The Canada Centre for Remote Sensing and the Canadian Astronaut Office Collaboration in the Space for Species Educational Program

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Abstract

A partnership between the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada, and the Canadian Astronaut Office (CAO), Canadian Space Agency, exists in order to promote Earth observation expertise from two unique perspectives; from satellites and from manned platforms. This paper focuses on one area of this effort, Space for Species (SFS), a Web-based learning program that promotes the monitoring of migratory species and their habitats from a perspective beyond the Earth's atmosphere. SFS is a co-operative effort involving the Canadian Space Agency (CSA), the Canadian Wildlife Service (CWS), the Canadian Wildlife Federation (CWF) and corporate sponsors. CCRS provides satellite imagery and research support to SFS. The program encourages students in grades six through nine to track the movements of four selected species at risk of extinction in Canada by observing the habitats of these species from space by using satellite imagery and astronaut photographs, monitoring daily and seasonal climatological conditions that affect species' movements and evaluating threats to species along migratory routes. The program also provides the opportunity for students to communicate with field biologists, remote sensing scientists and Canadian astronauts; all of whom will offer expertise, as well as, help students interpret collected data. Students also gain first-hand experience in developing species recovery plans. This paper describes the SFS learning program and highlights the Earth observation component and content of the program Web site.

Introduction

A partnership between the Training and Technology Transfer Section (TTTS) of the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada, and the Canadian Astronaut Office (CAO), Canadian Space Agency (CSA), was developed in 1999 to promote Earth observation (EO) from two unique space perspectives; satellites and manned space-platforms. One emphasis of this effort has been the development of the Space for Species (SFS) learning program. This program was initiated in 1998 by Canadian astronaut Dr. Robert Thirsk and is a joint venture of the CCRS, CSA, the Canadian Wildlife Service (CWS), the Canadian Wildlife Federation (CWF) and corporate sponsorship. SFS arose from a desire to engage young Canadians in an inquiry-based, hands-on science experience. The objectives of this project include increasing student knowledge of the principles and applications of space technology and wildlife conservation, increasing student experience with practical research methodologies and encouraging students to pursue careers in science and technology. While the primary objectives are

educational, the project is also expected to attract the attention of the media and the public, consequently increasing the visibility of all partners (*Thirsk, 2000*).

This paper identifies the issues surrounding science literacy in Canada, describes the benefits and themes of the SFS learning program and highlights CCRS's main contribution to this effort, the EO component and content of the SFS Web site.

Background

Science Literacy in Canada

Canadians are a highly educated people with 80% of our working population completing secondary school and a significant proportion continuing onto post-secondary education. The job market in Canada is evolving rapidly, creating a need for highly skilled and technologically intensive labour (*Conference Board of Canada {CBC}, 2001*). The movement toward a 'knowledge-based economy' is reflected in a shift in the required workforce skill sets. Competence in science, technology and mathematics (STM) is at the center of this knowledge-based economy.

Despite being one of the world's biggest education spenders, national and international test results indicate that Canadian students do not excel in STM learning. It has been found that there is a lack of motivation and desire among students to pursue studies in these disciplines after grade ten (*CBC, 1998*). The demand for graduates in STM industries is growing steadily and as a result STM education will be a key element in developing scientific literacy, as well as, building a strong future for Canada's next generation.

The CSA, CWF, CWS and CCRS are in a unique position to address Canada's comparatively poor performance in STM. These science-based organizations employ scientists, engineers and environmental professionals who are involved in leading-edge research and development, which often has a high public profile. This is particularly true with the activities of Canada's Astronaut Team. As a result, these organizations have the opportunity to demonstrate that careers in STM are challenging, exciting and rewarding (*Thirsk, 1998*). The SFS program engages students in open-ended science activities related to wildlife conservation using technologically advanced tools such as remote sensing and satellite tracking.

The Space for Species Learning Program

SFS is available for implementation by teachers in schools across Canada during the 2001-2002 academic year. Teachers can access this program through the SFS Website *(www.spaceforspecies.ca)* and the program's Educator's Guide (*CWF, CWS & CSA, 2000*). Participants study up to four different species at risk. Tasks include monitoring the complete migratory cycle of the different species. Prior to and during migration, students study maps and remote sensing images and evaluate enroute hazards. The species enroute progress is tracked in context to landscape features, regional weather and environmental conditions as accessed through the program's Web site.

Benefits: *achieving science literacy*

One barrier to the effective teaching of STM skills is the inadequacy of appropriate educational materials (*CBC, 1998*). Scientific literacy is based on the development of science-related attitudes, knowledge and skills such as problem-solving, decision-making and scientific inquiry. The Common Framework of Science Learning Outcomes, established by the Pan-Canadian Protocol for Collaboration on School Curriculum has identified four foundations for the development of scientific literacy in Canada. These foundations include:

- Science, technology, society and the environment (STSE): Students develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and

environmental contexts of science and technology.

- Skills: Students develop the skills required for scientific and technological inquiry, for solving problems for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

- Knowledge: Students construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate and extend their knowledge.

- Attitudes: Students develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment *(Council of Ministers of Education, 1997).*

SFS has been developed to address the fundamental elements of this framework. Participation in SFS encourages students to discover linkages that exist between science, technology, society and the environment. Through scientific inquiry, students become familiar with space science, as well as, the Earth's biodiversity, systems, interactions, habitats and communities. The resources available through the SFS project assist teachers with promoting science literacy.

Themes: *Species & Space*

Species at Risk in Canada

Presently 364 species of wildlife are at risk in Canada (*CWS, 2001*). Habitat loss is a major reason for this decline along with other anthropogenic impacts. Species chosen to be highlighted in the SFS program are the Polar Bear (*Ursus maritimus*), the King Eider (*Somateria spectabilis*), the Anatum Pergrine Falcon (*Falco peregrinus anatum*) and the Leatherback Turtle (*Dermochelys coriacea*) (*Figure 1*). These species are either classified as being endangered (facing imminent extinction or extirpation); threatened (likely to become endangered if limiting factors are not reversed); of special concern (meriting attention because of characteristics that make them particularly sensitive to human activities or natural events) or in decline (*SFS, 2001*). All of these species are currently the focus of research programs in Canada that use satellite telemetry to meet conservation objectives and have relevance to students across Canada, from coast to coast. Conservation concerns for these species range from ocean pollution for the King Eider, to poaching and habitat loss for the Leatherback Turtle to environmental contamination for the Peregrine Falcon and the Polar Bear.

Figure 1: SFS Educational Poster

(CCRS, 2001)

Role of Space Technology

Space technology, including satellite telemetry and EO satellites are currently being employed by wildlife biologists to gain a better understanding of species at risk. Satellite telemetry enables researchers to monitor the location of an animal tagged with a transmitter, regardless of how remote that animal's location may be. SFS participants use this data to study migratory routes and habitat locations.

Imagery from EO satellites and manned-space platforms provide information on topics such as nesting and wintering habitats or threats along migration routes, as well as, daily and seasonal climatological conditions that might affect species' movement.

The following example extracted from the SFS Web site, illustrates the impact weather

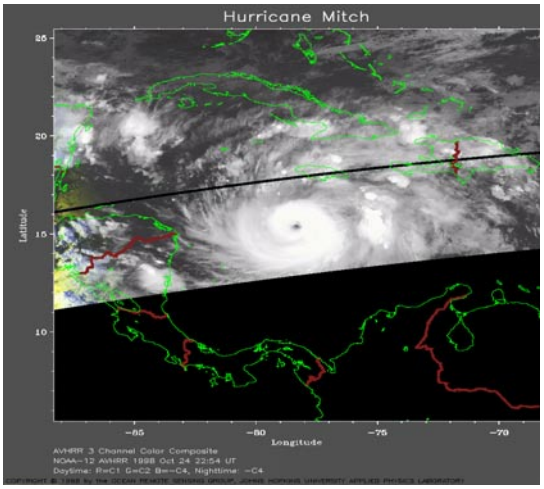
conditions can have on the migration of a peregrine falcon. On October 24, 1998 peregrine # 5375, which had been tagged by the CWS, was tracked enroute from Northern Alberta to Venezuela. Hurricane Mitch with wind speeds of 160 kilometres per hour was centred to the west of the falcon's location (*Figure 2*). Figure 3 illustrates the impact that Hurricane Mitch had on the actual flight path of the falcon. Tracking reveals that the falcon had been forced to change directions to avoid the adverse weather conditions of Hurricane Mitch (*Holroyd*, *1998*).

Space technology resources provided by project partners to the Web site will include remote sensing imagery and interpretation, satellite tracking data, weather information and photographs of relevant habitats taken by astronauts and by wildlife biologists. CCRS is responsible for the contribution of remote sensing imagery and interpretation.

CCRS's expertise in EO technology and its application has contributed significantly to the space technology sections of the SFS Web site and the program's Educator's Guide. Information is available in various formats including; downloadable remote sensing tutorials, EO imagery case studies and interactive, 'hands-on' student activities. In addition, several of CCRS's application scientists will be available to answer questions and offer expertise through the project's 'Ask the Expert' section.

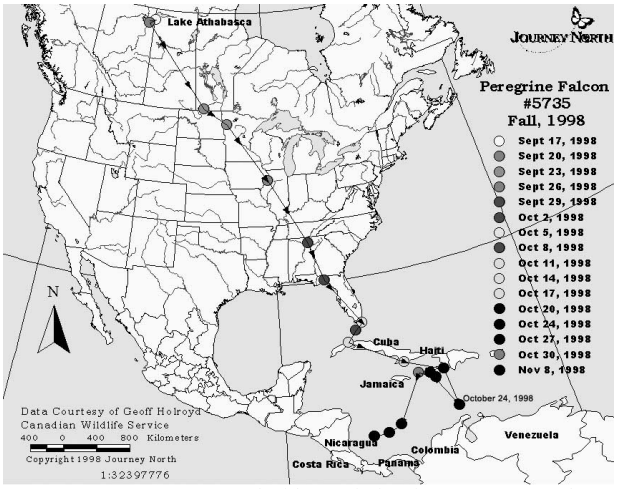
EO material is used to monitor the environmental condition of various species habitats (e.g. nesting, moulting and wintering areas) prior to their arrival and during their stay. Remote sensing imagery is used to assess the impact of industrial, agricultural, urban and recreational developments on the habitats. The effect of droughts, floods or hurricanes on the endangered species can also be assessed. RADARSAT-1, Canada's first EO satellite has been featured prominently in the program materials.

Figure 2: Hurricane Mitch 10/24/98



NOAA, 1998

Figure 3: Migration Path of Falcon #5375



Used with permission from Journey North (www.learner.org/jnorth)

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CCRS On-line Educational Resources

Several educational resources are available through the Education & Reference section of the CCRS Web site at *www.ccrs.nrcan.gc.ca*. These resources have also been made available to program participants through direct links from the SFS Web site and include remote sensing tutorials covering a wide range of topics. The tutorials are entitled: Radar and Stereoscopy, Fundamentals of Remote Sensing, Digital Images and Digital Analysis Techniques, Watching Over Our Planet from Space and Looking at the Earth's Environment through the "Eyes" of a Satellite. CCRS educational resources have proven to be valuable and popular teaching materials. These tutorials have been downloaded over 5000 times in total between January and April 2001 (*Naluzny, 2001*).

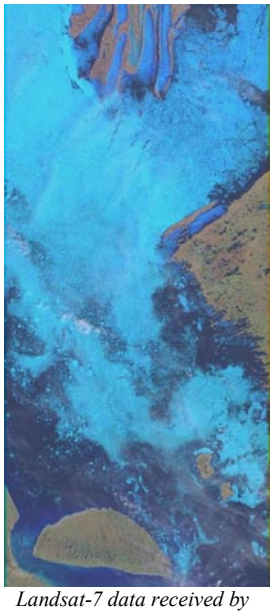
Imagery-Based Case Studies

Significant effort has been invested at CCRS into the identification, collection and interpretation of suitable satellite imagery to assist in meeting the research objectives outlined for each of the four species. The research objectives for which the use of satellite observation is relevant, include:

- assessing sea-ice conditions as related to Polar Bear movement throughout the year in the south-western Hudson Bay area;
- assessing at-sea habitat during King Eider migration;
- characterizing the movements and habitat use of Leatherback Turtles in the Northwest Atlantic; and
- monitoring weather and landscape patterns and the related impacts on Peregrine Falcon migration behaviour (*Thirsk, 2000*).

An excellent resource that has been used in locating relevant imagery is the CCRS Quicklook Swath Browser at http://ceocat.ccrs.nrcan.gc.ca/quicklook/quicklook.html. The browser assists users in conducting on-line searches and downloading free-of-charge recently acquired RADARSAT-1, Landsat - 7 and NOAA/AVHRR imagery in low-resolution 'quicklook' swath format (*Adair,2000*). Recently featured on the Quicklook Web site was a Landsat - 7 swath showing the spring ice break-up in Hudson Bay (*Figure 4*). Ice imagery is useful for monitoring Polar Bear movements since this animal prefers sea-ice habitat for travelling and hunting prey. Seasonal changes to ice concentrations in Hudson Bay can seriously influence the movement and hunting patterns of polar bears (*CWS, 2001*).

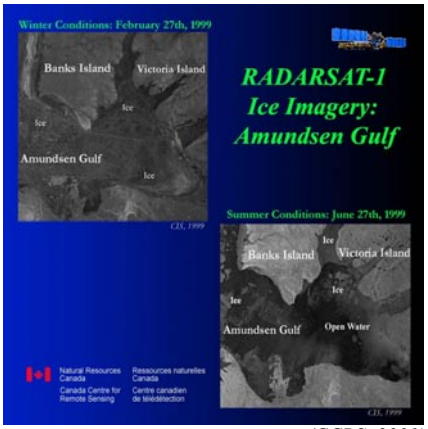
Figure 4: Partial Landsat - 7 Swath: South-West Hudson Bay



Landsat-7 data received by CCRS under MOU with USGS

RADARSAT-1 imagery also provides information on sea-ice conditions, useful for assessing at-sea habitat during the migration of King Eider populations to nesting grounds on Banks Island. King Eiders are open sea feeders and a major threat to this species is starvation due to unfavourable ice and weather conditions (*Figure 5*). Monitoring ice conditions is vital in understanding possible threats to this species.

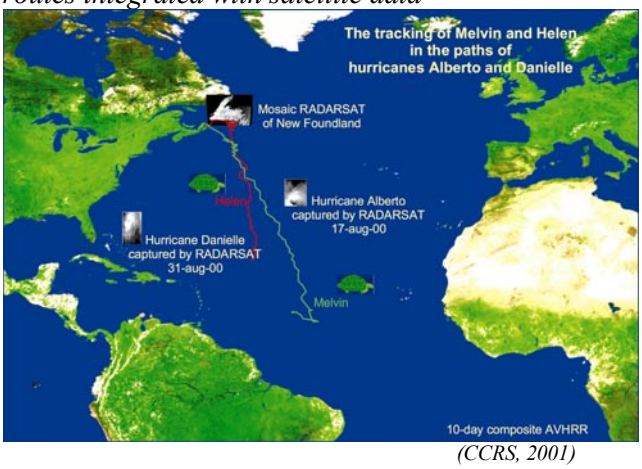
Figure 5: Changing Ice Conditions Banks Island Area



(CCRS, 2001)

Incorporating a Geographic Information System (GIS) mapping tool into the SFS program proved effective for accessing the information content of relevant image products. Arc-Info© GIS software makes it possible to integrate latitudinal and longitudinal Leatherback Turtle migration co-ordinates with NOAA/AVHRR Land Cover and RADARSAT-1 Mosaic and hurricane datasets (*Figure 6*). Timely image-map products help illustrate the impact of factors such as hurricanes on the migratory patterns of leatherbacks in the North Atlantic.

Figure 6: GIS Product: Leatherback migration routes integrated with satellite data



(CCRS, 2001)

Additional imagery that has been featured on the SFS Web site include the RADARSAT-1 Mosaic of Canada and National Oceanic and Atmospheric Administration (NOAA/AVHRR) satellite land cover imagery.

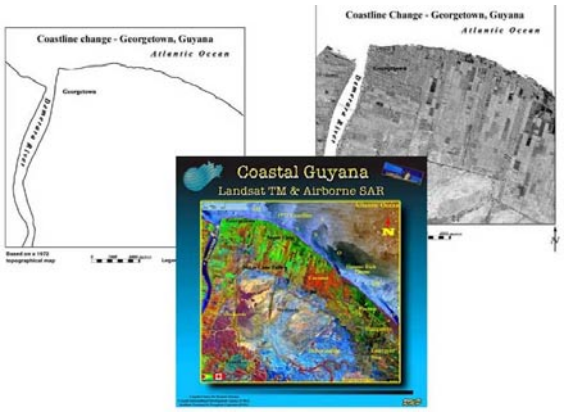
Student Activities

One SFS program objective is to encourage 'hands-on' learning activities with emphasis on the implementation of the scientific method (*Thirsk, 2000*). To meet this objective, interactive remote sensing activities have been developed at CCRS for this program. One such activity entitled 'Off the Beach' introduces students to the use of remote sensing for identifying threats to Leatherback Turtle nesting habitat. In this activity, remote-sensing images and coastline maps are compared so as to learn about the extent of beach erosion and loss of Leatherback turtle nesting habitat over a 20-year

period (*Figure7*). The objectives of this activity include:

- Introducing students to the use of remote sensing as a tool for conservation.
- Analyzing wildlife habitats from space and assessing visible changes.
- Deepening awareness of habitats used by migratory animals worldwide.
- Understanding how habitats are affected by human and natural impacts.
- Learning the difference between observations and calculations.
- Practising the implementation of research procedures.

Figure 7: 'Off the Beach' Student Activity



(Courtesy Vern Singhroy, CCRS, 2001)

The EO resources provided by CCRS assist in accomplishing SFS goals, which include increasing student knowledge of the principles and applications of space technology and wildlife conservation; increasing student experience with practical research methodologies and encouraging students to pursue careers in STM. While the primary objectives of the program are educational, an important opportunity for CCRS to increase involvement and visibility within the education community and with youth audiences exists. (*Thirsk, 2000*). The program is also beneficial in highlighting the research achievements of the Canadian government, as well as, the achievements of academic and industry partners in Earth observation science, technology and applications.

Summary

A partnership between the Canada Centre for Remote Sensing and the Canadian Astronaut Office has enabled the development of an educational program that offers significant potential in encouraging young Canadians to participate in scientifically sound research in a dynamic, interactive, geomatics-driven setting. Space for Species provides a window to the exciting opportunities of combining Earth observation technology with wildlife and habitat conservation. Committed to the goal of exposing students in a positive and exciting way to socially relevant challenges in environmental and Earth sciences, Space for Species provides materials and supporting resources for improving science literacy in Canada.

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