Population Dynamics and Extinction

Extinction and Reasoning about Loss of Biodiversity
Population Dynamics: Wolves and Moose of Isle Royale
(Optional: Introduction to Extinction Project)

Version September 2018

Symbols

We use these symbols to communicate to students the following actions:

Think	Share	Write down	Work in research groups

www.modelbasedbiology.com

Why should we care about biodiversity? Why does it matter?

Take a moment to think of at least one idea.

Write the idea (or ideas) on your **doodle sheet in the first box (Box 1)**.

(Then we'll share with a neighbor.)

Turn to a partner and share your ideas. Also be ready to share one idea from your pair with the whole group

Why should we care about biodiversity?
Why does it matter?

[insert class list here or post in the room]

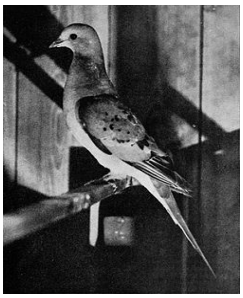
What do we know is happening to biodiversity now?

- [insert class ideas here]

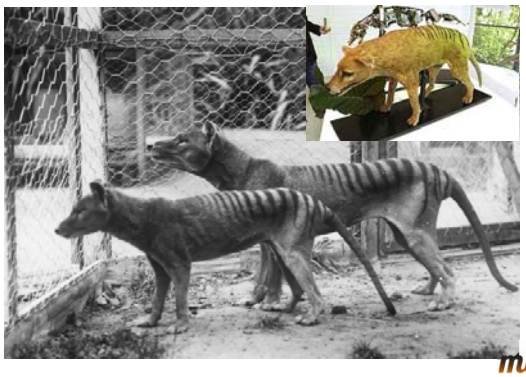
West African black rhinoceros (R.I.P. 2011)

golden toad (R.I.P. 1989)

passenger pigeon (R.I.P. 1914)



Tasmanian tiger or "thylacene" (R.I.P. 1936)



Dutch Alcon blue butterfly (R.I.P. 1979)

Pyrenean ibex (R.I.P. 1979)

Spix's macaw (R.I.P. 2004)

Carolina parakeet (R.I.P. 1918)

Steller's sea cow (R.I.P. 1768)

Yangtze River dolphin (R.I.P. 2006)

What is Extinction?

[record student ideas here or elsewhere in the classroom]

Write your best summary/paraphrased definition of extinction on your **Doodle Sheet in Box 2**.

Looking to the Past

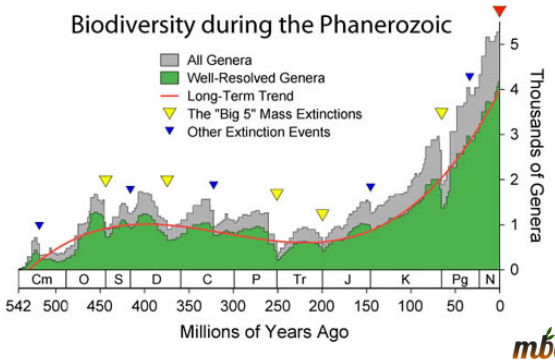
Have extinctions happened in the past?

Can you think of examples of species that existed long ago but have not been around for millions, maybe even hundreds of millions of years?

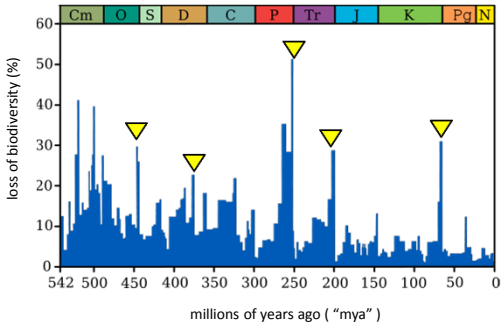
So, if we know that the same species haven't always been around, what can we say about biodiversity over the history of our planet?

Let's look at what the big pattern of extinction looks like over the entire history of the earth…

Extinctions Have Always Happened



5 Mass Extinctions



Recent Extinctions

(since we've been paying attention)

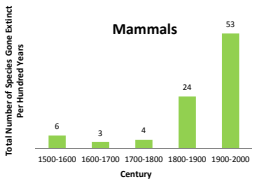
Group	*Extinctions since 1500*	*Est. Number Species**
Birds	145	9,956
Mammals	79	5,416
Amphibians	36	6,199
Snails and Clams	324	81,000
Reptiles	22	8,240
Ray-finned Fish	71	30,000
Flowering Plants	121	258,650
Crabs and Shrimp	8	40,000
Mosses	2	15,000
Insects	58	950,000
Arachnids	9	180,000**

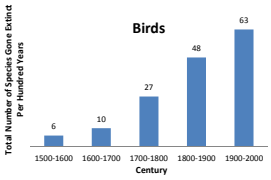
Question:
Why were these arranged in this particular order?

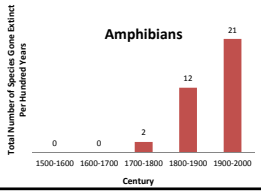
Does anyone see a pattern?

*http://www.factmonster.com/ipka/A0934288.html
**Coddington & Levi (1991) Annual Review of Ecology

Extinctions Across Some Major Animal Groups







Graphs produced by MBERbio.

Data taken from Scientific papers:

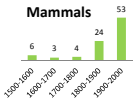
Maas 2014, Szabo *et al.* 2012, Pimm 2014

Are we in the 6th Mass Extinction?

- Read the article and highlight a couple o facts you think might be interesting to discuss with your group.
- Respond to the questions at the end of the article. (Be prepared to share your answers with your group.)

Are we in the 6th Mass Extinction?

- Use "Talking Sticks" to discuss the article:
  - The first person has 30 seconds to share their response to question #1.
  - The second has 30 seconds for question #2…
    and so on.
  - After everyone has shared, take one minute to discuss any points you didn't understand or any of the responses where you didn't all agree.
- Class discussion: What do we think?

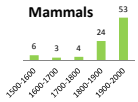


Causes of Extinction

Let's go back to thinking about the recent extinctions from the last few centuries…

What might be the cause of these recent extinctions?
What do we think is going on here?

Record your ideas in **Doodle Box 3**.



Causes of Extinction

Discuss your ideas with your group and come up with a group list "Causes of Extinction" on your whiteboard. Try to come up with as many ideas as you can, but make sure your ideas are clear.

Be ready to share one idea with the whole class.

Causes of Extinction:

Looking for Patterns

Let's try to look at our list for patterns and any places we shorten it or combine ideas…

Is there a way to shorten our class list?

Are there any general ***patterns*** or ***themes*** among our causes for extinctions?

Record our class ideas in **Doodle Box 4**.

Human Impacts

- One commonality among our ideas about the causes of extinction is the role of humans.

In **Doodle Box 5**, record one specific way in which you think humans may have contributed to extinctions. Be specific.

- *Example: Though hunting can be a really good way to help control animal populations, humans (including early humans) have hunted a number of animal species to extinction.*

Human Impacts

Dodo Bird: Skeleton cast and model of dodo at the Oxford University Museum of Natural History, based on modern research.

(Photo/Caption: Wikipedia)

Human Impacts

Comparison of a woolly mammoth (left) and an American mastodon (right).

(Photo/Caption: Wikipedia)

Human Impacts

Canis lupus, the gray wolf

– nearly hunted to extinction in the United States during the 19th and 20th centuries.

Human Impacts: Saving Species in Trouble

- What have humans done to protect species?

In Doodle Box 6, record one idea you have about how humans have worked or can work to protect species from extinction.

- Let's look at one species' story to learn more about the factors that affect populations of wildlife, what might make them go extinct, and some of the ways in which humans may have prevented their loss.

The Case of the Gray Wolf in North America

- *Canis lupus*, the gray wolf – one of the few large predators native to our continent.

What else do you know about gray wolves?

Record your thoughts in Doodle Box A.
(On the new Doodle Sheet.)

What's Up With Wolves?

Before European settlement
≈ 250,000 - 500,000

By 1960 < 300 wolves were left in the entire continental U.S.

Wolves only lived in Minnesota and in one other place…

Isle Royale National Park

Isle Royale National Park

- **Established as a national park in 1940.**
- **Isolated: 15 miles to mainland.**
- **No evidence of long-term human habitation.**
- **Seemingly just large enough to support wolves and moose.**
- **A great place to study these animals and their ecosystem!**

Wildlife Conservation Biologists

Rolf O. Peterson

Research Professor

PhD, Wildlife Ecology, Purdue University
BA, Zoology, University of Minnesota

"The challenge of wild carnivore restoration."

John A. Vucetich

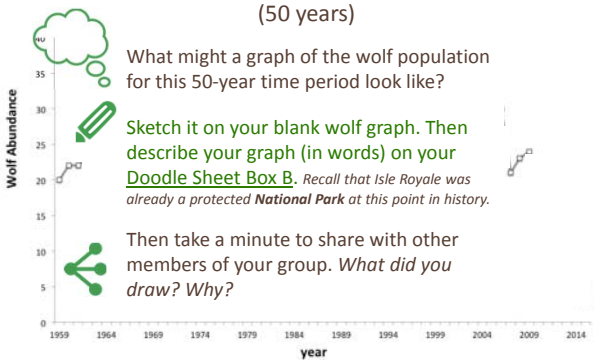
Professor, School of Forest Resources and Environmental Science

PhD, Forest Science, Michigan Technological University
BS, Biology, Michigan Technological University

"I am a population biologist. I spend most of my time studying the wolves and moose of Isle Royale. I am also interested in the philosophy and ethics of ecological and conservation science."

These scientists are *part of a team* that has collected more than 50 years of data on the ecosystems of Isle Royale.

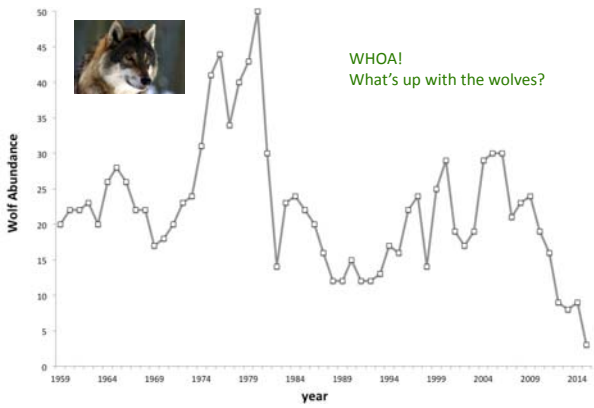
How has the wolf population changed over time? (50 years)

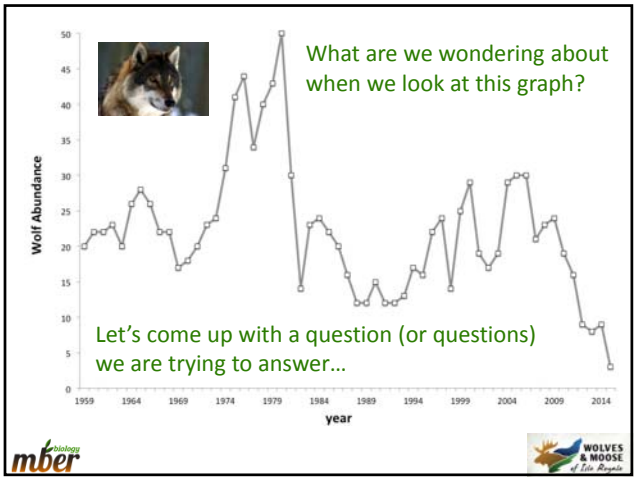


What might a graph of the wolf population for this 50-year time period look like?

Sketch it on your blank wolf graph. Then describe your graph (in words) on your Doodle Sheet Box B. *Recall that Isle Royale was already a protected **National Park** at this point in history.*

Then take a minute to share with other members of your group. *What did you draw? Why?*





Now in your groups, consider the following specific questions:

(1) What patterns do you notice?

(2) What factors might explain the patterns?

(3) What are you wondering about? Specifically, what other information might it be helpful to have?

Record your group ideas in Doodle Box C.
Be ready to share at least two.

Wanting to learn more…

So, there are a number of things we are still wondering about…

Would it be helpful to know more about the wolves?

And the moose?

Wanting to learn more…

Each member of your group will read a different story.

When everyone is done, each person will share the main ideas from their reading.

Readings: Island Overview, Moose, & Wolves

Instructions:

- Read over the handout in front of you.
  - Highlight or underline key points.
  - Be ready to share out the key points to your group.
- In preparation, record your key ideas in the top portion of Doodle Box D.
- In a minute, you will have a chance to hear what other group members read about, so be sure to leave some room to record their key ideas as well.

Readings: Island Overview, Moose, & Wolves

- Use the "Say Something" protocol to share ideas within the group.
- Goal: Listen attentively and record a couple of points each person makes.
- "Say Something"
  - One person talks at a time. When the first person is done, then…
  - The "responder"
    - **Makes an observation or comment**
    - **Clarifies something**
    - **Makes an inference**
    - **Makes a connection**
    - **Asks a question**

"Say Something" in response… (some ideas)

Observation/Comment	Clarify	Inference	Connect	Questions
I noticed that… I think that… I saw (heard, smelled)… This is good because… This is hard because… This is confusing because… This makes sense because…	Now I understand… No, I think it means… At first I thought…, but now… I agree with you, and… What this means is…	I predict that… I bet that… Based on these data I think… One thing I think is… I wonder if…	This reminds me of… This process is like… This is similar to… This…makes me think of… It also… This…is like…because…	How did… In what ways are…like… What might happen if… Do you think that… What evidence supports… In other words, are you saying…

From "Success in Science Through Dialogue, Reading and Writing"
By Beauchamp, Kusnick McCallum 2011

What's Up With Wolves?

Wolves are highly social – live and hunt in packs of 7-8 adults, usually led by one breeding pair.

Annual litters of 4-7 pups.
Pups cared for collectively by the pack for about the first 10 months of their lives.

Prey to no other animal.

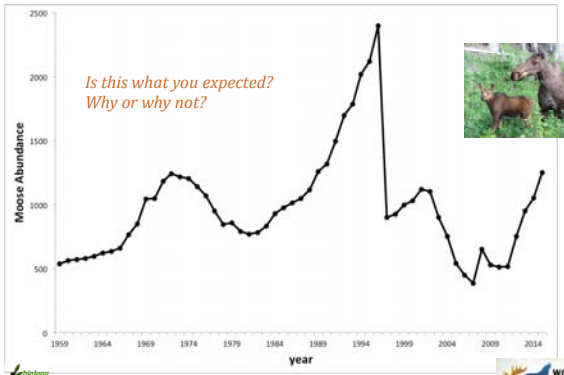
Adding to Our Ideas

- Now that we've learned a bit more about the wolves, do we have any changes / additions to our initial ideas about what might be contributing to their population numbers?
- Let's quickly add those now…
- What about questions we have?
  Are there any big holes in our understanding?

We might also want to know:
What's up with the moose?

Let's look at the *moose* population to see if it can shed more light on what might be happening with the wolves.

The moose population over time…



What's up with the moose?

Given what we know about the moose at this point, what factors do you think might affect the size of the *moose* population on Isle Royale?

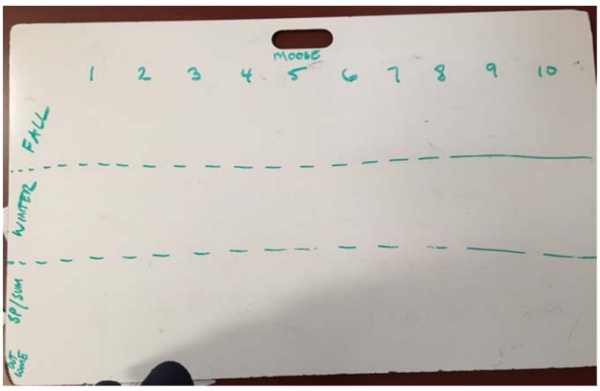
Record ideas in Doodle Box E.

Let's share some of our ideas publically.

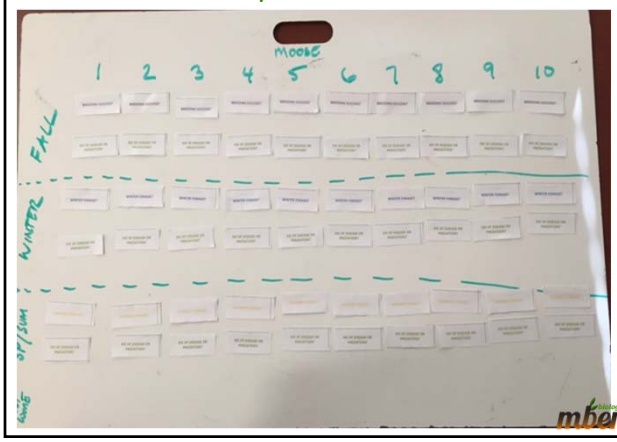
Good. We know some things from our readings, but let's explore further with a game…

End of Notes for Today

Moose Population Simulation



Moose Population Simulation



Moose Population Simulation

Be sure to record your data!

Isle Royale Moose Survival Data

Round 1

Starting Population	# born	# died (Adults and babies)	End of Year Population

Causes of deaths and how many died from each:

Rounds 2 and 3

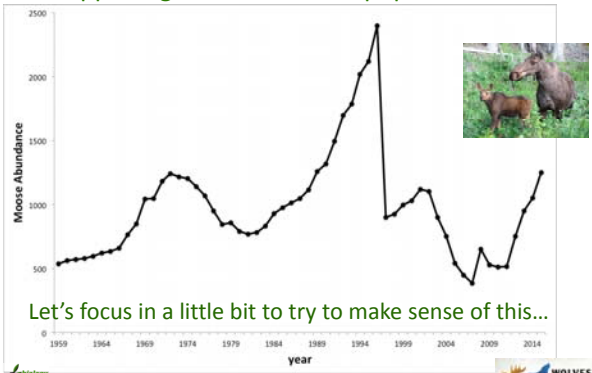
Starting Population	# born	# died (Adult and babies)	End of Year Population

Causes of deaths and how many died from each:

RESULTS – 1 year of Moose Population

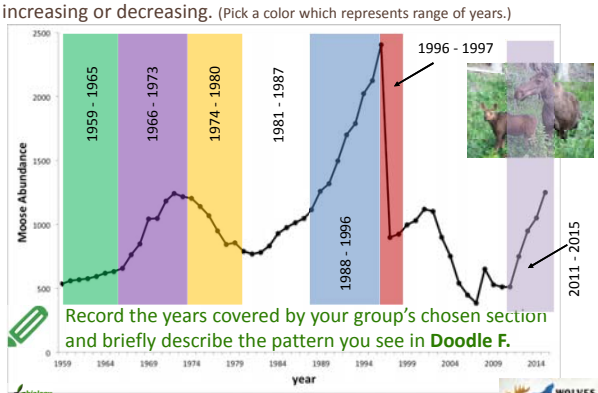
Group-Round	Starting Moose	Births	Deaths	Ending Moose
Table 1	30	21	27	31
Table 2	30	12	12	34
Table 3	30	21	34	17
Table 4	30	19	17	32
Table 5	30	27	42	23
Table 6	30	12	32	28
Table 7	30	25	12	48
TOTAL	210	137	176	213

Do our game results help us to understand what is happening with the moose population?



Let's focus in a little bit to try to make sense of this…

Choose one part of the graph where the population is either increasing or decreasing. (Pick a color which represents range of years.)



Record the years covered by your group's chosen section and briefly describe the pattern you see in **Doodle F.**

In your groups, discuss the following:

In the game, the population stayed pretty stable. Think about / talk about why it was stable.

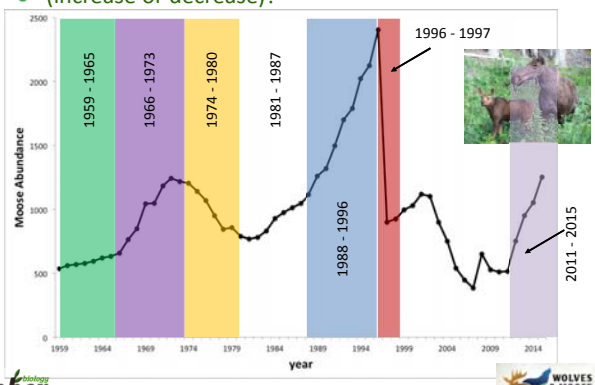
What is *one specific* modification you might make to the game to instead produce the trends you see in the moose population in your focal section of the graph? Discuss in your group.

Be certain to clearly explain how changing this one factor could produce the pattern you see in the years you are focusing on in the real moose population.

Record your group's ideas in **Doodle Box F.**

And be ready to share with the class.

How do we explain these times of population change (increase or decrease)?



Let's boil it down…

Think about what all of the times of increase had in common.

Think about what all of the times of decrease had in common.

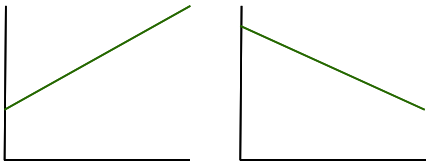
What fundamentally determines whether the moose population increases or decreases during any time interval? What does it all come down to?

Take a moment to answer on your doodle sheet in Box G.

Our Model and the Moose

[insert model ideas associated with increasing populations]

[insert model ideas associated with decreasing populations]



How do all of the factors we said control the moose population relate to our model?

Our Model and the Moose

How do all of those specific factors we said control the moose population relate to our model?

Pick 3 of the factors that we've agreed affect the moose population. (See our class list!)

With your group, create a representation that clearly relates each of factors to (1) birth, (2) death, or (3) both.
Would the factor cause the population to increase or decrease? How can you tell?

Our Model and the Wolves

With your group, do the same thing for the wolves that we did with the moose. Create a representation that clearly relates each factor the model.

You may use some of the same factors if they also apply to the wolf population.

Wrapping It Up

How does our model help us here?
What questions do we still have?

Add any ideas that came up just now.

- We have a pretty decent understanding of our model and how it broadly helps us to explain changes in the number of wolves over time.
- But we know there are some things we still cannot explain…

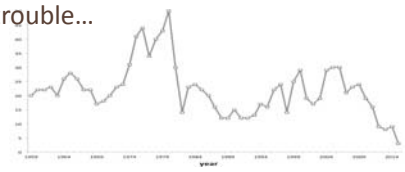
What ideas do we now have to make sense of how populations change in size over time?

[use this space or the records you have posted in your classroom to review the phenomenon and question with your students and then to summarize and "finalize" the model; skip this step if you've already completed this task]

Let's revisit extinction…

So, what does it mean to "go extinct"?
Maybe we need to revisit our definition…

We've seen that gray wolves on Isle Royale are in real trouble…



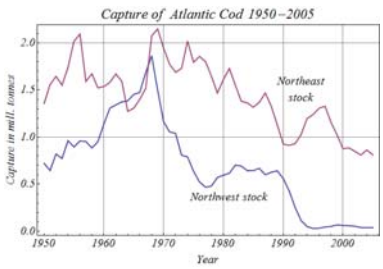
But were gray wolves ever in danger of going extinct? Why or why not?

What does it mean to go extinct?

Are the wolves of Isle Royale becoming extinct?
And what about gray wolves in general?

Record your thoughts in Doodle Box 7.

Let's revisit extinction…



What does this graph about cod show us?

Let's revisit extinction…

What more have we learned about extinction regarding the wolves and in general?

Write your new ideas about extinction in Doodle Box 7.

What does it mean to go extinct?

It can be hard to tell when things go extinct…

Lost (c 1850) and… FOUND!!! (2003)

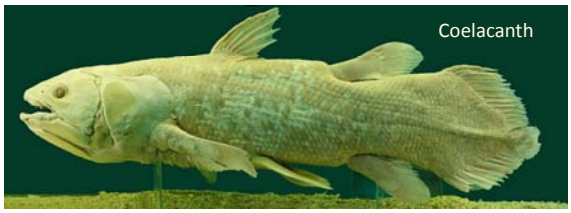
What does it mean to go extinct?

It can be hard to tell when things go extinct…

Lost (c 1971) and… FOUND!!! (2005)

What does it mean to go extinct?

It can be hard to tell when things go extinct…



Lost (66 million years ago) and… FOUND!!! (1938)

What does it mean to go extinct?

It can be hard to tell when things go extinct…

Sometimes extinct species can be "re-discovered"!

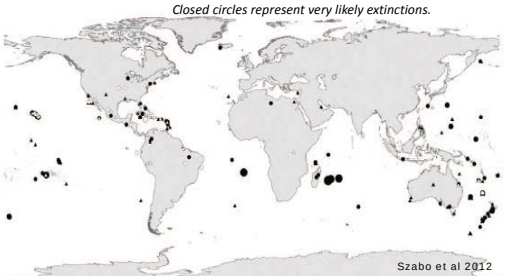
Coelacanth

Why do you think this happens?
Share with a partner for one minute and then I'll ask for some volunteers.

Let's add these ideas to our Doodle Box 7.

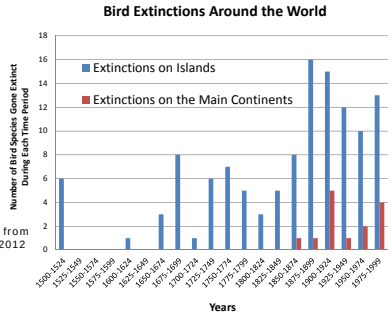
Where do extinctions occur?

Open circles show areas where extinctions are 100% certain.
Closed circles represent very likely extinctions.



Locations of bird species extinctions since 1500.
Bigger circles show the areas where more bird species have gone extinct. Is there a pattern?

Where do extinctions occur?



Reproduced from Szabo et al 2012

Record our new ideas in Doodle Box 8.

A good example of a bad thing.

Brown tree snakes were introduced to Guam accidently from the Admiral Islands immediately following World War II.

Over the next 30 years, 10 of the 12 native bird species went extinct.

The remaining two species have fewer than 200 individuals remaining on the island.

So…why do you think extinctions could be more common on islands?

Record your ideas in Doodle Box 8.

Why on islands?

Why do we think species go extinct on islands?

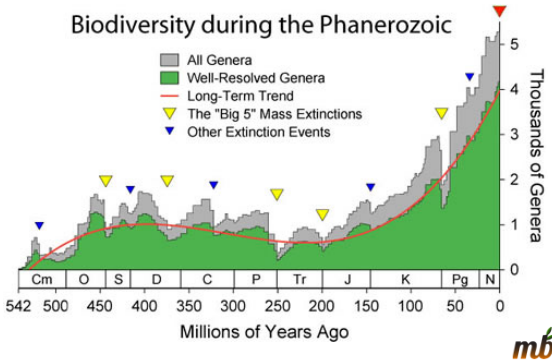
How does our conversation about islands relate to our wolf population?

Hint: recall our earlier questions…
(1) Are the wolves of Isle Royale becoming extinct?
(2) And what about gray wolves in general?

Back to Unity and Diversity

- How might our birth and death model help us to think about changes in biodiversity?

Looking again…



Back to Unity and Diversity

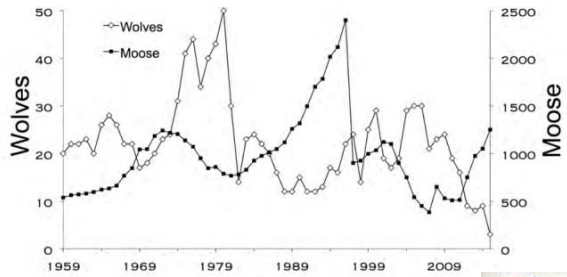
- How might our model help us to think about changes in biodiversity?
- What if we look at the graph in the same way we looked at population graphs.
- Instead of tracking *individuals* over time, we are tracking *species* over time.
- Can we make an analogy here?

Back to Unity and Diversity

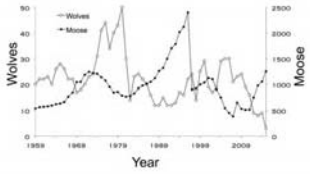
- How might our model help us to think about changes in biodiversity?
- What if we look at the graph in the same way we looked at population graphs.
- Instead of tracking *individuals* over time, we are tracking *species* over time.
- Can we make an analogy here?

Is it the moose that drive changes in the wolf population?

What is the relationship between the populations?



Considering Moose and Wolves Together…



Do changes in one population depend on the other?

Are other factors more important?

Do any factors affect BOTH populations?

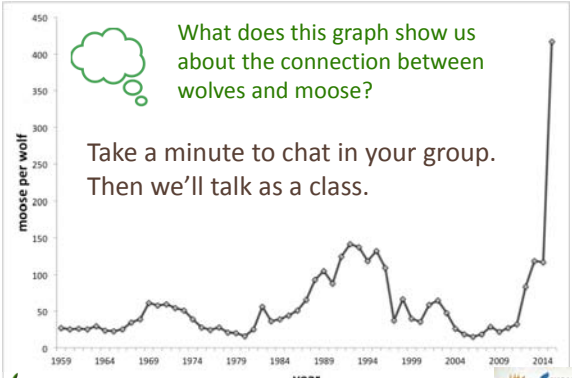
What do you think are the most important factors for the wolf population?

→ Be sure to talk about evidence for your claims.

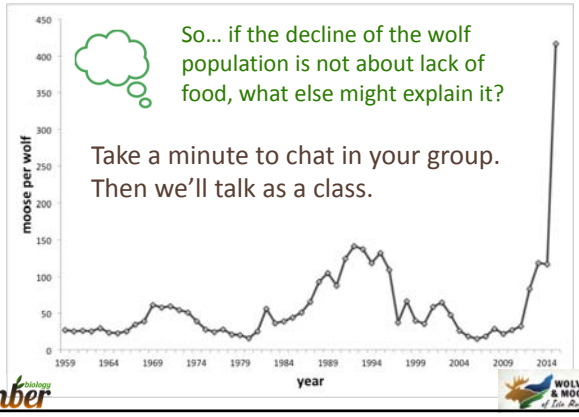
Number of moose for every one wolf.

What does this graph show us about the connection between wolves and moose?

Take a minute to chat in your group. Then we'll talk as a class.



Number of moose for every one wolf.



So… if the decline of the wolf population is not about lack of food, what else might explain it?

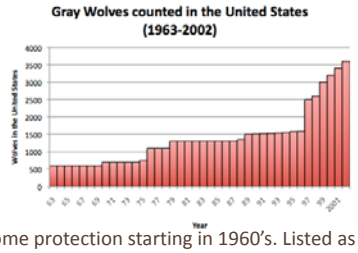
Take a minute to chat in your group. Then we'll talk as a class.

We may explore some of these ideas in later units…

…but for now, it remains a mystery.

So, what's the story now?

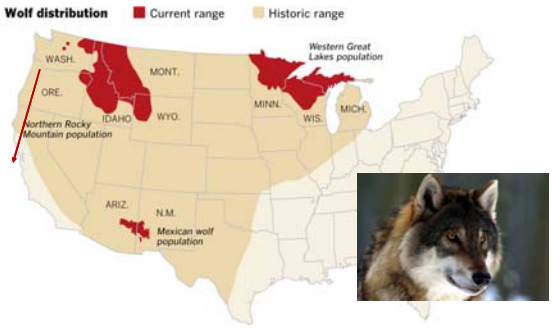
What has happened to gray wolves in the U.S.?

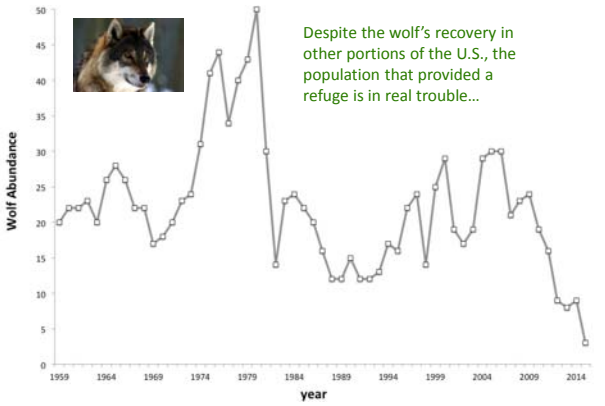


Graph courtesy of WOLVES & MOOSE of Isle Royale

- Some protection starting in 1960's. Listed as "Endangered" in the 1970's.
- Recovery was slow until the 1990's when some wolves were imported from Canada to help repopulate.

Canis lupus, the gray wolf – a story of recovery?





Despite the wolf's recovery in other portions of the U.S., the population that provided a refuge is in real trouble…

Wanting to learn more…

Let's find out a little more about the recent decline of the wolves.

Read the article in front of you. Some of the language may be technical, but do your best.

- Highlight key points.
- Put parentheses around sentences or words you have questions about.
- Be ready to discuss with your group.

What did we learn?

What has happened recently with the wolf population?

What is the suggested solution?

What do you think about the proposed solution?