Draft: Invasive Plant Species Protocol

Purpose

- To identify, document, monitor and (possibly) eradicate the invasive alien plant species found in study sites.
- To provide accurate, useful information to local and/or regional authorities to aid in the location and control of invasive plant species.

Overview

Students will visit their study site and identify plant species on it. This may be done in collaboration with local experts and/or appropriate plant identification resources. They will record the data using the land cover/canopy cover/biometry protocols. In some instances, students may be able to provide useful data to existing initiatives and local authorities for the eradication the invasive alien species.

Student Outcomes

Students will be able to:

- Describe their site in a scientifically correct manner.
- Identify native, alien and invasive alien plant species.
- Provide information to local and/or regional authorities that may be useful for locating and eradicating invasive plant species.

Science Concepts

Physical Science

- Biomass, height and percent cover of vegetation can be measured using instruments: (GLOBE instruments e.g. Clinometers, densitometers, etc).
- The position of plants (e.g. trees and shrubs) can be determined with reference to other objects and landmarks.

Life Science

- Invasive alien plants suppress the natural growth of native plants and in rural communities have a direct bearing on quality of life.
- Invasive alien plants may have a negative impact on the availability of water for native species.
- Invasive alien plants may curtail the economic potential of native plants.

Geography

- Topographic and/or thematic maps, air photographs, satellite images and Geographic Positioning Systems (GPS) technology can be used to describe the physical characteristics of the study area.
- Characteristics and distribution of ecosystem(s) in the study area can be determined by mapping the plant communities.

Scientific Inquiry Abilities

- Make and correctly use instruments to gather scientifically valid data.
- Use vegetation field guides to identify vegetation species.
- Record and communicate the results to make an informed decision as to what gets eradicated and what stays.
- Identify questions that can be answered in the context of the site, but that are also relevant to other plant issues.
- Design and conduct scientific investigations.
- Develop descriptions and predictions using evidence.
- Recognize and analyze alternative explanations.
- Communicate procedures, descriptions and predictions to peers.

Time

60 minutes excluding travel time (it is best to choose study sites close to the school)

Level

Late primary, secondary /, middle and high school.

Frequency

New sites can be set-up as frequently as desired.
If any given site is being monitored, return once a week to twice a month to document the changes in the plants.

NOTE: If other protocols are being incorporated into the monitoring of the site, (e.g. leaf or flower budburst), more frequent visits may be required to fully document the target plant phenological stages.

Material and Tools

GPS Protocol, Field Guide, Data Sheet, tools and materials
Invasive Plant Species Site Definition Field Guide and *Data Sheet*
Surveyor's stakes or GLOBE flags (5) and/or surveyor's tape
Tape measures (appropriate lengths)
Compass
Digital camera (with extra batteries)
Topographic map
Land Cover Biometry Protocol guide, data sheets, tools and materials (optional)
Land Cover Instruments guide (optional)
Clipboard
Pencil or Pen
Calculator/Random Number Table

Wooden pegs, additional surveyor's stakes and/or GLOBE flags (4 per group)
Ball of twine or string (1 per group)
Tape measures (1 per group)

Quadrat frames (optional)
Cover estimation templates (optional)
Hand lens (optional, 1 per group)
Plant reference materials (guides for invasive and local (native) plants)

Any other materials and tools needed for companion GLOBE protocols if used

Preparation

Become familiar with the local environment for the purpose of selecting a sampling site.

Review the associated documents: *Vegetation Sampling, Using Random Numbers for Locating Sample Subplots, How To Make A Rectangular Frame* and *Hints On Using A Compass.*

Work through *Random Sampling Learning Activity* (optional).

Find the appropriate reference materials (books, government pamphlets and reports, university studies, web sites, etc.) for identifying plants found in your region (native, invasive, etc.). Those with good pictures and desciptions of the plant and its habitat are best. These may contain recommendations about eradicating the invasive species and/or preventing these species from being unintentionally spread to other areas. You may also want to enlist the help of local experts.

Review the GLOBE GPS Protocol (used for site set-up). It is also recommended that the Biometry Protocol and Land Cover Instruments Guide be reviewed; they can be used to characterize the land cover of the general site.

Other GLOBE protocols that could be used to document or monitor the site(s) are: the Air Temperature Protocol(s), Precipitation Protocol, Soil Characterzation Protocol, Green-up Protocol, Green-Down Protocol, Budburst Protocol, Hydrology Protocol(s), etc.

Students make the necessary Land Cover field instruments (e.g. clinometers and densiometers). Instructions are given in the GLOBE Land Cover Investigation.

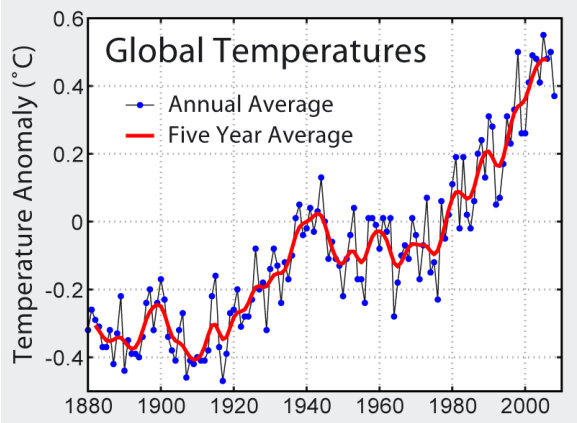
Prerequisites

None

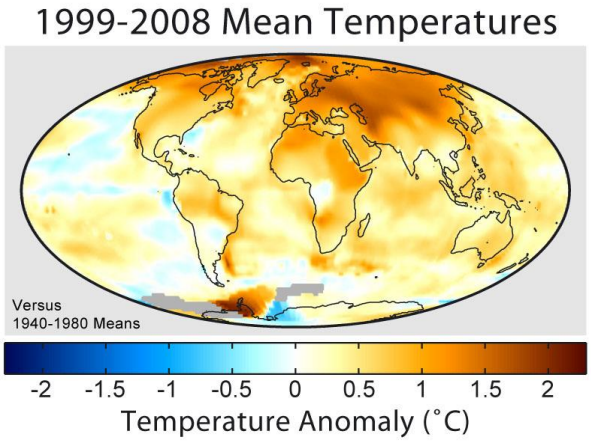
Invasive Plant Species
Introduction

Climate Change

During the twentieth century, the earth's surface warmed by about 0.74±0.18°C. The graph (below left) shows the global mean surface temperatures from 1880 to 2007. Note the strong upward trend in the data. The image (below right) shows the difference between the mean global temperatures calculated for the periods 1999-2006 and 1940-1980. Note that except in a very few instances, global mean temperatures for 1999-2006 were warmer than 1940-1980.



Global mean surface temperature anomaly relative to 1961–1990.
Source: http://www.globalwarmingart.com/wiki/Image: Instrumental_Temperature_Record_png



Mean surface temperature anomalies during the period 1999 to 2008 with respect to the average temperatures from 1940 to 1980.
Source: http://www.globalwarmingart.com/wiki/Image: Global_Warming_Map_jpg

There are a variety of potential causes for global climate change, including natural and human-induced mechanisms. Though a few scientists remain skeptical, there is a growing consensus that the present day warming is real and humans are driving it. Evidence for global warming can be found in every part of the Earth system. Besides well-documented changes in air temperature, global warming is:

- Heating the world's oceans;
- Reducing sea ice extent, especially in the Arctic;
- Desalinating the oceans;
- Melting glaciers;
- Causing sea level to rise;
- Altering habitats; and
- Affecting plant and animal distributions.

Growing seasons in many parts of the globe have shifted as a result of warmer temperatures. Scientists have observed that plants have been slowly moving toward higher elevations in some mountain regions. This "escalator effect" as it

has been called, has pushed some plant species up as much as ten feet (3 meters) in some mountain regions. Because some plant species migrate faster than others, established ecosystems could be severely altered.

The effects of global warming will not be the same in all places. The smallest changes in temperature will occur in tropical regions, while the Arctic and Antarctic will experience significant changes. This is because a small change in annual air temperatures can have a major impact on the cryosphere (ice) that dominates the region. This includes: the thickness, distribution and duration of the annual (and multi-year) sea ice cover; the thickness and duration of the annual lake and river ice cover; the duration of the annual snow cover; changes in the permafrost region (distribution, depth of active layer, and annual duration of active layer); and changes in glaciers (length of melt season and change in location of equilibrium line causing a change in ice volume). Changes in the polar regions will have implications for non-polar regions e.g. sea level rise due to the melting of the Greenland ice sheets and Alaska glaciers.

Native, Alien and Invasive Plant Species

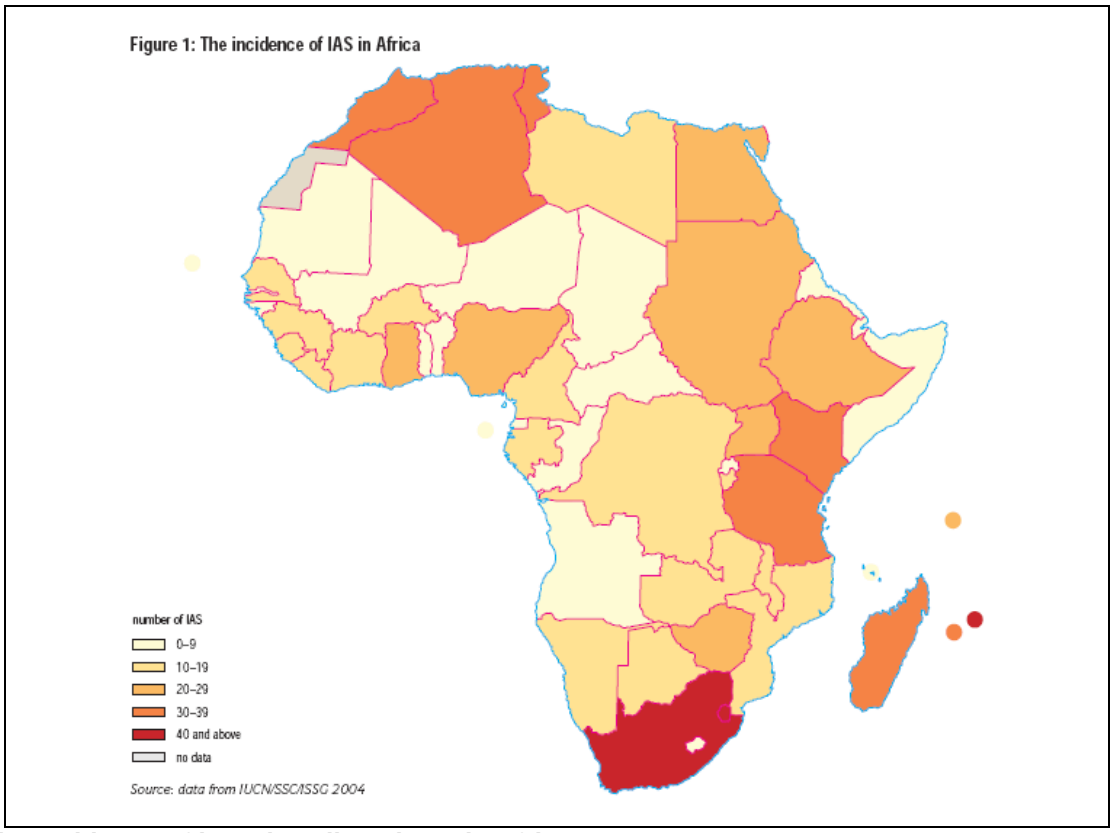
An organism's home, or native range, is determined by a host of influences such as climate, geology, soils, hydrology, and biological interactions. Each species of bacteria, fungi, plant, animal, and other organism has a home somewhere on this planet where it has existed and evolved for thousands of years.

Native species are those present in part or all of a specified region without direct or indirect human intervention, growing within their native range and natural dispersal potential. Other terms for native species include *indigenous* and *aboriginal*.

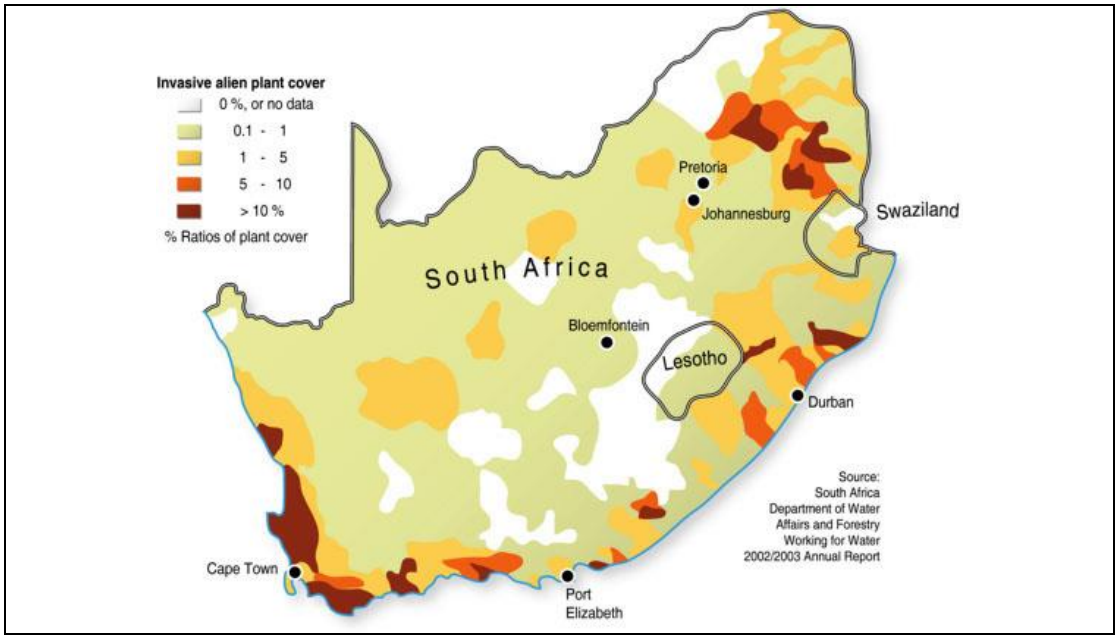
Non-native species are those present in a specified region only as a direct or indirect result of human activity. This designation applies to a species introduced from another continent, another ecosystem, and even another habitat within an ecosystem. Other terms that are often used as synonyms for non-native include *alien, exotic, introduced, adventive, non-indigenous,* and *non-aboriginal.* Non-native species maintaining themselves outside of cultivation or other human care may be considered *naturalized.* The maps below illustrate the extent of invasive plants on the continent of Africa and in the country of South Africa.

There are a number of different ways that unintentionally introduced species arrive in a new area. These include:

- On imported nursery stock or soil;
- On imported fruits and vegetables;
- In untreated, discharged ballast water of ships;
- In or on vehicles like boats, airplanes, trucks, ships, etc.;
- In bilge water, live wells, bait buckets, and on fishing gear;
- In packing material and shipping containers;
- Mixed in with seed packets or shipments;



The Incidence of invasive alien plants in Africa. (Source: http://www.unep.org/DEWA/Africa/docs/en/aeo-2/factsheets/aeo-2_IAS_factsheet.pdf).



Invasive alien plants in South Africa. Species that have been introduced on purpose or spread in the wild threaten livelihoods in agriculture or water resources. As illustrated in this map, some regions of South Africa have very high ratios of invasive alien plants but are subject to government projects that limit the information distribution campaigns for the public.
(Source: http://maps.grida.no/go/graphic/invasive_alien_plants_in_south_africa).

- From people traveling for tourism, recreation, or commerce;
- Through canals and other humanly produced paths; and
- On imported or migrating animals.

Some means of deliberate introduction include:

- Sport fishing;
- Aqua culture;
- Home aquaria;
- Biological control;
- Research facilities;
- Seeds/Gardens/Landscaping;
- Erosion control; and
- Fur/silk production (e.g., nutria, European gypsy moth).

In some places invasive species have a legal definition: “An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health . . . Alien species means, with respect to a particular ecosystem, any species . . . that is not native to that ecosystem.”

Invasive species have adverse impacts on native plants, animals, and natural ecosystems. These include:

- Reducing native biological diversity;
- Altering hydrologic conditions and flooding regimes;
- Altering soil characteristics;
- Altering fire intensity and frequency;
- Interfering with natural succession;
- Competing for native pollinators;
- Repelling or poisoning native insects;
- Displacing rare plant species;
- Increasing predation on native birds
- Serving as reservoirs of plant pathogens;
- Replacing complex communities with monocultures;
- Diluting the genetic composition of native species through hybridization; and
- Out competing crops for soil and water resources in agricultural landscapes

The best way to limit the impact of non-native species is **prevention**. Methods include decontamination of freight, packaging material and transportation equipment that could contain unknown biotic hitchhikers, and restricting deliberate imports of potentially harmful species.

Once a non-native or invasive species has arrived, the following steps may be taken to eliminate or limit it:

- **Eradication** may be possible early in an invasion or in a restricted area. Early detection and rapid response is an efficient tactic for local eradication of new invaders. Regular monitoring programs to identify new exotics soon after they invade are critical components of this strategy. ***This protocol can be used to assist local government agencies and other agencies accomplish this by providing early detection of invasive plant species.***

- **Containment** (preventing further transport of existing exotics within the region) is an important tool to reduce the impact of existing invaders. Strategies for containment generally combine tools used in prevention and eradication.

- **Control** methods can include any of the following:
    - *Chemical control* (using pesticides, herbicides, or fungicides) can be effectively used to kill invasive species, but may also harm non-target species.

    - *Mechanical control* (physically removing the invasive species or changing habitat conditions with methods like fire or flooding) is often successful, but can be expensive and labor intensive.

    - *Biological control* (introducing a natural enemy – predator or parasite – generally from the invader's native range) may be used to control an invasive species that has established dense populations over large areas. However, there is a risk that during or after the initial eradication, the biological control species could become established and have a negative impact its new environment (e.g. the moth *Oxyptilus pilosellae* Zeller introduced in New Zealand to control Hawkweed).

- **Restoration** of native communities is an important step to minimize the chances an area will be reinvaded. Many control techniques inherently create disturbance, which may increase the vulnerability of an area to subsequent invaders.

Many of these steps may be beyond the resources of local volunteers and should be taken by the appropriate local and regional government agencies. However, as noted above, if GLOBE students can identify and report the location of invasive plant species to the appropriate authorities in a timely fashion, eradication may be possible.

Teacher Support

Timing and Types of Observations

Plants may be identified by a number of different attributes:

- Habitat, - elevation, aspect, hydrology, adjacent plants, etc.
- Growth characteristics – annual or perennial, solitary or numerous, close growing (reproduction by roots) or scattered (reproduction by seeds)
- General form – height and shape
- Stem – woody or herbaceous, upright, arched or creeping, smooth, hairy or thorns
- Leaves – number, size, shape, arrangement on stem (alternate or opposing), color (color in autumn), pattern and prominence of leaf veins
- Flowers – color, shape, size, location on plant, structure, number of flower stalks
- Fruit and seed pods – shape, color, texture
- Underground structures - roots (fibrous or taproot), bulb, rhizome, tuber

The natural history of the plants in your area will dictate when you should go out and identify the plant species in your study site. It may be necessary to see a plant at several points of its annual (life) cycle, in order to see some of these "markers". For example, a plant may flower before the leaves come out or flowers may bloom after the leaf cover is well developed.

Site Selection and Set-Up

Choose a site that has easy access during the entire growing season, is close to the school and is representative of local conditions. The selected site(s) should be relatively uniform across the site. If you would like to monitor plants in two adjacent habitats, please document them as separate sites. For example, a clearing in forest should be documented as a separate site from the forest. Make sure not to disturb fragile environments or protected plant species.

It is recommended that, where possible, sites should be relatively flat or gently sloping, and not be either excessively dry or wet for your area. If possible, avoid steep, south-facing or north-facing slopes, and areas that are subject to drifting snow or excessive winds. Also, avoid locations where plants are given supplemental water or fertilizer. In forested areas, the site should reflect the overall canopy composition and stature/size. If these conditions are not available, be sure to enter as metadata what the exception(s) are to the preferred site characteristics.

When choosing a sampling site some other factors need to be considered:

- *Sensitivity* - sampling sites should be chosen to avoid adverse effects to populations of rare and threatened species and sensitive habitats;
- *Safety* – this should be considered both in terms of the physical terrain and the reaction of certain species to disturbance due to sampling; and
- *History of land use and distribution* – this will have an effect on the

vegetation currently occupying the site.

In order to set-up your site do the following:

1. Walk through the general area and assess the general topography and land cover.
2. Find a place that meets the site recommendations above.
3. Decide on the size of the site based on the general land cover and the recommendations (See *Vegetation Sampling*).
4. Mark out the site – remember this site may be "permanent" so it can be revisited. This may be done by using Surveryor's stakes, GLOBE flags or other wooden poles OR by tying Surveryor's tape or strips of colored cloth to trees. If you have a large site, you may want to get GPS readings at the corners, as well as at the center of the site.
5. Determine the number, shape and size of the subplots based on number of students, topography and vegetation cover (See *Vegetation Sampling*). If you are using temporary plot, they may be staked out with the wooden pegs and string or flags OR you can use quadrat frames.

Complementary GLOBE Protocols and Learning Activities

Teachers should consider performing the following GLOBE protocols at the school's study sites so that students can see the relationships between the vegetation cover and the forcing environmental conditions. This will require setting up an atmosphere study site within 100m of the Invasive Species study site. (The protocols are available on the GLOBE web site (http://www.globe.gov/tctg/tgtoc.jsp) or the GLOBE Teacher's Guide CD, 2005):

1) **Temperature protocols**, *Atmosphere Chapter*
   maximum, minimum and current air temperature protocol
   OR digital multi-day max/min/current air and soil temperatures protocol
   OR Automated soil and air temperature monitoring protocol
2) **Precipitation protocols**, *Atmosphere Chapter*
3) **Soil Characterization protocol**, *Soil Chapter*
4) **Budburst, Green-Up and Green-Down protocols**, *Earth as a System Chapter*

There are related materials and activities in the *Earth as a System* Chapter that provide a broad background and develop useful skills:

- Introduction – The Seasonal Cycle and Scales of Understanding (local, regional and global)
- Seasons – learning activities
- Local Connections – learning activities
- Regional Connections – learning activities
- Global Connections – learning activities

Teacher Resources

Climate Change

Africa – Atlas of Our Changing Environment (UNEP, 2008)
http://na.unep.net/atlas/AfricaAtlas/

Africa's Lakes – Atlas of Our Changing Environment (UNEP, 2006)
http://na.unep.net/AfricaLakes/

Case Studies on Climate Change and World Heritage (UNESCO, 2007)
http://whc.unesco.org/documents/publi_climatechange.pdf

Climate Change: Global Warming
http://www.uwsp.edu/gEo/faculty/ritter/geog101/textbook/climate_systems/climate_change.html

GLOBAL WARMING: Early Warning Signs http://www.climatehotmap.org/index.html

Earthshots: Satellite Images of Environmental Change (USGS)
http://earthshots.usgs.gov/tableofcontents

One Planet Many People – Atlas of Our Changing Environment (UNEP, 2005)
http://na.unep.net/OnePlanetManyPeople/index.php

PEW Center on Global Climate Change http://www.pewclimate.org/

Native, Exotic, Alien and Invasive Plants

A guide to native plant gardening (Lady Bird Johnson Wildflower Center)
http://www.wildflower.org/howto/show.php?id=4

Botanic Gardens Conservation International (BGCI) http://www.bgci.org/

Center for Invasive Species and Ecosystem Health
http://www.invasive.org/

Endemic Biodiversity, Natural Enemies, and the Future of Biological Control
http://www.invasive.org/publications/xsymposium/proceed/12pg875.pdf

Global Invasive Species Database (GISD) http://www.issg.org/database/welcome/

Guide to Monitoring Exotic and Invasive Plants (Environment Canada)
http://www.eman-rese.ca/eman/ecotools/protocols/terrestrial/exotics/intro.html

Indigenous, Alien and Invasives http://www.botany.uwc.ac.za/envfacts/facts/aliens.htm

Invasive Alien Species in Africa (The Encyclopedia of Earth)
http://www.eoearth.org/article/Invasive_alien_species_in_Africa

Invasive Species http://alic.arid.arizona.edu/invasive/index.shtml

Invasive Weeds: A growing pain (Bureau of Land Management Learning Landscapes)
http://www.blm.gov/education/weed/native.html

Learning About Plants
http://www.swcoloradowildflowers.com/learning%20about%20plants.htm

Learning on the Land – A Conservation Education e-Newsletter (Jul,y 2007)
http://www.sjma.org/whoweare/news/LearningontheLand/LearningontheLand0707.pdf

National Geographic Xpeditions – Lesson Plans – Designing a Native Plant Garden
http://www.nationalgeographic.com/xpeditions/lessons/08/gk2/tggarden.html

National Geographic Xpeditions – Lesson Plans – Invasive Species
http://www.nationalgeographic.com/xpeditions/lessons/14/g68/newsinvasive.html

The National Geographic's STRANGE DAYS on Planet Earth – Invaders
http://www.pbs.org/strangedays/episodes/invaders/

National Invasive Species Information Center http://www.invasivespeciesinfo.gov/

Return of the Native (RON) – A Curriculum and Online Toolbox for the Restoraion of Native Plants and Eradication of Invasive Weeds
http://watershed.csumb.edu/ron/roncor/cor/main.htm

SCA – Student Conservation Association Conservation Corps Project Sites
http://fieldstaff.thesca.org/index.php?option=com_content&task=view&id=51&Itemid=24

The United States National Arboretum – Invasive Plants
http://www.usna.usda.gov/Gardens/invasives.html