The Impact of Climate Change on Prairie Potholes
Activity 2: Graphing/Data Analysis

Region: Prairie Grasslands

Grade Level(s): Intended for Middle School, but can be adapted to other grade levels

Time Required: Two 45-minute class periods (90 minutes)

Focus Questions:

- What happens to the Mallard Duck population (and other waterfowl) when the prairie potholes disappear?
- Are some species impacted more than other species?
- Why are the prairie potholes disappearing?

Learning Objectives:

- The students will be able to analyze the relationship between data on the prairie potholes and the Mallard Duck population.

Prerequisite Knowledge:

- Content:
  - Weather patterns
  - Climate change
- Skills:
  - Graphing
    - Discuss dependent and independent variables.
    - Which variable is the dependent variable?
    - Which variable is the independent variable?
    - How should data be graphed?

Materials:

- Graph paper, pencils

Background:

- Refer to Prairie Grasslands Case Study

Procedures/Instructional Strategies:

1. Graph the data that is provided in the charts found at the end of this Activity.

2. Alternate plan: each group or pair of students could graph the data from a different species.

3. Graph breeding pairs of a variety of species and available habitat.

4. Using information from the Prairie Grasslands Case Study, lead a discussion with the students about the effects of habitat destruction and climate change on the breeding success of waterfowl.

5. Ask students to consider the following questions:
    - What generalizations can you make about the data?
    - What is the correlation between drought and breeding success?
    - What is the correlation between rainy weather patterns and breeding success?

6. R.A.F.T. Assessment: Role of the Writer, Audience, Format, Topic. (See References section for more information on R.A.F.T.)
    - Have students play the role of an environmental advisor to the President. Have students write a memo to the President summarizing the impact of climate change on the prairie pothole region. Ask the students to make recommendations about the status of the wetlands and wildlife. Their position should be supported with evidence.

National Science Education Standards:

Regulation and Behavior

- Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, including cells, organ systems, and whole organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.

- An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

Populations and Ecosystems

- A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.

- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some micro-organisms are producers--they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.

- For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

Diversity and Adaptations of Organisms

- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

Earth Science – Structure of the Earth System

- Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.

- Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.

- Clouds, formed by the condensation of water vapor, affect weather and climate.

- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Physical Science

- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Additional Resources:

- Episode on Prairie Potholes, Upper Midwest Aerospace Consortium (UMAC)
  http://www.umac.org/ocp/videos/prairiePotholes.html

- EPA's book list for wetlands
  http://www.epa.gov/OWOW/wetlands/science/readlist.html
- EPA: The Wetlands Program Across the Country
  http://www.epa.gov/owow/wetlands/regions.html
- EPA: Wetlands: Prairie Potholes
  http://www.epa.gov/owow/wetlands/types/pothole.html
- Iowa State University
  http://www.ag.iastate.edu/centers/iawetlands/Pothole.html
- Iowa State University
  http://www.ag.iastate.edu/centers/iawetlands/mammal.html

References:

1. "Wetland Birds of the Northern Great Plains", USGS: Northern Prairie Wildlife Research Center (NPWRC)
   Data about waterfowl species, which can be used in graphing activities
   http://www.npwrc.usgs.gov/resource/habitat/grlands/wetbirds.htm

2. "Waterfowl in the Prairie Pothole Region", USGS: Northern Prairie Wildlife Research Center (NPWRC)
   Data on water conditions, which can be used in graphing activities
   http://www.npwrc.usgs.gov/resource/habitat/grlands/waterfwl.htm

3. "Climbing the Chart", U.S. Department of the Interior: Bureau of Land Management
   Graphing activity, which could be used with all case studies, but needs to be adapted. The focus could be on population changes over time or the fluctuation of the number of prairie potholes and the population of various species of waterfowl.
   http://www.blm.gov/education/00_kids/wild33.pdf

4. Strategies for Reading Comprehension: R.A.F.T. Papers, Nancy Vandervanter, in Adler, 1982 (http://readingquest.org/strat/raft.html)

5. Rubric for R.A.F.T.
   (http://tides.sfasu.edu/Teachers/LessonPlans/PaulaWarden/RaftRubric.pdf)

Table 1. Densities (breeding pairs per square kilometer) of breeding birds by wetland class in North Dakota (Kantrud and Stewart 1984).

Species	Wetland class					
	Temporary	Seasonal	Semipermanent	Permanent	Alkali	Fen
Pied-billed grebe		5.4	11.9	1.3		12.2
Horned grebe		1.4	0.6	0.3		
Eared grebe		3.9	1.9	1.6		
Western grebe			0.2	2.8		
American bittern	5.8	3.3	5.8	0.1		8.4
Black-crowned night-heron		0.4	4.2	1.0		17.2
Northern harrier		0.6	1.5			7.5
Virginia rail		0.4	1.8			7.5
Sora	10.1	12.9	12.6		0.2	25.1
American coot	25.2	73.8	180.5	8.9		52.8
Piping plover			0.2		2.2	
Killdeer	20.6	7.2	5.3	1.2	2.0	
American avocet		3.2	3.2		19.5	
Willet	10.1	12.3	7.0	1.0	1.3	2.5
Marbled godwit	10.1	6.9	3.6	0.1	2.7	5.0
Wilson's phalarope	45.4	28.9	11.5	0.1	4.3	5.0
Black tern	5.8	19.0	44.9	3.3		17.2
Marsh wren		4.9	43.8			52.6
Common yellowthroat		7.9	7.8			55.4
Savannah sparrow	188.9	21.5	15.4		5.0	8.6
Red-winged blackbird	300.0	99.8	106.8	16.9	14.9	125.5
Yellow-headed blackbird	11.1	18.1	253.3			271.0
Total	**633.1**	**331.8**	**723.8**	**38.6**	**52.1**	**673.5**

Source: http://www.npwrc.usgs.gov/resource/habitat/grlands/wetbirds.htm

Table 2. Breeding bird populations in North Dakota: numbers in 128 randomly selected quarter-sections and statewide population estimates, 1967 and 1992-1993.

Species	Number of breeding pairs			Population estimate	
	1967	1992	1993	1967	1992-1993
Pied-billed grebe	11	4	7	24,000	12,000
Horned grebe	2	1	0	4,000	1,000
Red-necked grebe	0	1	1	0	2,000
Eared grebe	40	48	22	90,000	78,000
Western grebe	0	2	1	0	3,000
American white pelican	0	0	2	0	2,000
Double-crested cormorant	0	1	10	0	12,000
American bittern	9	2	8	19,000	10,000
Great blue heron	2	1	3	4,000	4,000
Black-crowned night-heron	17	5	5	37,000	11,000
Northern harrier	15	21	34	33,000	60,000
Yellow rail	0	1	0	0	1,000
Virginia rail	3	5	2	7,000	8,000
Sora	32	41	78	68,000	128,000
American coot	348	76	124	761,000	220,000
Piping plover	5	2	1	11,000	3,000
Killdeer	105	112	142	227,000	280,000
American avocet	14	6	13	31,000	21,000
Willet	18	16	27	39,000	48,000
Spotted sandpiper	12	12	9	26,000	22,000
Marbled godwit	17	8	14	37,000	24,000
Common snipe	0	2	7	0	10,000
Wilson's phalarope	73	30	36	157,000	72,000
Franklin's gull	22	79	56	48,000	148,000
Ring-billed gull	1	49	11	2,000	65,000
California gull	0	0	2	0	2,000
Forster's tern	3	6	4	6,000	11,000
Common tern	6	6	3	13,000	10,000
Black tern	118	39	39	254,000	84,000
Belted kingfisher	0	1	1	0	2,000
Sedge wren	10	20	37	22,000	62,000
Marsh wren	51	113	153	112,000	293,000
Common yellowthroat	134	91	175	285,000	286,000
Le Conte's sparrow	6	2	14	12,000	16,000
Nelson's sharp-tailed sparrow	3	3	13	7,000	34,000
Red-winged blackbird	945	597	710	2,038,000	1,421,000
Yellow-headed blackbird	89	155	175	193,000	356,000

Source: http://www.npwrc.usgs.gov/resource/habitat/grlands/wetbirds.htm

Table 3. Trends from the U.S. Geological Survey Breeding Bird Survey for the central region, 1966-1994, 1966-1979, and 1980-1994. Also given is average number recorded per route (R.A.) for the entire period.

Species	1966-1994		1966-1979	1980-1994
	R.A.	Trend[a]	Trend[a]	Trend[a]
Pied-billed grebe	0.39	0.5	1.2	5.8
Eared grebe	0.67	5.2	24.0 ↑	-16.2 ↓
American white pelican	1.22	3.5 ↑	0	1.1
Double-crested cormorant	0.56	26.6 ↑	6.7 ↑	11.1 ↑
American bittern	0.50	-3.1	-4.9	0.1
Great blue heron	0.89	3.0 ↑	6.4 ↑	0.6
Black-crowned night-heron	0.37	3.3	-10.3 ↓	2.2
Yellow-crowned night-heron	0.53	0.7	19.6	-2.9
Great egret	2.84	3.8	4.2	4.4 ↑
Snowy egret	1.66	27.5	87.2	15.7 ↑
Little blue heron	2.98	-1.8	-0.9	-3.9 ↓
Tricolored heron	1.20	10.4	88.0	-4.1
Cattle egret	21.67	2.2	5.2	-2.8 ↓
Green heron	1.00	0.6	1.2	-3.4 ↓
White ibis	6.10	22.3 ↑	80.0	17.4 ↑
White-faced ibis	5.90	8.5	9.1	-9.9
Northern harrier	0.61	-2.1 ↓	-1.9	-0.3
King rail	0.82	-1.4	5.0	-2.0
Sora	0.94	-2.6	-8.5 ↓	11.0 ↑
Common moorhen	1.79	6.1	22.4 ↑	0.6
American coot	2.14	-0.8	-1.5	3.6
Killdeer	8.88	-0.3	3.0 ↑	-2.0 ↓
American avocet	0.63	-0.2	11.2 ↑	-1.8
Willet	1.03	-1.8	4.7 ↑	-0.4
Spotted sandpiper	0.08	2.1	9.4	-2.2
Marbled godwit	1.36	0.7	7.9 ↑	---
Common snipe	1.22	0.7	6.7 ↑	-1.0
Wilson's phalarope	1.24	-3.2	-5.7 ↓	6.7
Franklin's gull	7.55	-7.6 ↓	-17.0 ↓	42.3 ↑
Ring-billed gull	2.47	6.4 ↑	-5.6 ↓	10.3 ↑
California gull	0.95	17.6 ↑	-9.3	11.3 ↑
Laughing gull	12.95	5.4 ↑	7.5	-3.2
Forster's tern	0.54	0.7	12.1 ↑	-0.9
Black tern	2.70	-5.0 ↓	-13.0 ↓	2.7
Belted kingfisher	0.16	-1.6	-1.4	0.8
Sedge wren	1.25	1.3	-4.1 ↓	5.7 ↑
Marsh wren	1.34	3.6	-4.9 ↓	6.7 ↑
Common yellowthroat	6.87	-0.9 ↓	1.8 ↑	-2.1 ↓
Le Conte's sparrow	0.84	0.7	6.5	7.3
Nelson's sharp-tailed sparrow	0.15	5.2	0	17.7 ↑
Swamp sparrow	0.25	1.3	6.3 ↑	2.5
Red-winged blackbird	85.09	-0.5 ↓	1.1 ↑	-1.3 ↓
Yellow-headed blackbird	15.77	0.5	3.3	-2.1 ↓

[a] Average percentage annual change between 1967 and 1993: ↓ indicates statistically significant population decline; ↑ indicates statistically significant population increase.

Source: http://www.npwrc.usgs.gov/resource/habitat/grlands/wetbirds.htm

Table 1. Breeding population estimates for all ducks in the prairie pothole region and estimates of numbers of ponds during May, 1986-1995.

Year	Number of breeding ducks	Number of ponds		
		Total	United States	Canada
1986	18,429,000	5,760,000	1,735,000	4,025,000
1987	16,521,000	3,872,000	1,348,000	2,524,000
1988	13,515,000	2,901,000	791,000	2,110,000
1989	12,725,000	2,983,000	1,290,000	1,693,000
1990	13,399,000	3,508,000	691,000	2,817,000
1991	11,944,000	3,200,000	706,000	2,494,000
1992	14,256,000	3,609,000	825,000	2,784,000
1993	12,180,000	3,611,000	1,350,000	2,261,000
1994	18,997,000	5,985,000	2,216,000	3,769,000
1995	21,892,000	6,336,000	2,443,000	3,893,000

Source: http://www.npwrc.usgs.gov/resource/habitat/grlands/waterfwl.htm

Table 2. Breeding populations (in thousands) of 10 duck species in the prairie pothole region in 1986-1995 (Smith 1995). TYA = 10-year average; LTA = long-term average (1955-1995).

Species	Year										TYA	LTA
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995		
Mallard	3,900	3,678	2,726	2,957	2,800	2,863	3,326	3,188	4,516	5,352	3,531	4,678
Blue-winged teal	3,892	2,800	2,761	2,438	2,318	3,113	3,572	2,409	4,199	4,847	3,235	3,594
Gadwall	1,463	1,244	1,237	1,301	1,458	1,443	1,916	1,636	2,201	2,734	1,663	1,293
Northern pintail	1,655	1,398	674	1,002	966	524	905	1,075	2,066	1,805	1,207	3,112
American wigeon	544	440	440	398	508	510	685	504	763	852	564	1,021
Northern shoveler	1,609	1,349	930	930	1,080	1,078	1,195	1,290	2,187	2,177	1,382	1,444
Lesser scaup	1,311	856	1,023	621	741	822	919	738	1,020	1,253	930	1,107
Redhead	509	479	398	458	416	349	498	403	581	855	495	512
Green-winged teal	297	307	345	309	356	331	403	281	574	686	389	530
Canvasback	285	309	240	201	238	247	215	210	293	491	273	329

Source: http://www.npwrc.usgs.gov/resource/habitat/grlands/waterfwl.htm