US Department of the Interior
National Park Service

Jamaica Bay Wildlife Refuge:
Investigating Bird Migration and Climate Change
Teachers Guide

photo by Don Riepe

Table of Contents

Cover Photo: Terns and Cityscape

United States Department of the Interior

NATIONAL PARK SERVICE
Gateway National Recreation Area
210 New York Avenue
Staten Island, New York 10305-5019

Dear Teacher:

Gateway National Recreation Area and the staff of the Jamaica Bay Unit are pleased to welcome you to the park. The information in this packet is designed to acquaint you with the Wildlife Refuge prior to your visit, in order to make the most of your experience.

The National Park Service administers Gateway National Recreation Area. Our mission is to preserve and protect the natural and cultural resources in the park. Education plays a vital role in the accomplishment of this objective. The foundation of this program is built on the New York City standards and emphasizes hands-on investigation of natural resources.

Our approach to environmental education is interdisciplinary and hands-on. The success of the program depends on the incorporation of both the pre-site and post site activities, included in this packet. It is extremely important that your students bring the field experience back to the classroom and the home/school environment.

The Wildlife Refuge habitat areas offer the opportunity for exciting investigations of the physical and natural worlds. Our primary goal is to stimulate student's natural sense of wonder and educate them about their environment.

Executive Summary

Our goal for students is to create a personal relationship with a bird species, so they care about the challenges that their bird will have in a warming climate.

Middle and high school students will participate in several classroom exercises in preparation for a visit to Jamaica Bay Wildlife Refuge (JBWR); they will then take buses from school to JBWR and use the Refuge as an outdoor classroom and laboratory; and finally, will undertake post-visit studies to summarize, extend and connect their JBWR experience to other environmental issues surrounding climate changes.

Essential Questions

- What makes Jamaica Bay such an important place for birds during migration? How will climate change impact the refuge?
- How can we maintain the refuge for generations to come?

What Every Teacher Needs to Know

Travel Directions

From Manhattan, Brooklyn and Queens

Take the Belt Parkway to Cross Bay Boulevard (Exit 17S). Drive south through the town of Howard Beach and over the North Channel Bridge (no toll). Continue one and a half miles south to a stop light. Make a right into the Wildlife Refuge entrance and parking lot.

From Rockaway

Take Beach Channel Drive/Rockaway Freeway to the Veteran's Memorial/Cross Bay Bridge. Cross north over bridge (toll) to Cross Bay Boulevard and through the town of Broad Channel. The refuge entrance/ parking lot is approximately ½ mile north of town on the west (left) side of Cross Bay Boulevard.

Bus Permit for the Belt Parkway

A bus permit is required by all buses traveling the Belt Parkway. The issuance of a permit is subject to restrictions, due to construction schedules. If you intend to use the Belt Parkway in order to reach the Wildlife Refuge, inquire about a permit with the bus company.

Program Information

When you and your class arrive at the Wildlife Refuge, a Park Ranger will meet you and begin your program. Groups are expected to arrive at 10 a.m. unless otherwise noted. Please call (718)338-4306 if you are going to be late or have to cancel your visit for any reason. Ranger guided programs last from 10 a.m. to 12 p.m. Afterwards, most classes spend approximately ½ hour for lunch and bus boarding.

Things To Remember

Preparation

1. The success of your visit depends on how well you are prepared. Please review the teacher packet and provide necessary information to your students. Discuss the park rules with your class and chaperones before the trip. Failure to follow the rules and improper behavior could lead to early termination of the class visit.
2. Please have at least one adult chaperone for every ten children. At no time are students to be left without adult supervision. Chaperones are encouraged to take part in ranger led activities.
3. Students are free to explore under the guidance of the ranger. The teacher and chaperones are responsible for discipline and control of the class. The class must stay together as a group and stay on the trails unless otherwise directed by the ranger.
4. To make the trip more personal for each student and to ease communication with individuals, we recommend that the students wear name tags.
5. This Bird Migration module requires that students come prepared for the on-site activity by having prior experience working in their cooperative teams and have an understanding of various environmental concepts. This can be assured if you work through the recommended pre-visit assignments with your students.

Dress

1. The refuge is usually windy and cool because it is near the shore, so please dress accordingly. We suggest the students dress in layers: a hat, scarf and gloves in cool weather, a hat and sun protection in warm weather. Rain gear such as a tarp or raincoat should be brought along, as the students will be expected to go outdoors, rain or shine.
2. Students should wear casual clothing as they may be required to sit on the ground or walk through muddy areas. All students should wear long pants and a long sleeved shirt (regardless of the temperature) and closed, comfortable walking shoes, boots or sneakers. Open sandals and high heels are not recommended.

Safety

1. Ticks are commonly found on and near vegetation during the spring, summer and autumn. They can be avoided by staying on the trails and dressing properly. For further information, please read the tick information bulletin included in this packet.
2. Poison Ivy is ubiquitous throughout the park. It is identified by its smooth-margined leaflets in groups of three, aerial rootlets and creamy white berries. It can grow as a vine, woody shrub or ground cover. Students can avoid contact with poison ivy by staying on the trails and not touching plants with which they are unfamiliar. If contact does occur with this plant, wash well with soap and water.

Lunch

1. There is no food concession at the refuge and an indoor eating space is not available. At the discretion of the teacher, students can bring a bag lunch for after the program.
2. Picnic tables are located outside of the visitor center. Please collect all of the lunches and place them in a large box or bag for distribution after the program. In the event of inclement weather, lunches could be brought back to the school, or with the permission of the driver, eaten on the bus.

Things to Bring

1. First aid kit, insect repellent and drinking water (other beverages are not permitted on the trail).
2. Extra lunches, clothing, rain gear, watches or timers, and pencils for those students not prepared.
3. Binoculars, cameras, hand lenses, field guides and a small notebook are recommended. Please note: specimen (i.e., soil, water, plants, shells, etc.) collecting is not permitted even for educational purposes.

Park Ranger leading a group of students at the Jamaica Bay Wildlife Refuge


Jamaica Bay Wildlife Refuge
Gateway National Recreation Area
New York / New Jersey
National Park Service
U.S. Department of the Interior
Joseph P. Addabbo Bridge
North
0 500 1,000 Feet
0 125 250 Meters
Report any emergency to United States Park Police:
718-338-3988
Fire Break
Seasonal Trail
Inquire about access at Visitor Contact Station
Woodland Trail
West Pond Trail
Multiuse Path
Subway Tracks
Upland
Marsh
Sand / Bay Shoreline
Fishing Area
M Visitor Information
^ Parking
m Restroom
ö Observation Blind
ç Trailhead
b Picnic Area
O Kayak Launch
+ Bus Stop
! West Pond Trail Bench
North Dike
Road
No Visitor Access
North Muck
North Island
Sanderling Point
West Firebreak
East Firebreak
Cross-Bay Boulevard
Jamaica Bay
Black Bank (North Marsh)
East Pond
North Garden
East Garden
Big John's Pond
"The Raunt"
West Pond
South Garden
Piling Point
South Flats
Visitor Contact Station
M m b
Black Bank (South Marsh)
Terrapin Trail
Broad Channel
To Broad Channel Station (A,S)

Why Do Birds Matter?

Biodiversity

They improve biodiversity by spreading seeds. Blue Jays are great at burying acorns, which sometimes sprout before they are eaten. Birds that eat berries inadvertently spread seeds in their droppings, leaving not only seeds but fertilizer as well.

Insect control

Birds do their part in controlling insect populations and disease. Insectivores, like swallows, keep insect populations in check. Detritivores, like vultures, crows, gulls and raptors, control the spread of disease by eating dead animals. Dead animals such as deer, for example, can be a breeding site for disease. Vultures, with their keen sense of smell and ability to eat decaying meat without getting sick, provide an important service by eating "carrion" or dead animals before the carcasses become diseased and harmful to human health.

Canaries in the Coal Mine

Birds have also helped humans in a more direct relationship. In the early days of coal mining, miners carried canaries into the mines. Canaries are highly sensitive to concentrations of odorless methane gas, which has the potential to explode in high concentrations. Humans couldn't detect the odor, but canaries would keel over, giving miners the message to leave the mine.

Birds continue to be studied as indicators of environmental health. While humans might not be able to perceive the changes in the environment, birds are quite sensitive to changes in temperature, availability of food sources, shifts in weather patterns. A National Audubon Society report, which looks at bird migration between 1966 and 2006, indicates that many bird species are shifting their wintering grounds northward an average of 35 miles, with some individual species, the American Robin for instance, remaining several hundred miles north of its historical wintering grounds. This is certainly a "canary in the coal mine" indication that changes are taking place in our environment.

Barn Owlet

Why is Jamaica Bay such a critical bird habitat?

The question of Jamaica Bay's importance to migrating and breeding birds can't be overstated. Jamaica Bay Wildlife Refuge is of global importance as a stopover for migrating birds on the ***Atlantic Flyway***, a migratory route defined as the area along the Atlantic coast and east of the Appalachian Mountains. Birds migrating from South and Central America need the food, water and habitats at the refuge. More than 325 species of birds have been seen at Jamaica Bay over the past 25 years.

According to the National Audubon Society, "The Atlantic Flyway is a super highway in the sky! From South America to Canada, it handles hundreds of species of birds and millions of individuals during any single migration season. The heaviest traffic is at night, and rush hour can last for weeks.

"There are literally tens of thousands of exits and rest stops along the Flyway, all leading to the same

thing: natural habitat that suits the needs of specific species for refueling or breeding. In the United States, on the eastern seaboard, human populations are dense. We compete with birds for space in almost every possible type of habitat required by a startling diversity of bird species."

The refuge's location is quite remarkable. It is surrounded by New York City, with a population of 8 million people, and it is within the New York Metropolitan Area, which is home to some 19 million people.

The refuge's location on the Hudson River ***estuary*** is important for migratory birds. An estuary is where the fresh water from a river mixes with the salt water from the ocean. This creates a suitable habitat for plants and birds tolerant of briny, or salty, water. At Jamaica Bay, diamondback terrapins, horseshoe crabs and shorebirds rely on the salt marsh and mudflats.

In addition to the estuary, the Jamaica Bay Wildlife Refuge also has other important habitats including: ***woodlands*** defined by trees and shrubs; ***meadows*** with grasses and other non-woody plants; and two ***fresh water ponds***, which support a host of wetland plant and animal life. While the estuary is important for shorebirds, these other habitats provide food, breeding grounds and rest for species with other needs. The woodland, for example, provides habitat for the American robin, sparrows and chickadees. Its two ponds provide habitat for ducks, herons and egrets. And, finally, the meadow habitat provides for wrens and finches among others.

Fall at the Wildlife Refuge

Pre-visit Activities

Pre-visit: Our goal with the pre-visit lessons is to excite students about bird migration by establishing a relationship between students and a bird species that they will likely see on their field trip. We also want to provide them with an understanding of how to identify bird features so they can return to the classroom and be able to key out a bird that they might not have studied prior to the field trip.

The pre-visit activities focus on short lessons critical to understanding their wildlife refuge experience:

1. website mapping activity
2. bird identification sheets created in class to be used at the refuge on the field trip
3. Vocabulary

Aquatic	Estuary	Invasive plant
Adaptation	Marine	Native plant
Coast	Meadow	Phenology
Coastal Upland	Refuge	Phenophase
Ecosystem	Pond	Woodland

Website / Mapping Activity

Group Size

When completed, teachers can use this as a whole class activity or have students view it on their own time.

Materials

Computer and Internet Access Map of Jamaica Bay Wildlife Refuge found on www.nps.gov/gate

As a non-tech approach (for schools with limited access to technology) we can provide a hard copy map of Gateway NRA and Jamaica Bay, along with a map of the greater NYC metro area. We can also provide a DVD of the resources noted here.

Mapping Activity

Using Gateway NRA maps found on the website below
www.nps.gov/gate/planyourvisit/map_jbu.htm
www.nps.gov/gate/planyourvisit/google_earth_gate.htm

Locate the following features:

- Jamaica Bay
- Rulers Bar
- East Pond
- West Pond
- Big John's Pond
- Woodlands; North Garden, South Garden, East Garden

It might also be helpful to students to get the directions from their school to Jamaica Bay, get an idea of where the refuge is in relation to their location. Then they will have a sense of what it will take to "migrate" from their school to the field trip site. Depending on how they plan to arrive, they can research this by car, MTA, on foot, or by bike.

What is a wildlife refuge?

A wildlife refuge is a safe place for native plants, wildlife and their habitats. What is remarkable about Jamaica Bay Wildlife Refuge is its significance as a safe haven for wildlife, within the largest city in the US. That it protects a rich biodiversity is remarkable, given its urban surrounding. At the same time, the refuge resources are fragile and human impact has and continues to make its mark. For birds, the refuge's prime location on the Atlantic Flyway, its natural habitats, and the fact that the refuge is surrounded by human development makes it a vital resting, feeding and nesting area.

NY Department of Information Technology and Telecommunications (NYDoITT)

This is a terrific tool for showing students the changes in the marsh from 1924 to present day.

Go to: http://gis.nyc.gov/doitt/nycitymap/

Under "Search for Location," scroll down to "place of interest." Type in Jamaica Bay Wildlife Refuge", and provide "Queens" for the borough. When you are forwarded to this page, click on the camera icon. You will get a scroll bar that allows you to look at Jamaica

Bay from 1924 to present day.

Students can do the same with the overall city map, clicking on the camera icon to see the changes in all 5 boroughs over time. Since our students will be coming from all of the boroughs, it might be useful for them to see how their neighborhoods have changed in the past 87 years.

Multimedia

There are three wonderful short videos available on the Gateway National Recreation Area site, one that focus on birds, a second which looks at diamondback terrapins, and a third providing a look at how climate change threatens the marsh. These are all accessible at:

- www.nps.gov/gate/photosmultimedia/jamaica-bay-videos.htm
- Video (or DVD) with ranger Dave Taft
- www.nyharborparks.org/visit/jaba.html
- Also, Jamaica Bay: Wilderness on the Edge www.nytimes.com/2011/07/31/nyregion/jamaica-bay-a-wild-place-on-the-edge-of-change.html?pagewanted=all

For those schools without technology options, we can provide a DVD with all of these videos on them. Most teachers have a computer that they can bring to their classrooms.

Diamondback Terrapin

Make Your Own Bird Identification Cards, and Make the Migration Connection

Goals

- Use bird study to make the global connection
- Use students' bird pages to create a field guide for Jamaica Bay Wildlife Refuge, which can be used onsite during the field trip.

Materials

- Common Birds of Jamaica Bay Wildlife Refuge Through the Seasons
- Access to the Internet or access to a printed field guide.
- Field Guide template for students to complete.
- Markers (purple, orange, yellow, blue) so students can mark their bird's range.

Time

Class period, or as a homework assignment with a report to class the following day.

Background

While we humans have lines on maps, indicating what belongs to us (our state and country and what belongs to others (Canada, Mexico, Central America, for instance), migratory birds don't recognize political boundaries. What is critical to them is availability of food for refueling, water and habitat for resting on their way. So when we refer to the migratory birds at Jamaica Bay Wildlife Refuge as ours, we can only claim them for a short time before they are headed elsewhere. By studying birds, we really have an opportunity to study geography and social studies. We also have to take into account the issues of habitat use to the north and south. What happens in Costa Rica or Belize or Mexico or Canada is really important to understand the health/stability of our bird populations.

Create a Bird ID card

This activity is designed to help each student become an expert on at least on bird that could be seen on your visit. This is a key activity that needs to completed before your field trip.
Each student will create a "Bird Identification Card" to be brought to JBWR on the day of your visit. The classes cards will collectively be used to help identify the birds you see.

- Step 1: Find the list of birds that correspond to the season when you will be visiting.
- Step 2: Assign the birds from the different habitats to the students for them to research. *Please note: When you arrive at the Refuge your students should be divided into four groups according to the habitat in which their birds can be found. An attempt should be made to make the groups as equal in number as possible and research all the birds in each season.*
- Step 3: Students research their birds using the sites provided and any other resources available. The information will be recorded on the Bird Identification Card provided. Please include a detailed sketch or photo of the bird. Range information will be indicated on the map that is also provided.
- Step 4: Remember to bring the cards to the field trip. *Optional: The bird identification cards could be used to make a complete field guide which could then be photocopied for each student.* Also, if there are more students than birds or students wish to research more than one bird, students could look at the preceding or following season for birds to research as there could be some overlap.

Create a field guide (using your bird identification cards)

- This is a key activity in advance of your trip to the wildlife refuge. Your students will need to complete the following:
- Each student needs to come to the refuge with field guides for ***two of the birds*** at the refuge. These need to include references to the ***habitat*** where they will likely find their bird.
- Students have studied the ***invasive plant*** species so they can identify those when they are at the refuge. Species they will likely see will be provided in the appendix to this module.
- It's probable that they will see birds that they haven't studied as well. It will be important for them to make some key field observations so they can return to the classroom and use the Cornell site to identify these birds.

When your students are ready to conduct their research, assign them to research the birds they will likely find at Jamaica Bay during your field trip ***(see the list below)*** and have them begin their field guide to Jamaica Bay Wildlife Refuge. We suggest looking at the key species they will definitely find and then have students create field guide pages for other birds they might find at the refuge.

Using the list of common birds of Jamaica Bay Wildlife Refuge, students can help us create a "field guide" of the birds they will possibly encounter on their visit to the refuge. Remember to provide your students with the list of birds for the season they will be visiting the refuge.

Once they've completed this list, if you have additional time, you might have them select one of the other birds from the list of birds common to Jamaica Bay Wildlife Refuge.

Common Birds of the Jamaica Bay Wildlife Refuge Through the Seasons

FALL

Salt Marsh Bay: Canada goose, Brant Goose, ring-billed gull

Meadow: American crow, Northern Mockingbird, Brant, Mockingbird

Woodland: Yellow-rumped warbler, American Robin, Northern Cardinal, American crow

Pond: Canada goose, Great Blue Heron, Double-crested cormorant, black duck, Northern Cardinal, cedar waxwing

WINTER

Salt Marsh Bay: Greater Black-backed gull, ring-billed gull, herring gull, bufflehead

Meadow: northern mockingbird, house finch, American crow, northern harrier

Woodland: Northern Cardinal, dark eyed Junco, American Crow, Black Capped Chickadee

Pond: Brant, Canada goose, Black Duck, Mallard, Snow Goose

SPRING

Salt Marsh/Bay: Osprey, red-winged blackbird, herring gull, oystercatcher, tree swallow

Meadow: tree swallow, red- winged blackbird, yellow warbler, house finch, northern mockingbird, house wren

Woodland: American robin, rufus-sided towhee, northern cardinal, American crow, yellow-rumped warbler

Pond: hooded merganser, Canada goose, northern shoveler, great or snowy egret.

SUMMER

Salt Marsh/Bay: Red-winged blackbird, laughing gull, herring gull, snowy egret, Willets, yellow legs, semi-palmated plover

Meadow: American goldfinch, northern mockingbird, tree swallow, yellow warbler

Woodland: Gray catbird, American redstart, Carolina wren, American robin

Pond: Mute swan, black-crowned heron, lesser yellowlegs, marsh wren, tree swallow

Note: If your school doesn't provide access to computers for students, we will provide you with a packet of all the materials you will need to complete this project.

Questions for students to answer

- Does your bird migrate or is it a year round inhabitant of Jamaica Bay?
- Where does it winter? If it winters in another country, or in another part of the United States, find out more about its winter habitat. Are there any environmental stressors of concern?

Laughing Gulls

- Where does your bird spend its summers? What is happening in its summer grounds?
- In which Jamaica Bay habitat would you likely find your bird?
- What is its diet at the refuge? On what other organisms, plant or animal, does it depend upon at Jamaica Bay?

Jamaica Bay Bird Data

Birders use this site to record their bird observations at Jamaica Bay. To access this site, go to: ebird.org, which is part of the Cornell Ornithology lab.

From here, there are **two ways to look at data.**

The first is by bird, date and location of sighting.
Click on: explore data then click on line Chart.
Input your species.
To change date range, click on change date.
In the upper right, type in Jamaica Bay Wildlife Refuge.

Recent sightings are in orange; past sightings in blue.

The second way is by bar graph. You can return to the View and Explore Data. Click on the bar chart, which provides you with a look at which birds are observed and when they have been seen. When you click on this, you will again be taken to a page to decide a region and sub-region. Scroll down to New York and then click on hotspots. From here, you will get an alphabetical list of locations. Go to Jamaica Bay Wildlife Refuge and click on this. You can choose to link to one of the habitats but you might want to look at the big picture at the refuge. When you get to this page, you might want to narrow down the years to this past one or even a 5-year span.

Once you get back to your classroom after the field trip, you can submit your students' data to the Cornell ebird site. Their observations can become part of these records kept by Cornell.

Piping plovers

Bird Identification Card

Common Name:

Scientific Classification:

Diet:

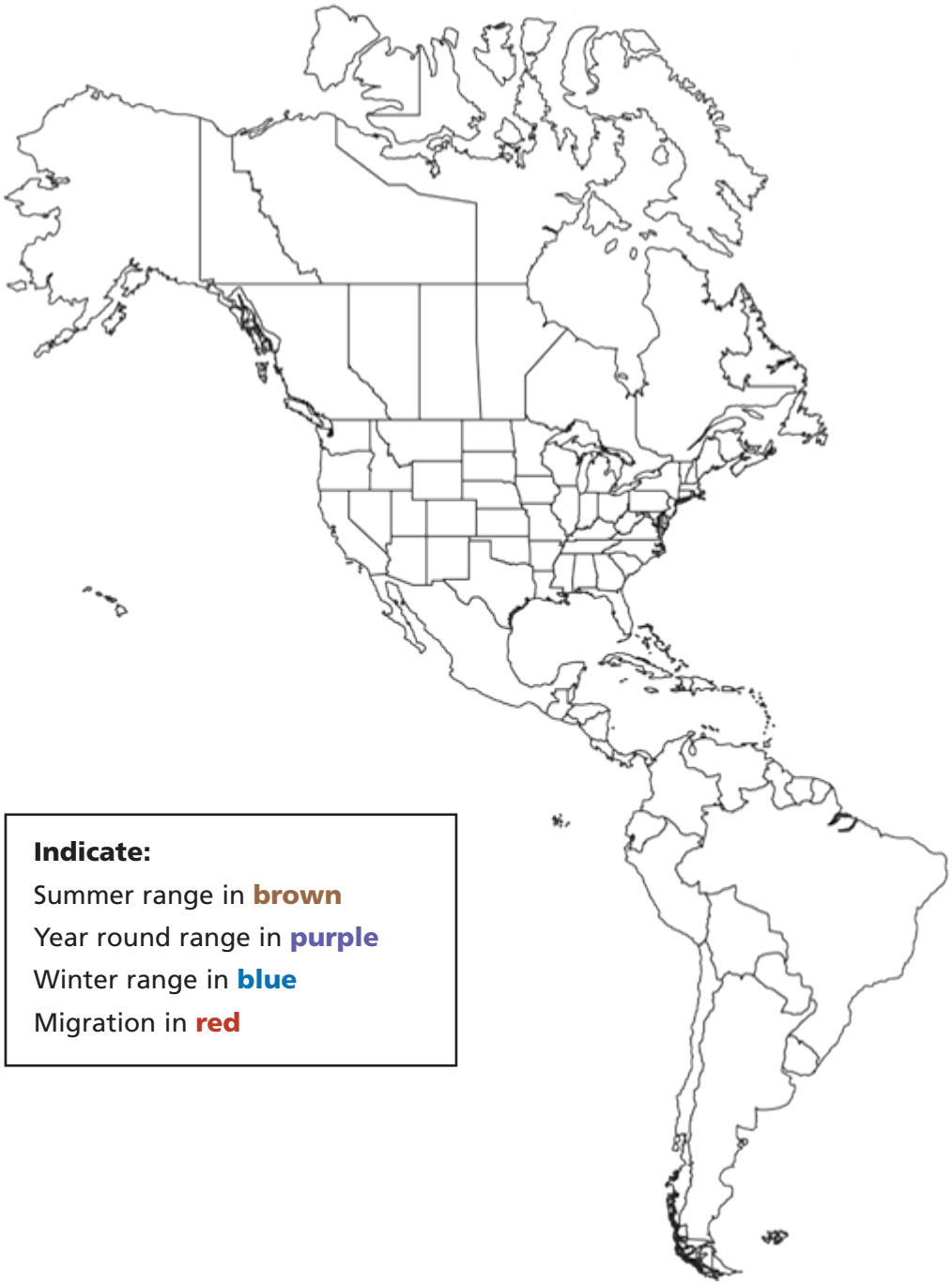
Nesting:

Habitat where it would likely be found at the refuge:

Name of bird:

Sketch of bird

Map of the Americas: Plotting the Migratory Route for Your Bird



Indicate:

Summer range in **brown**

Year round range in **purple**

Winter range in **blue**

Migration in **red**

Field Study at Jamaica Bay Wildlife Refuge

Applying Classroom Lessons at Jamaica Bay

Goal

To introduce students to the habitats that comprise the Jamaica Bay Ecosystem and to the features of each habitat which make it a vital stop for migratory birds.

Time

90 minutes to 2 hours

Materials

- Students should bring the materials they created at school.
- Materials will be provided at the refuge. These include: maps, data sheets, and binoculars. We encourage students or teachers to use their cameras to take pictures during the field trip.

Note: Teachers can post feedback on their field trip on the Gateway NRA Facebook page.

Group Size

Students can be divided into their Jamaica Bay Wildlife Refuge field guide (habitat) groupings. Students will be divided into four groups. Two groups will be near each other at stops 4 & 5 on the trail; with one group observing the West Pont and the other group observing birds our along the South Marsh area. A third group will be in the south garden area and a fourth group will be observing the meadow behind the visitor center.

Depending on the availability of rangers and chaperones, students may head over to the east pond to make observations as well.

At the designated habitats, students will fill out their data sheets.

1. Record initial observations on weather, time of day, temperature. During field trip, students should take photos to use later.
2. List the different types of birds they see in that habitat. If they know the names of the species, that would be great. This is a good time for students to use their field guide pages to identify birds at the refuge. If they can't identify a species, they can take photos and use these to later key out their birds using a field guide back in the classroom
3. Observe and note bird behavior. What are the birds doing? Are they eating, flying, and diving down, for example?
4. In addition to birds note any other animals present (squirrels, turtles, snakes, earthworms, clam shells, bird nests, bird nesting boxes, bat boxes).
5. Describe the plants in your habitat. You can take pictures, but might also want to describe them. Are they trees or shrubs? Are they blooming? What do the blossoms look like? Do you see any birds feeding on the plants? Are they native of invasive plants (see the appendix for images of the key invasive plants at the refuge.
6. If time permits, have the class gather together and have the "experts" for each of the habitats provide a brief tour of their habitat to the other groups. It would be interesting to know if the birds the students learned about in the classroom were observed at the refuge.
7. You might have students report on their experience via the Gateway National Recreation Area Facebook page.

Jamaica Bay Wildlife Refuge Field Study Data Sheet

Group Name:

Lat/Long:

Date and Time:

Today's Weather	Yesterday's Weather
Temperature:	Temperature:
Precipitation:	Precipitation:
Cloud Cover:	Cloud Cover:

Description of where the tide is in its cycle:

Description of habitat (woodland, meadow, marsh, pond):

Sketch of habitat:

Notes:

Description of plants in study area:

Bird species

If you don't know the species, make some observations (size, silhouette, color markings). When you get back to school, you can do research to identify the bird you've seen:

Describe your bird's behavior: (diving, perching, eating):

In the space provided, or on the back of this sheet, provide a quick field sketch of the species.

Mark your park map with the location of the birds in your field area. If there is more than one of a species, note that as well.

The rangers have provided you with a camera for use at the refuge today. Please take pictures of your field area, to use as reference back at school.

Wildlife in your field study area: what other animals, or signs of animals, are present in your field area (squirrels, turtles, snakes, earthworms, clam shells, bird nests, bird nesting boxes, bat boxes)?

Post Field Study

Post Visit Essay

So, how will climate change impact birds in general, and specifically, birds that visit Jamaica Bay Wildlife Refuge?

Aquatic Ecosystems

Jamaica Bay has several aquatic habitats: fresh water ponds, salt marsh and intertidal mud flats. Each of these is critical for different plant and animal species.

According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1° F. in the past century, with faster warming in the last several decades. This may not seem like a big deal, but the impacts are observable. A study from Columbia University, of Jamaica Bay, notes that sea level from 1932 to the present has increased by 3.9 cm per decade. This indicates that the rate of sea level rise will nearly double in the 21st century. Even a tiny increase per decade adds up over time. Another concern is that intense storms will cause erosion and a breach in the ponds could change the fresh water pond to salt.

With sea level rising, one of the concerns at Jamaica Bay is whether salt marsh plants and animals can adapt quickly, in evolutionary term, to the inundation of water. In its natural state, a marsh continues to recede into the land and thrive. However, with hard surfaces surrounding the marsh (like neighborhoods and roads) the marsh doesn't have any place to go. Some species, like the horseshoe crab, are dependent on the salt marsh. If less of the intertidal environment is available, what will this do to the sustainability of critical species?

In addition to rising water level, changes in temperature will have an impact on the sustainability of aquatic species. Temperature-dependent sex determination means that the sex of an animal, like Jamaica Bay's diamondback terrapin, is determined by temperature during incubation (the thermosensitive period) rather than at the time of fertilization. In diamondback terrapins, for example, higher nest temperatures produce more females; lower temperatures more males. The imbalance could impact the sustainability of this species, if they can't find a mate because they are all the same gender.

Food

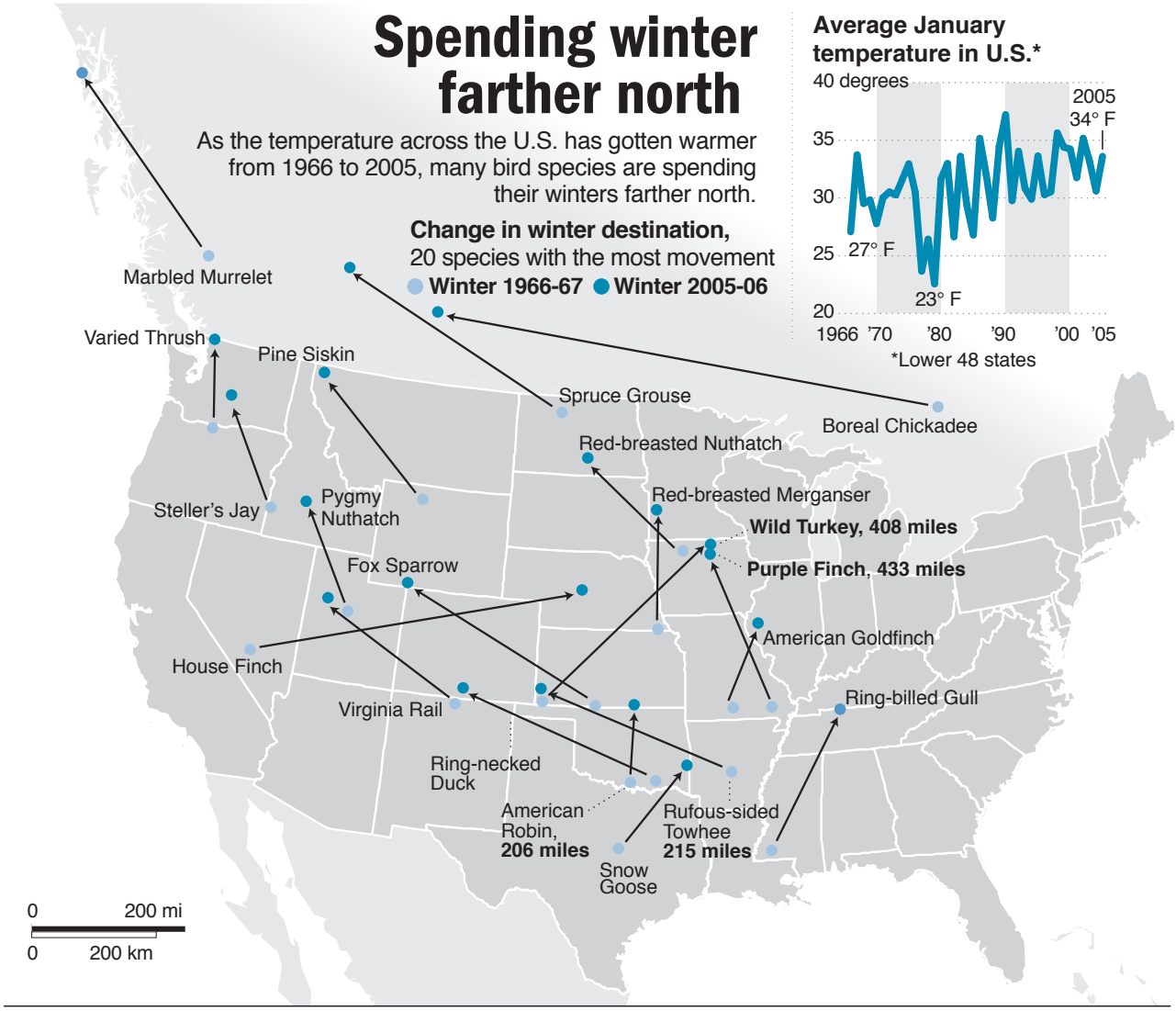
Timing is a matter of life and death in nature. Timing of migration and availability of food are critically interconnected, since migratory species need to arrive when food is abundant. Scientists refer to this as phenology, a word derived from the Greek words phainos, meaning, "to appear, to come into view" and logos, meaning, "to study." Basically, phenology is the study of plant and animal life cycle events throughout the seasons and over time. In the case of flowering plants, these life cycle events, or phenophases, include leaf budburst, first flower, last flower, first ripe fruit, and leaf shedding, among others. Phenophases observed in animals include molting, mating, egg-laying or birthing, fledging, emergence from hibernation, and migration. Birds that migrate early or later, may risk arriving before their food source (insects and nectar, for example) are available. For both the early and late migrations, there may be less food available (insects, nectar, etc.) by the time the birds arrive in the spring, this would impact the species' ability to complete their flight.

If, for example, the return of spring migrating shore birds, like the herring, laughing and black back gulls, is out-of-synch with the horseshoe crab egg laying, birds will be severely impacted. Gulls, and a number of other shorebird species, are heavily dependent on the crab eggs as a critical food source.

Habitat

We touched on some habitat issues above. With the increase in water level, habitat for plant and animal species depending on the salt marsh and mud flats will likely find themselves competing for less space.

Warmer temperatures are also creating a change in the wintering habits of a number of bird species. The National Audubon Society, which has been conducting a Christmas Bird Count since 1900, recently produced a map showing the change in winter destinations for 20 species. The American Robin, a common backyard species, is currently wintering 206 miles north of where its northern range was 40 years ago.



SOURCES: Audubon Society; NOAA AP

Additional Resources: Audubon Birds and Climate Change:
http://birds.audubon.org/sites/default/files/documents/birds_and_climate_report.pdf
EPA Climate Change and Ecosystems:
www.epa.gov/climatechange/downloads/Climate_Change_Ecosystems.pdf
Intergovernmental Panel on Climate Change: www.ipcc.ch/

A "Growing" Growing Season

Goal

To illustrate the concept of phenology by plotting frost dates.

Materials

- Frost dates for Central Park
- Formula for converting dates to days of the year, suitable for creating a graph.

In addition to the graphs here, an attachment provides the raw data so students can practice graphing the information for themselves.

Class Size

Individually or in small groups

Time

Class Period

Background

Timing is critical for migrating birds. If they arrive too soon, they risk not having enough food to continue their migration. If they arrive too late, the same fate awaits them. While we humans don't notice the earth warming, at least not on a daily basis, plants respond to the gradual warming by beginning their growing season earlier.

The concern for migrating birds is that their arrival might not coincide with the time when food is most abundant. So, they might not have enough fuel to complete their migration.

In this activity, students can plot frost dates and create a trend line to see the lengthening of the growing season.

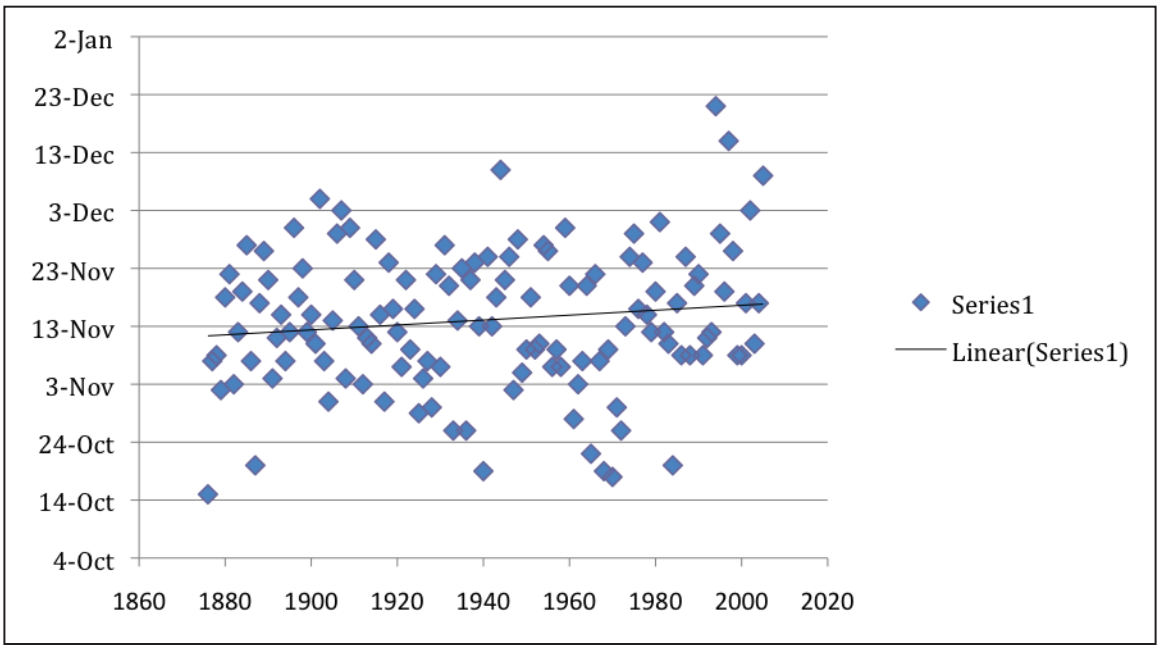
Questions for Students

- How might a longer growing season impact the plants and animals at Jamaica Bay?
- How else might you apply this data? Is it possible to make some predictions about future climate from the data? Why or why not?

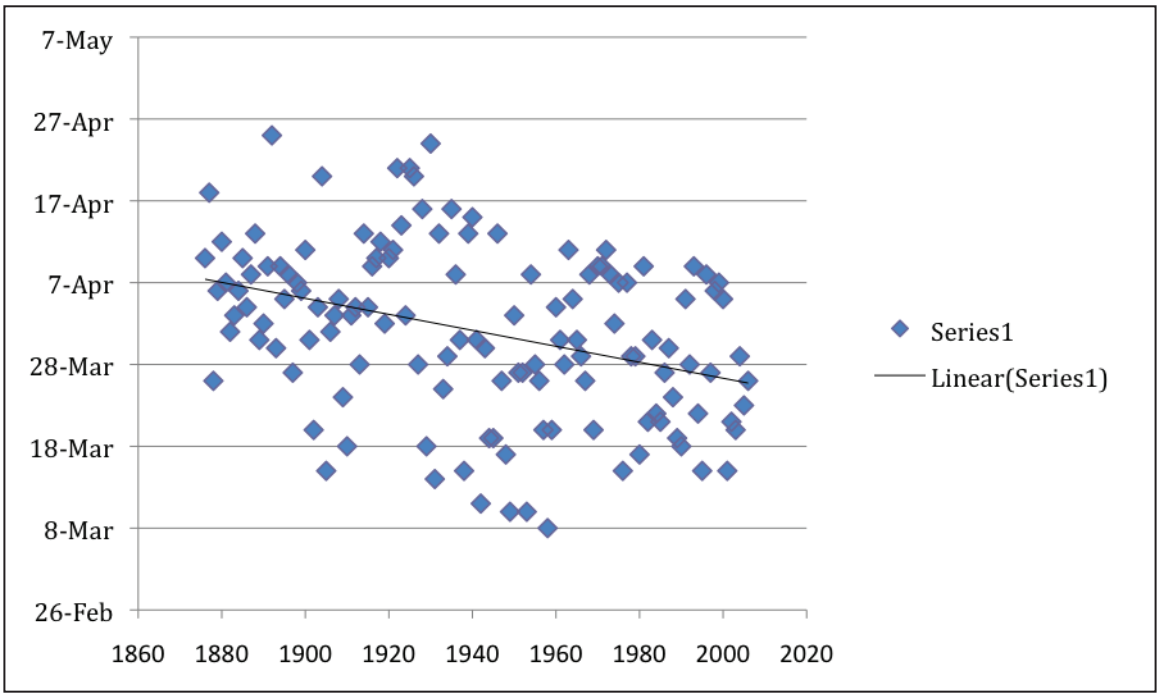
Additional Teacher Resources:

USA Phenology Network: www.usanpn.org/
Mid-Atlantic Phenology Network: http://www.mapseasons.net/

Snow Bunting



First frost date for Central Park, NYC; the recording period is 10 November 1886
Our first average frost date at the end of the recording period is 17 November 2005



Frost date for Central Park, NYC; the average at the beginning of the recording period is 10 April 1886
Our last frost date average at the end of the recording period is 26 March 2006

Optional Post Activities

Preserving the Refuge for Future

Goal

To provide a culminating activity which presents students with climate change scenarios to address. How do we maintain Jamaica Bay as a critical place for birds, in light of the challenges of climate change? Referring back to the frost date charts and the organism you researched for the field guide, insert dates of migration, other life events on the chart, then argue specifically for how your bird will be impacted by the lengthening growing season.

Materials

Variable, depending on how you and your students want to approach this activity. We'd love to see a vodcast or photography, listen to a podcast or see a public service campaign designed by students.

Extensions

- Create a blog, or a poster, about what the habitats in the wildlife refuge would look like if seawater flooded over the trails, and how this would effect bird migration.
- What would you do, as the Herb Johnson of the future, if you managed the wildlife refuge?
- Start a sustainability project at your school, to reduce your impact on the environment. This could include white paper recycling, using reusable water bottles, and promoting trash free lunches.
- What does your family do now to reduce, reuse and recycle?
- Share textbooks, recycle paper or bottles, Styrofoam, compost, reduce chemicals.
- Pick up litter around school grounds or nearby park.
- Spend one hour a day with all electronic devices off (no TV, computer, or iPod). Better yet, go outside.

Take Action!

Climate Change In Your Daily Life: Doing Your Part

While the problems of climate change are bigger than one person, there are many simple actions you can take beginning now to reduce your impact on the planet. Each person, doing his or her own part, combined with others doing their part can make a big difference. Mahatma Gandhi, an Indian philosopher said, "Be the change you want to see in the world."

- Restore habitat – The National Park Service welcomes volunteer efforts on many of its projects. For more information on volunteering in parks, visit nps.gov/getinvolved/volunteer.htm
- Be a citizen scientist. You can provide data for wildlife research projects. These include:

Phenology: Project Bud Burst http://neoninc.org/budburst/

Christmas Bird Count: http://birds.audubon.org/christmas-bird-count

The Great Backyard Bird Count: www.birdsource.org/gbbc/

Project Feeder Watch: www.birds.cornell.edu/pfw/

Nest Watch: http://watch.birds.cornell.edu/nest/home/index

Project Noah: www.projectnoah.org/

History

Jamaica Bay's geography has been determined largely by the glaciers that intermittently covered our region between 1.5 million and ten thousand years ago, and the melt waters and outwash that formed much of southern Queens and Brooklyn. Wind, wave, tide and creeks have been dynamic forces which continually sculpt the ever-changing borders and the shape of Jamaica Bay.

The retreat of the glaciers coincides with the oldest dated remains of Native Americans in this area. The Lenape Indians dwelled around Jamaica Bay where they hunted, fished and collected wild grains and fruits. Starting approximately 1,000 B.C. they began cultivating maize, beans and squash.

Dutch settlers arrived in New Amsterdam in the 1600s. They traded with the Lenape and learned much about hunting, fishing and farming from them. The Dutch and other European settlers eventually gained dominance over the land.

The nineteenth century witnessed a period of rapid growth in New York City as population and industry expanded. In order to accommodate this development, much of the marshland in and around Jamaica Bay was drained and filled through the 1950s. The bottom of the bay was dredged for fill, or to create channels for water-borne transportation.

Robert Moses, Commissioner of Parks for New York City, realized the great loss of resources that accompanied the destruction of the bay and sought a plan to arrest the dangerous trend. In 1950, the city adopted his proposal to develop five parks around the bay and the Jamaica Bay Wildlife Refuge was established. Shortly thereafter, plans were put in motion to improve the area and create additional habitat for the diverse wildlife population.

In 1953, the New York City Transit Authority sought permission from Commissioner Moses to build an embankment for the IND train track across Jamaica Bay. Moses granted the permit with the stipulation that the Transit Authority construct a series of dikes or impoundments that would prevent the flow of tidal waters behind them. Rain water filled these natural low lying areas, the results of which became the 45 acre West Pond and the 120 acre East Pond.

Material was dredged from the bay to create additional upland landmasses. These areas, as well as the early dikes, were then planted with vegetation that would stabilize the new soils, as well as provide important food, cover and nesting areas for wildlife.

Much of the early work was accomplished by a small crew of workers headed by Herbert Johnson, the first manager of the Jamaica Bay Wildlife Refuge. He spearheaded the plans for habitat improvement, developed an environmental education program for urban school children and created a trail system for the enjoyment of the visiting public.

Robert Moses, Commissioner of Parks for New York City, realized the great loss of resources that accompanied the destruction of the bay and sought a plan to arrest the dangerous trend.

On October 27, 1972, the United States Congress authorized the National Park Service to accept donations of land from New York and New Jersey to establish Gateway National Recreation Area. One of these acquisitions included the Jamaica Bay Wildlife Refuge. Today the refuge's 9,155 acres of salt marsh, open bay, freshwater ponds and uplands provide safe haven for marine life, small mammals, reptiles, amphibians and over 325 species of birds.

Habitats At Jamaica Bay Wildlife Refuge

Meadows

Definition

Higher ground not subject to marine tides or standing water, often characterized by the presence of woody plant species and other vegetation.

Ecological Importance

The fruits, buds, leaves and stems of upland plants provide food for a wide variety of insects, birds and mammals. Thick vegetation offers cover from predators as well as nesting sites and shelter for all forms of wildlife. The deciduous nature of many woody plants leads to the annual input of organic matter into the soil each autumn, in the form of detritus. This detritus is fed upon and broken down by fungi and soil organisms and, through time builds a topsoil of moist, nutrient rich humus.

Through the years, uplands go through the process of natural succession as pioneer plants that require strong sunlight and do well in poor soils get replaced by more competitive, shade-tolerant species that thrive in moist, rich environments. Through evaporation and transpiration, woodland communities supply significant amounts of moisture to the atmosphere and moderate the local climate. As a by-product of photosynthesis, the oxygen given off by green plants is important to most animal life on earth.

Meadow Plants

Here at the refuge, the upland plants include species that were planted to provide food and cover for wildlife as well as naturally occurring early successional species. Original tree plantings of autumn olive, Japanese black pine, European alder, willow oak, red maple, red cedar, American holly and cottonwood still persist. Some of these, particularly species native to the area like American holly and red cedar, are successfully reproducing and saplings can be found throughout the upland community. Gray birch, black cherry and pussy willow, native early successional woodland species, have appeared here on their own, without the help of humans. In addition to trees, a variety of woody shrubs and vines can be found in the uplands including poison ivy, bayberry, European buckthorn, winged sumac, multi-flora rose, Virginia creeper, Japanese honeysuckle and oriental bittersweet. Wildflowers, ferns and grasses are also common.

Meadow Animals

During spring, the uplands brim with activity as migrant warblers, vireos and tanagers touch down to glean insects from the tree limbs before continuing their northbound journeys, and resident songbirds begin their breeding and nesting season. Squirrels make their leafy nests high in the trees and chipmunks can occasionally be seen scurrying across the trail as they forage for food.

Box turtles, snakes, tree frogs, though well hidden, are common upland residents, as are earthworms, other soil invertebrates, and a host of insects from beetles to fireflies. Songbirds such as mockingbirds, mourning doves and robins feed off the fleshy fruits of meadow plants. Finches, sparrows and nuthatches prefer the dry fruits and seeds of birch, alder, pine and many herbaceous plants. During the autumn migration, woodland hawks hunt small birds and mammals in the uplands. In winter, the evergreen pines and cedars offer important cover for many wildlife species and superb roosting areas for owls.

Curious Gray Tree Frog

The Salt Marsh

Definition

The land and water behind the barrier beach at the edge of the bay, subject to the rise and fall of the tides.

Ecological Importance

Salt marshes are one of the most productive natural habitats in the world. Several factors contribute to this great productivity, but the lion's share comes from the perennial grasses that dominate the salt marsh landscape. Each autumn, when the salt marsh grasses die back to the root stocks, a tremendous amount of biomass in the form of organic matter (detritus) is released into the tidal wetlands. This detritus is fed upon and broken down by many organisms, which in turn become food for others, and so on, all the way up to the top of the food chain. In addition, with each ebb and flow of the tide, organic matter produced in the salt marsh enters the open bay and eventually the ocean. From zooplankton and small marine invertebrates to shellfish, finfish and eventually top predators, the salt marsh grasses form the basis of a complex marine food web.

The extensive root systems and stems of salt marsh grasses trap sediments, debris and other runoff pollutants before they have a chance to enter the open bay. In urban areas, where airports, landfills and sewage treatment facilities are often located at the water's edge, this cleansing role of salt marshes is critical to the health of the bay. Salt marshes are also important buffers to the mainland that they fringe. By absorbing wave energy, they help control coastal erosion and are the first defense against coastal storms.

Salt Marsh Plants

The dominant plant species in this habitat are the perennial salt marsh grasses, salt marsh cordgrass and salt marsh hay. Salt marsh cordgrass grows closest to the open bay, at the lowest elevations of the marsh, and is subsequently inundated with saltwater during most high tides. Salt marsh hay grows on slightly higher ground, further back from the open water and is inundated only during extreme high tides associated with storms and full moons. Other salt marsh plants include black rush, spike grass, sea lavender and glasswort. The non-native, invasive,Phragmites is common to salt marshes where natural elevation gradients have been disturbed due to dredging or other factors.

Salt marsh plants have few competitors among terrestrial plant communities. Most plants cannot tolerate the extremes of salinity and drought experienced by salt marsh plants, which are caused by the alternate flooding and receding of tidal waters. At high tide the salt marsh plants are flooded with saltwater, at low tide they are exposed to the drying effects of the sun, as well as fresh water in the form of rain.

Just upland from the salt marsh we find plants tolerant of sandy soils, full sun and salt spray. These include groundsel, bayberry, salt-spray rose, beach grass and seaside goldenrod.

Spawning Horseshoe Crabs, Plumb Beach

Salt Marsh Animals

The fertile, protected waters of salt marshes provide spawning sites and nursery grounds for many marine animals including bluefish, striped bass, flounder and other commercially important finfish. Atlantic silverside and killifish feed on the abundant algae and small invertebrates found in the salt marsh. Salt marsh mosquitoes and green head flies begin their lives in the marsh, as do grass shrimp, fiddler crabs, periwinkle snails and ribbed mussels. During late spring, horseshoe crabs move into the shallows and shorelines of the salt marsh to mate and lay eggs. Tree swallows hunt mosquitoes and other flying insects on the wing. Egrets and herons stalk fish in the shallow

waters, while glossy ibis, sandpipers and plovers probe the mudflats for invertebrates. Osprey nest upon man-made platforms at several locations on Jamaica Bay salt marshes and occasionally they can be seen hunting fish. Gulls are abundant year-round. During spring and summer, red-winged blackbirds, song sparrows and common yellowthroat warblers can be heard calling from the upper reaches of the salt marsh. During the winter months, salt marshes proved food and shelter for thousands of ducks and geese.

The Ponds

Definition

The ponds at the Jamaica Bay Wildlife Refuge differ from many you may know in several significant ways. For one, both the East and West Ponds are slightly salty or "brackish." For another, they are man-made, created under the auspices of Robert Moses in the 1950s. The West Pond measures 45 acres with an average depth of 4 feet. The East Pond is less salty than the West Pond. It measures approximately 120 acres and, in some areas, is almost 20 feet deep.

History and Ecological Significance

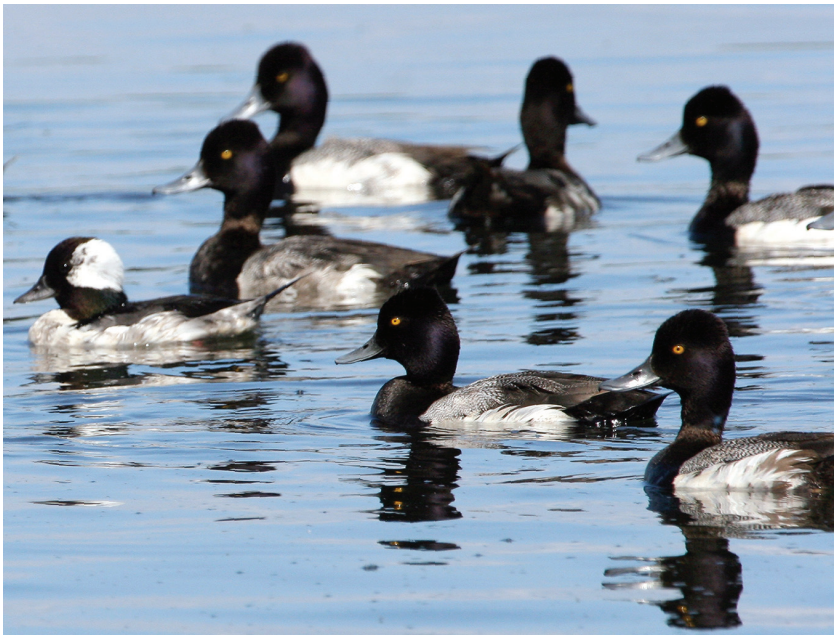
Both the East and West Ponds were created in the early 1950s by banking up sandy materials from the bottom of Jamaica Bay. This proved to be one of the most important changes that occurred on Rulers Bar Hassock, the island where the Jamaica Bay Wildlife Refuge is located. Before the ponds were created approximately 60 species of birds could be found on the island while presently over 325 species have been observed. Many amphibians, reptiles and mammals also depend upon the ready availability of fresh water that the ponds afford. In 1982 a third, smaller pond was dredged on the east side of Cross Bay Boulevard. This pond, known as Big John's Pond, contains the freshest water of all three ponds.

Pond Plants

Within the ponds themselves simple plants known as algae grow in thick mats, but only Big John's pond contains vascular aquatic plants such as elodia, or emergent plants such as arrow arum. A common plant bordering all of the refuge ponds, often in dense stands, is the tall reed grass, phragmites. This hardy, salt-tolerant and frequently invasive grass can grow to almost 20 feet tall. Further landward from the pond edges, grasses such as little bluestem and American beach grass dominate. Bayberry and wild black cherry are common in patches bordering the grassy areas.

Pond Animals

Several species of finfish call the ponds home. Most notably killifish and white perch adapt well to life in brackish water, white perch may reach lengths of 16 inches. Birds of all varieties use the ponds for bathing and drinking. Waterfowl such as black ducks and Canada geese feed on plants in or near the pond edges. Wading birds such as great blue herons and snowy egrets are also regularly observed as they feed upon small fish. Primarily nocturnal, mammals also make use of the ponds for feeding and grooming. Raccoons are common visitors overnight, and in the evenings and early mornings, muskrats play the pond edges looking for new shoots of grass and buds. Common reptiles in the ponds include the eastern painted turtle and snapping turtle.



Bufflehead and Greater Scaup

Invasive Flora

Warmer temperatures also favor invasive plant species. Invasive species are those that have been introduced into an ecosystem from elsewhere in the world. While it's tempting to think that every green living thing is good, plants that have been introduced from other parts of the globe pose a serious threat to our native plant and insect species. Invasives are plants out of place that typically have no natural biological controls so they easily spread and take over a habitat, often choking out native species that have a higher food value for local insects, birds and mammals. As a result, if high food value insects like caterpillars (which have evolved to prefer specific plants in their habitat), are unable to find enough food to sustain their population, they will disappear from the landscape here at Jamaica Bay. Without these high protein meals, bird species that depend on these insects for their survival are impacted pretty quickly.

Yellow Starthistle

Fire Tree

Musk Thistle

Garlic Mustard

Purple Loosestrife

Japanese Stiltgrass

City and State Standards Met by the Program

Common Core Standards

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12

1. Writes arguments focused on discipline-specific content.
2. Writes informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
6. Uses technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.
7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
8. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis reflection, and research.

Reading Standards for Literacy in Science and Technical Subjects 6-12

1. Cite specific textual evidence to support analysis of science and technical texts.
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Reading Standards for Literacy in History/Social Studies 6-12

1. Cite specific textual evidence to support analysis of primary and secondary sources.

High School Math

Interpreting Categorical and Quantitative data S-Id
Summarize, represent, and interpret data on a single count or measurement variable

1. Represent data with plots on the real number line (dot plots, histograms, and box plots).
2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread of two or more different data sets.
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
    a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
    b. Informally assess the fit of a function by plotting and analyzing residuals.
    c. Fit a linear function for a scatter plot that suggests a linear association.
7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

New York State High School Level Science Core Curriculum

Standard 1: Scientific Inquiry and Analysis

1.1a Scientific explanations are built by combining evidence that can be observed with what people already know about the world.

1.1b Learning about the historical development of scientific concepts or about individuals who have contributed to scientific knowledge provides a better understanding of scientific inquiry and the relationship between science and society.

1.1c Science provides knowledge, but values are also essential to making effective and ethical decisions about the application of scientific knowledge.

1.2a Inquiry involves asking questions and locating, interpreting, and processing information from a variety of sources.

1.2b Inquiry involves making judgments about the reliability of the source and relevance of information.

1.3a Scientific explanations are accepted when they are consistent with experimental and observational evidence and when they lead to accurate predictions.

1.3b All scientific explanations are tentative and subject to change or improvement. Each new bit of evidence can create more questions than it answers. This leads to increasingly better understanding of how things work in the living world.

1.4a Well-accepted theories are ones that are supported by different kinds of scientific investigations often involving the contributions of individuals from different disciplines.

2.3a Hypotheses are predictions based upon both research and observation.

2.3b Hypotheses are widely used in science for determining what data to collect and as a guide for interpreting the data.

2.3c Development of a research plan for testing a hypothesis requires planning to avoid bias (e.g., repeated trials, large sample size, and objective data-collection techniques).

3.4b Claims should be questioned if the data are based on samples that are very small, biased, or inadequately controlled or if the conclusions are based on the faulty, incomplete, or misleading use of numbers.

3.4c Claims should be questioned if fact and opinion are intermingled, if adequate evidence is not cited, or if the conclusions do not follow logically from the evidence given.

Standard 4: Living Environment

1.1a Populations can be categorized by the function they serve. Food webs identify the relationships among producers, consumers, and decomposers carrying out either autotropic or heterotropic nutrition.

1.1b An ecosystem is shaped by the nonliving environment as well as its interacting species. The world contains a wide diversity of physical conditions, which creates a variety of environments.

1.1c In all environments, organisms compete for vital resources. The linked and changing interactions of populations and the environment compose the total ecosystem.

1.1d The interdependence of organisms in an established ecosystem often results in approximate stability over hundreds and thousands of years. For example, as one population increases, it is held in check by one or more environmental factors or another species.

1.1e Ecosystems, like many other complex systems, tend to show cyclic changes around a state of approximate equilibrium.

1.1f Every population is linked, directly or indirectly, with many others in an ecosystem. Disruptions in the numbers and types of species and environmental changes can upset ecosystem stability.

Standard 4: Earth Science

2.1i Seasonal changes can be explained using concepts of density and heat energy. These changes include the shifting of global temperature zones, the shifting of planetary wind and ocean current patterns, the occurrence of monsoons, hurricanes, flooding, and severe weather.

2.2c A location's climate is influenced by latitude, proximity to large bodies of water, ocean currents, prevailing winds, vegetative cover, elevation, and mountain ranges.

2.2d Temperature and precipitation patterns are altered by:

- natural events such as El Niño and volcanic eruptions
- human influences including deforestation, urbanization, and the production of greenhouse gases such as carbon dioxide and methane.

New York State Learning Standards for Mathematics, Science and Technology

Standard 1 – Analysis, Inquiry and Design (Intermediate)

Mathematical Analysis

3. The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

   Students:

   - design charts, tables, graphs and other representations of observations in conventional and creative ways to help them address their research question or hypothesis.
   - interpret the organized data to answer the research question or hypothesis and to gain insight into the problem.
   - modify their personal understanding of phenomena based on evaluation of their hypothesis.

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

   Students:

   - elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent their thinking.
   - hone ideas through reasoning, library research, and discussion with others, including experts.
   - work toward reconciling competing explanations; clarifying points of agreement and disagreement.
   - coordinate explanations at different levels of scale, points of focus, and degrees of complexity and specificity and recognize the need for such alternative representations of the natural world.

2. Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

   Students:

   - devise ways of making observations to test proposed explanations.
   - refine their research ideas through library investigations, including electronic information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion.
   - develop and present proposals including formal hypotheses to test their explanations, i.e., they predict what should be observed under specified conditions if the explanation is true.
   - carry out their research plan for testing explanations, including selecting and developing techniques, acquiring and building apparatus, and recording observations as necessary.

New York State Learning Standards for Mathematics, Science and Technology (continued)

Standard 1 – Analysis, Inquiry and Design (Commencement)

Mathematical Analysis

3. The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

   Students:

   - use various means of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data.
   - apply statistical analysis techniques when appropriate to test if chance alone explains the result.
   - assess correspondence between the predicted result contained in the hypothesis and the actual result and reach a conclusion as to whether or not the explanation on which the prediction was based is supported.
   - based on the results of the test and through public discussion, they revise the explanation and contemplate additional research.
   - develop a written report for public scrutiny that describes their proposed explanation, including a literature review, the research they carried out, its result, and suggestions for further research.

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Intermediate Level Science Core Curriculum Grades 5-8

Standard 1: Analysis Inquiry and Design

Mathematical Analysis

Key Idea 1:
Abstraction and symbolic representation are used to communicate mathematically.

Key Idea 2:
Deductive and inductive reasoning are used to reach mathematical conclusions.

Key Idea 3:
Critical thinking skills are used in the solution of mathematical problems.

Scientific Inquiry

Key Idea 1:
The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

S1.1 Formulate questions independently with the aid of references appropriate for guiding the search for explanations of everyday observations.

S1.1a Formulate questions about natural phenomena

S1.1b Identify appropriate references to investigate a question

S1.1c Refine and clarify questions so that they are subject to scientific investigation

S1.2 Construct explanations independently for natural phenomena, especially by proposing preliminary visual models of phenomena.

S1.2a Independently formulate a hypothesis

S1.2b Propose a model of a natural phenomenon

S1.2c Differentiate among observations, inferences, predictions, and explanations

S1.3 Represent, present, and defend their proposed explanations of everyday observations so that they can be understood and assessed by others.

S1.4 Seek to clarify, to assess critically, and to reconcile with their own thinking the ideas presented by others, including peers, teachers, authors, and scientists.

Key Idea 2:
Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

S2.1 Use conventional techniques and those of their own design to make further observations and refine their explanations, guided by a need for more information.

S2.1a Demonstrate appropriate safety techniques

S2.1b Conduct an experiment designed by others

S2.1c Design and conduct an experiment to test a hypothesis

S2.1d Use appropriate tools and conventional techniques to solve problems about the natural world, including:

- measuring
- observing
- describing
- classifying
- sequencing

S2.2 Develop, present, and defend formal research proposals for testing their own explanations of common phenomena, including ways of obtaining needed observations and ways of conducting simple controlled experiments.

S2.2a Include appropriate safety procedures

S2.2b Design scientific investigations (e.g., observing, describing, and comparing; collecting samples; seeking more information, conducting a controlled experiment; discovering new objects or phenomena; making models)

S2.2c Design a simple controlled experiment

S2.2d Identify independent variables (manipulated), dependent variables(responding), and constants in a simple controlled experiment

S2.2e Choose appropriate sample size and number of trials

S2.3 Carry out their research proposals, recording observations and measurements (e.g., lab notes, audiotape, computer disk, videotape) to help assess the explanation.

S2.3a Use appropriate safety procedures

S2.3b Conduct a scientific investigation

S2.3c Collect quantitative and qualitative data

Key Idea 3:
The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

S3.1 Design charts, tables, graphs, and other representations of observations in conventional and creative ways to help them address their research question or hypothesis.

S3.1a Organize results, using appropriate graphs, diagrams, data tables, and other models to show relationships

S3.1b Generate and use scales, create legends, and appropriately label axes

S3.2 Interpret the organized data to answer the research question or hypothesis and to gain insight into the problem.

S3.2a Accurately describe the procedures used and the data gathered

S3.2b Identify sources of error and the limitations of data collected

S3.2c Evaluate the original hypothesis in light of the data

S3.2d Formulate and defend explanations and conclusions as they relate to scientific phenomena

S3.2e Form and defend a logical argument about cause-and-effect relationships in an investigation

S3.2f Make predictions based on experimental data

S3.2g Suggest improvements and recommendations for further studying

S3.2h Use and interpret graphs and data tables

S3.3 Modify their personal understanding of phenomena based on evaluation of their hypothesis.

Standard 2: Information Systems

Key Idea 1:
Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.

1.1 Use a range of equipment and software to integrate several forms of information in order to create good-quality audio, video, graphic, and text-based presentations.

1.3 Systematically obtain accurate and relevant information pertaining to a particular topic from a range of sources, including local and national media, libraries, museums, governmental agencies, industries, and individuals.

1.4 Collect data from probes to measure events and phenomena.

1.4a Collect the data, using the appropriate, available tool

1.4b Organize the data

1.4c Use the collected data to communicate a scientific concept

Intermediate Level Science Core Curriculum Grades 5-8 (continued)

Standard 6: Interconnectedness

Key Idea 5:
Identifying patterns of change is necessary for making predictions about future behavior and conditions.

5.1 Use simple linear equations to represent how a parameter changes with time.

5.2 Observe patterns of change in trends or cycles and make predictions on what might happen in the future.

Standard 4: Living Environment

3.2a In all environments, organisms with similar needs may compete with one another for resources.

3.2b Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to permit its survival. Extinction of species is common. Fossils are evidence that a great variety of species existed in the past.

6.1a Energy flows through ecosystems in one direction, usually from the Sun, through producers to consumers and then to decomposers. This process may be visualized with food chains or energy pyramids.

6.1b Food webs identify feeding relationships among producers, consumers, and decomposers in an ecosystem.

7.1a A population consists of all individuals of a species that are found together at a given place and time. Populations living in one place form a community. The community and the physical factors with which it interacts compose an ecosystem.

7.1b Given adequate resources and no disease or predators, populations (including humans) increase. Lack of resources, habitat destruction, and other factors such as predation and climate limit the growth of certain populations in the ecosystem.

7.2a In ecosystems, balance is the result of interactions between community members and their environment.

7.2b The environment may be altered through the activities of organisms. Alterations are sometimes abrupt. Some species may replace others over time, resulting in long term gradual changes (ecological succession).

7.2c Overpopulation by any species impacts the environment due to the increased use of resources. Human activities can bring about environmental degradation through resource acquisition, urban growth, land-use decisions, waste disposal, etc.

7.2d Since the Industrial Revolution, human activities have resulted in major pollution of air, water, and soil. Pollution has cumulative ecological effects such as acid rain, global warming, or ozone depletion. The survival of living things on our planet depends on the conservation and protection of Earth's resources.

Standard 4: The Physical Setting

1.1i The tilt of Earth's axis of rotation and the revolution of Earth around the Sun cause seasons on Earth. The length of daylight varies depending on latitude and season.

Teacher Resources

USA Phenology Network: www.usanpn.org/

Mid-Atlantic Phenology Network: www.mapseasons.net/

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What is the National Park Service?

The National Park Service is a bureau of the U.S. Department of the Interior. The "Organic Act" of 1916 established the National Park Service"...to conserve the scenery and the natural objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations...". The mission of the National Park Service is to protect and maintain these cultural and natural resources for the use and enjoyment of all people today and in the future.

Today, there are some 396 sites in the National Park System. These sites include national parks, historic sites, recreation areas, preserves, seashores, scenic rivers, lakeshores and scenic trails. The System is divided into 7 regions. Gateway NRA is part of the Northeast Region, which includes 100 units from Maine to Virginia. Other parks in this region include Statue of Liberty/Ellis Island National Monument, Acadia National Park, Edison National Historic Site, Cape Cod National Seashore and Gettysburg National Military Park. For further information on parks in this region, contact your nearest national park, or visit us on the Web at www.nps.gov.

Active participation in your parks is encouraged. The Volunteers in Parks (VIP) program offers those interested, the opportunity to give their time and abilities to support park programs and resource protection. For further information about volunteering, contact any Gateway unit or go to www.nps.gov/gate/supportyourpark/volunteer.htm.