161 - 1452">
            <SIMPLEMARKERSYMBOL color="255,73,73" width="25" />
          </RANGE>
        </VALUEMAPRENDERER>
      </LAYER>
```

```
<LAYER type="featureclass" name="Mammals July - Aug" visible="false" id="6">
 <DATASET name="Cet_July_Aug_sub1" type="point" workspace="shp_ws-14" />
 <VALUEMAPRENDERER lookupfield="NUMBER">
   <RANGE lower="1" upper="5" label="Less than 5">
     <SIMPLEMARKERSYMBOL color="255,255,0" width="5" />
   </RANGE>
   <RANGE lower="5" upper="9" label="5 - 9">
     <SIMPLEMARKERSYMBOL color="255,221,0" width="11" />
   </RANGE>
   <RANGE lower="9" upper="13" label="9 - 13">
     <SIMPLEMARKERSYMBOL color="255,187,0" width="17" />
   </RANGE>
   <RANGE lower="13" upper="17" label="13 - 17">
     <SIMPLEMARKERSYMBOL color="255,153,0" width="23" />
   </RANGE>
   <RANGE lower="17" upper="21" label="17 - 21">
     <SIMPLEMARKERSYMBOL color="255,119,0" width="30" />
   </RANGE>
 </VALUEMAPRENDERER>
</LAYER>
<LAYER type="featureclass" name="Mammals May - June" visible="false" id="7">
 <DATASET name="Cet_May_June_sub1" type="point" workspace="shp_ws-14" />
 <VALUEMAPRENDERER lookupfield="NUMBER">
   <RANGE lower="1" upper="9" label="Less than 9">
     <SIMPLEMARKERSYMBOL color="102,51,0" width="5" />
   </RANGE>
   <RANGE lower="9" upper="17" label="9 - 17">
     <SIMPLEMARKERSYMBOL color="127,43,0" width="10" />
   </RANGE>
   <RANGE lower="17" upper="25" label="17 - 25">
     <SIMPLEMARKERSYMBOL color="152,35,0" width="15" />
   </RANGE>
   <RANGE lower="25" upper="33" label="25 - 33">
     <SIMPLEMARKERSYMBOL color="178,26,0" width="20" />
   </RANGE>
   <RANGE lower="33" upper="41" label="33 - 41">
     <SIMPLEMARKERSYMBOL color="203,18,0" width="25" />
   </RANGE>
 </VALUEMAPRENDERER>
</LAYER>
<LAYER type="featureclass" name="Plankton May-June" visible="false" id="8">
 <DATASET name="Meso_1_sub" type="point" workspace="shp_ws-14" />
 <VALUEMAPRENDERER lookupfield="ABUND_M3">
   <RANGE lower="0.0" upper="195.0412" label="Less than 195.0412">
     <SIMPLEMARKERSYMBOL color="192,192,192" width="5" />
   </RANGE>
   <RANGE lower="195.0412" upper="390.0825" label="195.0412 - 390.0825">
     <SIMPLEMARKERSYMBOL color="175,181,175" width="7" />
   </RANGE>
   <RANGE lower="390.0825" upper="585.1237" label="390.0825 - 585.1237">
     <SIMPLEMARKERSYMBOL color="157,170,157" width="10" />
   </RANGE>
   <RANGE lower="585.1237" upper="780.165" label="585.1237 - 780.165">
     <SIMPLEMARKERSYMBOL color="140,159,140" width="13" />
   </RANGE>
   <RANGE lower="780.165" upper="975.2062" label="780.165 - 975.2062">
     <SIMPLEMARKERSYMBOL color="122,147,122" width="16" />
   </RANGE>
   <RANGE lower="975.2062" upper="1170.2475" label="975.2062 - 1170.2475">
     <SIMPLEMARKERSYMBOL color="104,136,104" width="19" />
   </RANGE>
   <RANGE lower="1170.2475" upper="1365.2887" label="1170.2475 - 1365.2887">
     <SIMPLEMARKERSYMBOL color="87,125,87" width="22" />
   </RANGE>
   <RANGE lower="1365.2887" upper="1560.34" label="1365.2887 - 1560.34">
     <SIMPLEMARKERSYMBOL color="69,114,69" width="25" />
   </RANGE>
 </VALUEMAPRENDERER>
</LAYER>
<LAYER type="featureclass" name="Plankton July-August" visible="false" id="9">
 <DATASET name="Meso_2_sub" type="point" workspace="shp_ws-14" />
```

```
        <VALUEMAPRENDERER lookupfield="ABUND_M3">
          <RANGE lower="0.02" upper="723.79" label="Less than 723.79">
            <SIMPLEMARKERSYMBOL color="204,255,204" width="5" />
          </RANGE>
          <RANGE lower="723.79" upper="1447.55" label="723.79 - 1447.55">
            <SIMPLEMARKERSYMBOL color="164,235,164" width="10" />
          </RANGE>
          <RANGE lower="1447.55" upper="2171.32" label="1447.55 - 2171.32">
            <SIMPLEMARKERSYMBOL color="123,215,123" width="15" />
          </RANGE>
          <RANGE lower="2171.32" upper="2895.08" label="2171.32 - 2895.08">
            <SIMPLEMARKERSYMBOL color="82,194,82" width="20" />
          </RANGE>
          <RANGE lower="2895.08" upper="3618.86" label="2895.08 - 3618.86">
            <SIMPLEMARKERSYMBOL color="41,174,41" width="25" />
          </RANGE>
        </VALUEMAPRENDERER>
      </LAYER>
  <LAYER type="featureclass" name="Northwest States" visible="true" id="10">
        <DATASET name="atlasbase7" type="polygon" workspace="shp_ws-14" />
        <VALUEMAPRENDERER lookupfield="KEY">
          <EXACT value="BC" label="BC">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,153,0" boundarycaptype="round" />
          </EXACT>
          <EXACT value="CA" label="CA">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,153,0" boundarycaptype="round" />
          </EXACT>
          <EXACT value="CAN" label="CAN">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,153,0" boundarycaptype="round" />
          </EXACT>
          <EXACT value="ID" label="ID">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,153,0" boundarycaptype="round" />
          </EXACT>
          <EXACT value="NEV" label="NEV">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,153,0" boundarycaptype="round" />
          </EXACT>
          <EXACT value="OR" label="OR">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,153,0" boundarycaptype="round" />
          </EXACT>
          <EXACT value="WA" label="WA">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,153,0" boundarycaptype="round" />
          </EXACT>
          <EXACT value="WAT" label="WAT">
            <SIMPLEPOLYGONSYMBOL boundarytransparency="1.0" filltransparency="1.0"
                fillcolor="0,51,255" boundarycaptype="round" />
          </EXACT>
        </VALUEMAPRENDERER>
      </LAYER>
    <LAYER type="featureclass" name="Oregon Cities" visible="False" id="11">
        <DATASET name="ocims_city" type="point" workspace="shp_ws-14" />
        <GROUPRENDERER>
          <SIMPLERENDERER>
            <SIMPLEMARKERSYMBOL color="127,27,127" width="6" />
          </SIMPLERENDERER>
          <SCALEDEPENDENTRENDERER lower="1:1" upper="1:1000000">
            <SIMPLELABELRENDERER field="NAME_BIG" labelpriorities="1,2,2,4,5,3,2,4">
              <TEXTSYMBOL font="Arial" fontstyle="regular" fontsize="10" />
            </SIMPLELABELRENDERER>
          </SCALEDEPENDENTRENDERER>
        </GROUPRENDERER>
      </LAYER>
</MAP>
  </CONFIG>
</ARCXML>
```

ArcIMS Parameter File (Java Script)

```
// ArcIMSparam.js
// javascript file with parameters specific to calling page

//***********************************************************************
//*                    parameters File for HTML Template                *
//***********************************************************************

// get machine name
var hostName = document.location.host;
// common portion of url
var esriBlurb = "/servlet/com.esri.esrimap.Esrimap?ServiceName="
// make URL for getting mapservice catalog
var catURL = "http://" + hostName + esriBlurb + "catalog";
// make prefix for URL
var serverURL  = "http://" + hostName + esriBlurb;



//*****************************************************************
//*                    parameters set by Designer                                  *
//*****************************************************************
var imsURL =
'http://terrene.science.oregonstate.edu/servlet/com.esri.esrimap.Esrimap?ServiceName=OcIM
S';
var imsOVURL =
'http://terrene.science.oregonstate.edu/servlet/com.esri.esrimap.Esrimap?ServiceName=OcIM
S';
var imsQueryURL = '';
var imsGeocodeURL = '';

//initial map extent
var startLeft = -2200737.75;
var startRight = 2576285.0;
var startTop = 4298546.0;
var startBottom = -970724.5;
//maximum map extent
var limitLeft = -3099466.87330911;
var limitRight = 2576284.9999999995;
var limitTop = 5534624.00645628;
var limitBottom = -2279564.65123772;

var usePan=true;
var usePanNorth=false;
var usePanWest=false;
var usePanEast=false;
var usePanSouth=false;
var useZoomIn=true;
var useZoomOut=true;
var useFullExtent=true;
var useZoomActive=true;
var useZoomLast=true;
var useIdentify=true;
var useMeasure=true;
var useSetUnits=true;
var useSelect=true;
var useQuery=false;
var useFind=true;
var useGeocode=false;
var useStoredQuery=false;
var useClearSelect=true;
var usePrint=true;
var useGeoNetwork=false;
var useBuffer=true;
var useExtract=false;

var MapUnits = "Feet";
var ScaleBarUnits = "Miles";
```

```
// End of Designer set parameters

var useHyperLink=false;
var useHyperLinkAny=false;
var useIdentifyAll=false;
var useBufferShape=false;
var hasToolBarOnLayer=false;
	// useHyperLink takes priority - both cannot be true
if (useHyperLink) useHyperLinkAny=false;
	// useIdentify takes priority - both cannot be true
if (useIdentify) useIdentifyAll=false;
	// allow debugging
var setDebug=true;


/***************************************
* Basic Map parameters
***************************************/

// variables for setting component colors
var mapBackColor = "51,153,255";
var ovBoxColor = "#ff0000";
var ovBoxSize = 3;
var zoomBoxColor = "#ff0000";

// variables for using individual components
var hasOVMap = true;
var hasTOC = true;
var useModeFrame = true;

// variables for map pixel offset from upper left corner of frame
	// horizontal offset
var hspc = 0;
	// vertical offset
var vspc = 0;

//panning factor for arrow buttons
var panFactor = 85/100;
//zoom factors for v.3
var zoomFactor = 2

// margin factor for zooming in on selected lines and polygons - based on feature width
and height. . . margin will be selectMargin * width or height
var selectMargin = 25/100;
// margin margin factor for zooming in on selected points - based on full extent. . .
margin will be selectPointMargin * fullWidth or fullHeight
var selectPointMargin = 25/1000

// show the scale factor
var showScalePercent=true;
// display coords in status line
var showXYs=true;

// Have ArcXML responses URL encoded? Will not work with multi-byte characters
var doURLencode = false;

// automatically adjust for ArcMapServer, if necessary
	// North Arrow size is smaller from ArcMapServer
var autoAdjustForArcMapServer = true;
// if it is an ArcMap Service, is it using a Personal Database?
	// critical for correct sql expression on queries on date fields
	// Syntax for date fields is different for layers from a Personal Database than
for other ArcMap Service data sources
var isPersonalDatabase = false;

//variables for MapDrawing
	// North Arrow
var drawNorthArrow = true;
var NorthArrowType = "4";
```

```
var NorthArrowSize = "15";
var NorthArrowCoords = "20 35";
var NorthArrowAngle = "0";
        // Scale Bar
var drawScaleBar = true;
        // MapUnits=DEGREES,FEET,METERS
        // can MapUnits be changed by user?
var setMapUnits=false;
        // ScaleBarUnits=KILOMETERS,METERS,MILES,FEET
var ScaleBarBackground = "false";
var ScaleBarBackColor = "255,255,255";
var ScaleBarFontColor = "255,255,255";
var ScaleBarColor = "255,255,255";
var ScaleBarFont = "";
var ScaleBarStyle = "Regular";
var ScaleBarRound = "1";
var ScaleBarSize = "9";
var ScaleBarWidth = "5";
var ScaleBarPrecision = 2;
var numDecimals = ScaleBarPrecision;
        // Scale Bar 2
var drawScaleBar2 = false;
var ScaleBar2Units = "KILOMETERS";
var ScaleBar2Background = "false";
var ScaleBar2BackColor = "0,0,0";
var ScaleBar2FontColor = "0,0,0";
var ScaleBar2Color = "128,128,128";
var ScaleBar2Font = "";
var ScaleBar2Style = "Regular";
var ScaleBar2Round = "1";
var ScaleBar2Size = "9";
var ScaleBar2Width = "5";
var ScaleBar2Precision = 2;

        // Copyright blurb
var drawCopyright = true;
var CopyrightFont = "";
var CopyrightStyle = "Regular";
var CopyrightSize = "8";
var CopyrightCoords = "3 3";
var CopyrightColor = "0,0,0";
var CopyrightBackground = "True";
var CopyrightBGColor = "255,255,255";
var CopyrightGlow = "False";
var CopyrightGlowColor = "255,255,255";
var CopyrightShadow = "False";
var CopyrightShadowColor = "32,32,32";
var CurrentYear = new Date().getFullYear();
var CopyrightText = "Map created with ArcIMS - Copyright (C) 1992-" +  CurrentYear + "
ESRI Inc.";

        // place bar behind Copyright text and scalebars
var drawBottomBar = false;
var bottomBarColor = "255,255,255";
var bottomBarOutline = "0,0,0";
var bottomBarHeight = "18";

        // Mode on Map
var drawModeOnMap = false;
var modeRefreshMap = false;
var modeMapColor = "255,255,255";
var modeMapGlow = "128,0,255";

var ovImageVar;
var ovBorderWidth = 2;
var ovExtentBoxSize = 2;

// map image background transparent? - requires gif or png8 types
var mapTransparent=false;

// setup test for Nav 4.0
```

```
var isIE = false;
var isNav = (navigator.appName.indexOf("Netscape")>=0);
var isNav4 = false;
var isIE4 = false;
var is5up = false;
//alert(navigator.appVersion);
if (isNav) {

	if (parseFloat(navigator.appVersion)<5) {
		isNav4=true;
		//alert("Netscape 4.x or older");
	} else {
		is5up = true;
	}
} else {
	isIE4=true;
	isIE=true;
	if ((navigator.appVersion.indexOf("MSIE 5")>0) ||
(navigator.appVersion.indexOf("MSIE 6")>0)) {
		isIE4 = false;
		is5up = true;
		//alert("IE5");
	}
}

/***************************************
* Extended Map parameters
***************************************/

// variables for ovmap offset
var ovHspc = 0;
var ovVspc = 0;

// color for Main Map zoombox in html hex RGB format
//var zoomBoxColor = "#ff0000";

// index of initial active layer. . . if more than or equal to layer count top layer used
var ActiveLayerIndex=99;

// variables for using individual components
var useTextFrame=true;
// use external window for dialogs
var useExternalWindow=false;

// colors for tables
var textFrameBackColor="Silver";
var tableBackColor="White";
var textFrameTextColor="Black";
var textFrameLinkColor="Blue";
var textFrameFormColor="Gray";

// LayerList visible at service load
var showTOC=true;
// set layer visibility according to LayerList or by custom programming
var toggleVisible = true;
// set layer visibility of OVMap according to LayerList or by custom programming
	// imsURL must equal imsOVMap - depends on one LayerList
var toggleOVVisible = false;
// will the LayerList show all layers, not just those available at current scale
var listAllLayers = false;

// toggle the check of non-listing of layers in LayerList and Legend
// if true, noListLayer array must have an element defined for each layer
var hideLayersFromList=true;
// layers that will be listed in the LayerList or Legend
	// Note: This does not affect map display
var noListLayer = new Array();
noListLayer[0] = false;
noListLayer[1] = true;
noListLayer[2] = false;
noListLayer[3] = false;
```

```
noListLayer[4] = false;
noListLayer[5] = false;
noListLayer[6] = false;
noListLayer[7] = false;
noListLayer[8] = false;
noListLayer[9] = false;
noListLayer[10] = false;
noListLayer[11] = false;

        // Mode on floating layer
var drawFloatingMode = false;
var modeLayerOn = false;
var modeLayerColor = "Black";
var modeLayerShadowColor = "White";
var modeLayerFont = "Arial";
var modeLayerSize = "4";

        // does the overview map a layer on top of map?...
var ovMapIsLayer=true;

var webParams = "";
if (parent.MapFrame!=null) {
        webParams = parent.document.location.search;
} else {
        webParams = document.location.search;
}

/***************************************
* Interactive Map parameters
***************************************/

// Click points - Measure/Shape Select/Shape Buffer
var clickMarkerColor="255,0,0";
var clickMarkerType="Circle";
var clickMarkerSize="6";


/***************************************
* Identify/Select/Query/Buffer parameters
***************************************/

// search tolerance in pixels around click
var pixelTolerance=7;
// color of selected features in decimal RGB format
var selectColor="255,255,0";
// color of highlighted feature in decimal RGB format
var highlightColor="255,0,0";
// level of transparency of selected and highlighted color
var transparentLevel = "0.5";
        // zoom to selected feature if only one is returned?
var zoomToSingleSelect = false;
        // use only unique values in sample field value lists
var onlyUniqueSamples = true;
        // are string queries case insensitive?
                // false by default to match Java Viewer and ArcExplorer
var queryCaseInsensitive=false;

// fields to be returned in identify/selection/query request. . . #ALL#=all fields
var selectFields= "#ALL#";
//var selectFields= "#ID# #SHAPE#";
// swap out the list of returned fields?
//If true, a list must be defined in selFieldList[n] for each layer to update
selectFields
var swapSelectFields=true;
// array for each layer's returned fields if swapSelectFields=true
var selFieldList = new Array();
// sample set for world - if not #ALL#, id and shape fields required. Separate with a
space
selFieldList[0]="#ALL#";
selFieldList[1]="#ALL#";
selFieldList[2]="#ALL#";
```

```
selFieldList[3]="#ALL#";
selFieldList[4]="#ALL#";
selFieldList[5]="#ALL#";
selFieldList[6]="#ALL#";
selFieldList[7]="#ALL#";
selFieldList[8]="#ALL#";
selFieldList[9]="#ALL#";
selFieldList[10]="#ALL#";
selFieldList[11]="#ALL#";

// use the field alias in the data display?
//If true, a list must be defined in fieldAliasList[n] for each layer defining aliases
for those fields needing them
var useFieldAlias=true;
// array for aliases for each layer's returned fields if useFieldAlias=true
var fieldAliasList  = new Array();
// sample set for world - fieldname:alias pairs separated by a bar (|)... if no aliases,
use empty string ("")
fieldAliasList[0]="";
fieldAliasList[1]="";
fieldAliasList[2]="LAT:Latitude|LONG:Longitude|WATER_DEPT:Depth in Meters Sample Was
Collected|DAY_LOCAL:Date|GENUS_SPEC:Scientific Name|ABUND_M3:Abundance Meters Cubed";
fieldAliasList[3]="LAT:Latitude|LONG:Longitude|WATER_DEPT:Depth in Meters Sample Was
Collected|DAY_LOCAL:Date|GENUS_SPEC:Scientific Name|ABUND_M3:Abundance Meters Cubed";
fieldAliasList[4]="DATE_:Date|LAT____:Latitude|LON:Longitude|Number:Number
Sited|COMMON_NAM:Common Name|SPECIES: Scientific Name";
fieldAliasList[5]="DATE_:Date|LAT____:Latitude|LON:Longitude|Number:Number
Sited|COMMON_NAM:Common Name|SPECIES: Scientific Name";
fieldAliasList[6]="DATE_:Date|LAT:Latitude|LON:Longitude|NUMBER:Number
Sited|SPECIES:Common Name";
fieldAliasList[7]="DATE_:Date|LAT:Latitude|LON:Longitude|NUMBER:Number
Sited|SPECIES:Common Name";
fieldAliasList[8]="";
fieldAliasList[9]="";
fieldAliasList[10]="";
fieldAliasList[11]="";



// Hide the ID field display? The ID Field must be included in field list, but we don't
have to show it.
var hideIDFieldData = true;
// Hide the shape field display? The Shape Field must be included in field list, but we
don't have to show it.
var hideShapeFieldData = true;


// parameters for setting up hyperlinks in data display
var hyperLinkLayers = new Array(); // layers to have hyperlink
var hyperLinkFields = new Array();    // field in those layers to be used for hyperlink
var hyperLinkPrefix = new Array();  // prefix (if any) to place before field value to
make hyperlink url
var hyperLinkSuffix = new Array();  // suffix (if any) to place after field value to make
hyperlink url
/*
hyperLinkLayers[0] = "Image";
hyperLinkFields[0] = "HOT";
hyperLinkPrefix[0] = "/gisdata/world/images/";
hyperLinkSuffix[0] = ".jpg";
*/

// will the returned data be displayed in text frame?
var showSelectedData=true;
// will the returned features be drawn?
var showSelectedFeatures=true;
// maximum number of features returned from query
var maxFeaturesReturned=25;
// for ID All - List all visible layers in response - default is false
        // if false only visible layers with idenitified features written to table
        // if true the names of all visible layers will be diplayed even if no features
returned
```

```
var listAllLayersInIDAll = false;


// number of data samples retrieved for query form
var numberDataSamples = 50;



/*************************************
* Legend parameters - aimsLegend.js
*************************************/

// legend map size
var legWidth=170;
var legHeight=300;
var legFont="Arial";
var legTitle="Legend";

/*************************************
* Options parameters - aimsOptions.js
*************************************/

// allowing user to set options
var allowOptions=false;

/*************************************
* ClassRender parameters - aimsClassRender.js
*************************************/

// parameters for custom class rendering... overrides default renderer
var ClassRenderLayer = new Array();  // layers to have custom renderers
var ClassRenderString = new Array(); // initial custom renderer XML string for the layers
ClassRenderLayer[0] = "Cities";
ClassRenderString[0] = "";
/*
ClassRenderString[0] ='<VALUEMAPRENDERER lookupfield="population">\n<RANGE LOWER="0"
UPPER="1000000">\n<SIMPLEMARKERSYMBOL color="255,0,255" type="circle" size="4"
/>\n</RANGE>';
ClassRenderString[0] = ClassRenderString[0] + '<RANGE LOWER="1000000"
UPPER="2500000">\n<SIMPLEMARKERSYMBOL color="255,0,255" type="circle" size="6"
/>\n</RANGE>';
ClassRenderString[0] = ClassRenderString[0] + '<RANGE LOWER="2500000"
UPPER="5000000">\n<SIMPLEMARKERSYMBOL color="255,0,255" type="circle" size="9"
/>\n</RANGE>';
ClassRenderString[0] = ClassRenderString[0] + '<RANGE LOWER="5000000"
UPPER="10000000">\n<SIMPLEMARKERSYMBOL color="255,0,255" type="circle" size="12"
/>\n</RANGE>';
ClassRenderString[0] = ClassRenderString[0] + '<RANGE LOWER="10000000"
UPPER="30000000">\n<SIMPLEMARKERSYMBOL color="255,0,255" type="circle" size="16"
/>\n</RANGE>\n</VALUEMAPRENDERER>';
*/

/*************************************
* Geocode parameters - aimsGeocode.js
*************************************/

// maximum geocode candidates returned - default = 20
var maxGeocodeCandidates=20;
// minimal acceptable geocode score for candidate
var minGeocodeScore=50;
var geocodePointColor = "255,0,0";
var geocodePointSize = "15";
var geocodeLabelSize = "12";
var geocodePointType = "star";
var currentGeocodePointIndex = 0;

// custom functions needed for Reverse Geocoding - RouteServer extension required
var useReverseGeocode = false;
var useRoute=false;

// the starting point. . . it all starts here on loading
```

```
function checkParams() {
	appDir = getPath(document.location.pathname);
	// global for overview map. . . change if not on same frame as Map
	ovImageVar = document.ovImage;
	debugOn = 0;
	if (parent.TextFrame==null) {
		useTextFrame = false;
		useExternalWindow=true;
	}
	if (!hasLayer("measureBox")) useMeasure=false;
	if ((!useMeasure) && (!drawScaleBar)) useSetUnits=false;
	if (ovImageVar==null) hasOVMap = false;
	if (parent.TOCFrame==null) hasTOC = false;
	if (parent.ModeFrame==null) useModeFrame = false;


	if (isIE)	{
		if (hasLayer("theTop")) document.all.theTop.style.cursor = "crosshair";
		if (hasOVMap) ovImageVar.style.cursor = "hand";
	}

	if (hasOVMap) {
		// size of ov map image
		i2Width = parseInt(ovImageVar.width);
		i2Height = parseInt(ovImageVar.height);
		forceNewOVMap = false;
		// position of ov map
		//ovMapLeft = iWidth - (i2Width + 6);
		//ovMapTop = 2;
	}
	if (webParams!="") {
		//alert(webParams);
		getCommandLineParams(webParams);
	}
	// if starting extents zero'd then flag to get start from mapservice
	if ((startLeft!=0) && (startRight!=0)) getStartingExtent=false;
	// if limit extents zero'd then flag to get max from mapservice
	if ((limitLeft!=0) && (limitRight!=0)) {
		getLimitExtent=false;
		enforceFullExtent=true;
	}
	if (ovBoxColor=="") ovBoxColor = "255,0,0";
	//ovBoxColor = convertHexToDec(ovBoxColor);
	checkCoords();
	if (aimsNavigationPresent) {
		// Set up event capture for mouse movement
		if (isNav4) {
			document.captureEvents(Event.MOUSEMOVE);
			document.captureEvents(Event.MOUSEDOWN);
			document.captureEvents(Event.MOUSEUP);
			//document.captureEvents(Event.MOUSEOUT);
		}
		document.onmousemove = getMouse;
		//document.onmousedown = chkMouseDown;
		document.onmousedown = mapTool;
		document.onmouseup = chkMouseUp;
		//document.onmouseout = chkMouseOut;
	} else {
		usePan=false;
		usePanNorth=false;
		usePanWest=false;
		usePanEast=false;
		usePanSouth=false;
		useMeasure=false;
		useZoomIn=false;
		useZoomOut=false
		//useFullExtent=false;
		useZoomActive=false;
		//useZoomLast=false;
	}
```

```
	if (!aimsBufferPresent) {
		useBuffer=false;
	}
	if (!aimsQueryPresent) {
		aimsBufferPresent=false;
		useQuery=false;
		useFind=false;
		useBuffer=false;
		useStoredQuery=false;
	}
	if (!aimsSelectPresent) {
		aimsQueryPresent=false;
		aimsBufferPresent=false;
		useSelect=false;
		useQuery=false;
		useFind=false;
		useBuffer=false;
		useStoredQuery=false;
		useClearSelect=false;
	}
	if (!aimsIdentifyPresent) {
		aimsSelectPresent=false;
		aimsQueryPresent=false;
		aimsBufferPresent=false;
		canQuery=false;
		useIdentify=false;
		useSelect=false;
		useQuery=false;
		useFind=false;
		useBuffer=false;
		useStoredQuery=false;
		useHyperLink=false;
		useHyperLinkAny=false;
		useIdentifyAll=false;
	}
	if (!aimsGeocodePresent) {
		useGeocode=false;
		useReverseGeocode=false;
	}
	if (!aimsPrintPresent) {
		usePrint=false;
	}
	if (!aimsOptionsPresent) {
		allowOptions=false;
	}
	if ((aimsXMLPresent) && (aimsMapPresent)) {
		if (aimsClickPresent) clickFunction("zoomin");
		if (parent.ToolFrame!=null)
parent.ToolFrame.document.location="toolbar.htm";
		startMap();
	} else {
		alert(msgList[0]);
	}
}
```

HTML file alteration for Layers Legend Panel (TOCTopFrame.htm)

```
<html>
<script TYPE="text/javascript" LANGUAGE="JavaScript">

var layerOff = "images/layer_tab.gif";
var layerOn = "images/layer_tab_active.gif";
var legendOff = "images/legend_tab.gif";
var legendOn = "images/legend_tab_active.gif";

function toggleLegend() {
        if(parent.MapFrame.legendVisible==false) {
                parent.MapFrame.clickFunction('legend');
                checkLegendMode();
        }

}
function toggleLayers() {
        if(parent.MapFrame.legendVisible==true) {
                parent.MapFrame.clickFunction('legend');
                checkLegendMode();
        }

}
function checkLegendMode(){
        if(parent.MapFrame.legendVisible==false) {
                document.tocTopFrameLayers.src = layerOn;
                document.tocTopFrameLegend.src = legendOff;
        }else{
                document.tocTopFrameLayers.src = layerOff;
                document.tocTopFrameLegend.src = legendOn;
        }
}
</script>

<body bgcolor="#CCCC99">

<table align="center" border="0" width="150" height="39" cellspacing="0"
cellpadding="0">
 <tr valign="bottom">
  <td align="center">
  <a href="javascript:toggleLayers();">
  <img name="tocTopFrameLayers" src="images/layer_tab_active.gif" border="0"
align="bottom" height="29" width="72" hspace="0" vspace="0" alt="Toggle between
Layer List and Legend"></a>
  </td>
  <td align="center">
  <a href="javascript:toggleLegend();">
  <img name="tocTopFrameLegend" src="images/legend_tab.gif" border="0"
align="bottom" height="29" width="72" hspace="0" vspace="0" alt="Toggle between
Layer List and Legend"></a>
 </td>
 </tr>
</table>

</body>
</html>
```