



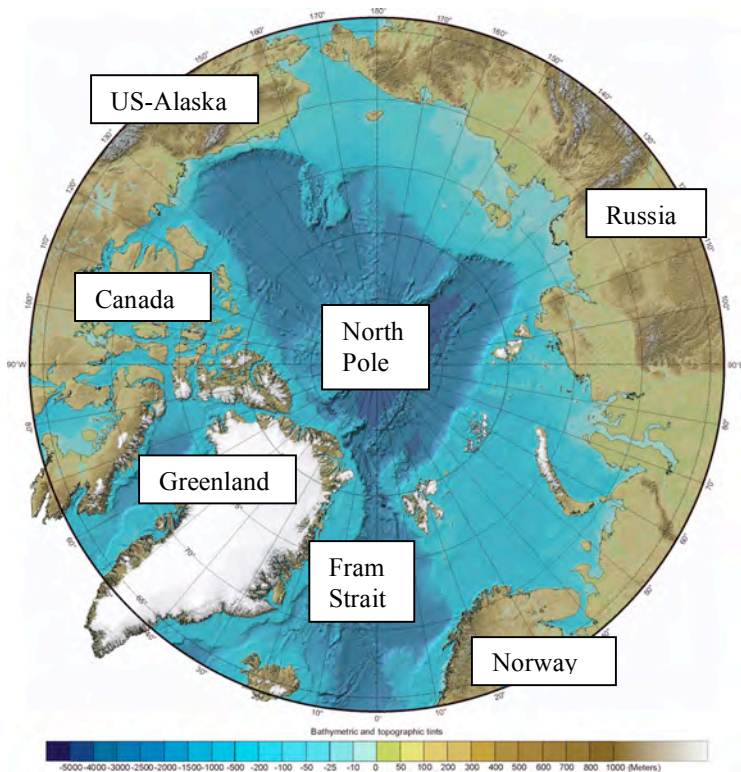
POLAR WEEKEND: SHRINKING ARCTIC SEA ICE



TOPIC:
Shrinking Arctic Sea Ice

PROJECT PERSONNEL:
Stephanie Pfirman, Oceanographer,
Barnard College

PHOTO: Dr. Pfirman dressed in her Arctic gear onboard an ice breaker studying sea ice cover.



WHERE ON THE MAP ARE WE?

The Arctic is at the northernmost end of our planet. Any area north of the 66° 30' N latitude line is considered to be in the Arctic. This latitude line is often referred to as the Arctic Circle (although the circle is imaginary), shown as the outer edge of this map. The Arctic is mainly ocean (shown here in blues), but it includes the northern parts of Alaska, Canada, Russian, Finland, Sweden, Norway, and most of Greenland.

This map is referred to as a 'bathymetric map', meaning its intent is to show the sea floor depth, size and features (topography). While this image is unusual since it does not show the sea ice that covers much of the Arctic Circle all year long, it does clearly show that the Arctic is mainly ocean surrounded by water.

GENERAL BACKGROUND INFORMATION ON THE SUBJECT:

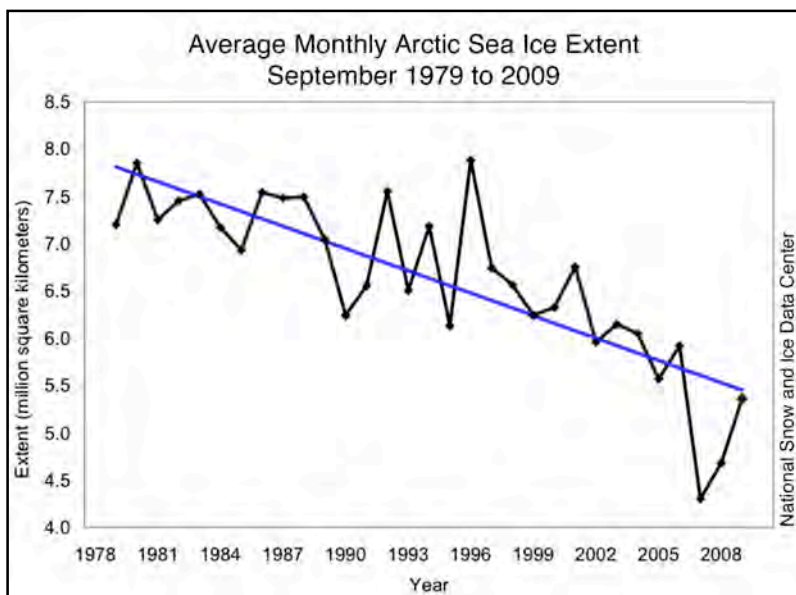
Sea ice is an important part of the Arctic ecosystem. Sea ice forms when the surface of the ocean freezes during fall and winter: air temperatures in the wintertime Arctic average -30°C (-22°F). During summer, the ice melts around the edges of the Arctic Ocean, near the continents. In the past, the sea ice was thick enough that about half of the ice cover remained in summer, forming what was called multiyear ice, or ice that lasted from one year to the next.

Old ice floes (floes are patches of ice) are thick because each winter freezing ocean surface water adds more ice to the underside of the floe. Floes also thicken when the wind blows one into another and they ride up on top of each other, forming ridges. In the past, old ice in the Arctic used to be more than 3 meters (9 feet) thick. This is different from sea ice in the Antarctic: it forms each winter and then mostly melts the following summer. Antarctic sea ice is just 1-2 meters (3-6 ft) thick.



http://earthobservatory.nasa.gov/images/imagerecords/38000/38284/arctic_min_max_map.jpg

The two images above are created from actual data. They show Arctic ice cover at two different times in one 'ice season'. The first image is from September, when the ice cover is usually at its minimum extent (smallest amount) at the end of the summer. The second is from February, the ice maximum in the middle of winter.



But summer sea ice in the Arctic is disappearing fast! Warm air and ocean temperatures melt the ice during the summer months. Observations from satellites indicate that since 1979, sea ice extent has declined at a rate of 11% per decade. The most dramatic decline in ice extent occurred during the summer of 2007. This graph charts the September minimum extent of sea ice from 1979 to 2008. You can see that the amount of ice varies each year but if you follow the blue line (which is called the trend line) you can see that overall the amount of ice is dropping. Now look for the year 2007 on the graph. See how ice cover drops really low that year?

In 2007, the ship passageway through the northern waters, called the **Northwest Passage** (below) became ice-free for several weeks in August for the first time since records had been collected (since 1978)! Scientists are concerned that if this trend continues, the Arctic Ocean could very soon become ice-free in summer.

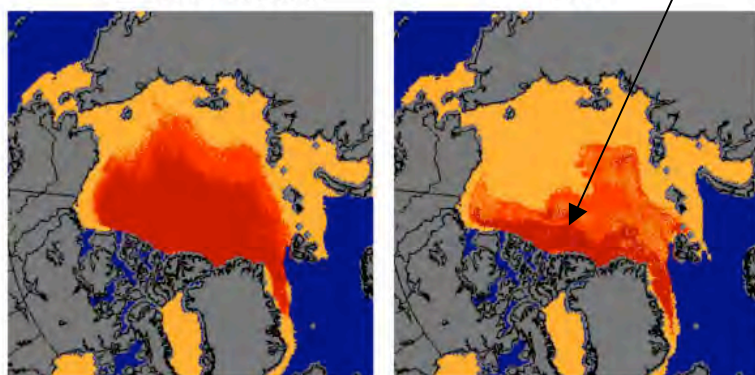


End of February Arctic Sea Ice Age

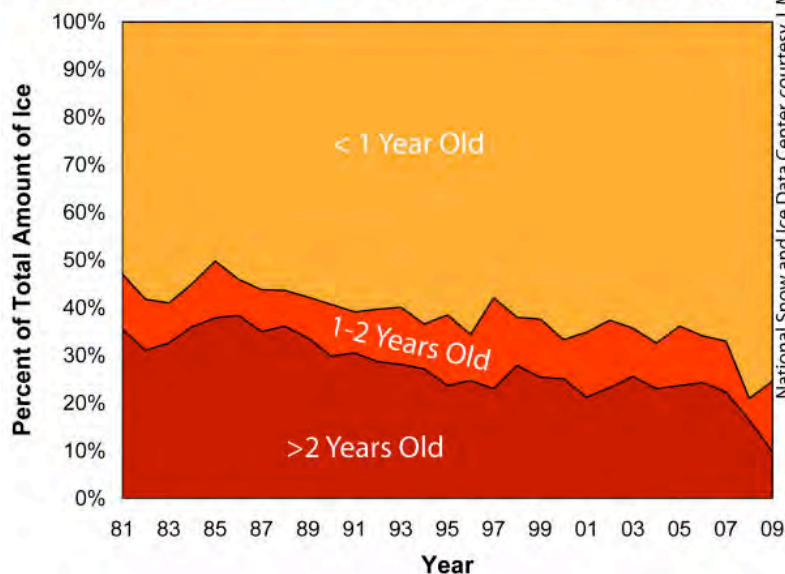
Sea ice refuge region with oldest and thickest sea ice

1981-2000 Median

2009



First year ice (< 1 Year Old)
 Second year ice (1-2 Years Old)
 Older ice (>2 Years Old)



National Snow and Ice Data Center, courtesy J. Maslanik and C. Fowler, Univ. Colorado

The other important change in the Arctic ice cover is that it is getting thinner. There is less and less of the thick, old ice that persisted from one year to the next. Because the ice is thinner, it is easier to melt all the way through, making it more vulnerable to future warming.

Look back at the map on the first page. The thickest and oldest ice collects north of Canada and Greenland. This is because the winds blow ice from the coast of northern Russia across the Arctic, over the North Pole, towards Greenland – this major current of ice is called the Transpolar Drift. While some ice continues out of the Arctic Ocean through Fram Strait between Greenland and Svalbard, a lot of the ice curves around north of Greenland, toward the north slope of Canada.

Models show that in the future, when warming melts ice covering the rest of Arctic Ocean in summer, this one area north of Canada and Greenland is likely to still have ice for a long time. How long, nobody knows, but it is likely to become a natural refuge for species that either needs sea ice, or just prefer to have it around.

WHAT ABOUT POLAR BEARS?



Polar Bears use sea ice for hunting seals, their main source of food. Polar bears know that they can find seals at their breathing holes – which are circular openings that the seals make in the ice. . The loss of sea ice is a real threat to the bears, because without it they will have difficulty locating and catching enough high quality food to sustain them and their young.

Rapid change is having an impact on the polar bear. North America hosts over 2/3 of the world's polar bear population. Over half of the 14 subpopulations are depleted (gone) or ecologically stressed. Future loss of sea ice could result in the loss many of world's polar bears. Other potential threats to

shrinking polar bear habitat include development of oil, gas and mineral production facilities, opening of transportation routes for shipping and increased traffic associated with tourism. Some scientists are pushing to establish a special sea ice management program in the natural ice refuge, which would also include polar bears.

TERMS YOU SHOULD KNOW (VOCABULARY):

Arctic - (from Greek arktikos which means northern) northern polar region of the earth which includes almost the whole area of the Arctic Ocean and adjacent areas of Eurasian and North American continents.

Albedo - a measure of how well a surface reflects solar energy.

Drift ice/pack ice – sea ice that moves from winds, currents, or other forces.

Ice floe -- an expanse of ice.

First-year ice - sea ice of no more than one year's growth

Multiyear or old ice - ice that has survived at least one melt season; it is typically 2 to 4 meters (6 to 13 feet) thick and thickens by ice growing on its underside.

Sea ice - any form of ice found at sea which has originated from the freezing of sea water.

WHY ARE WE STUDYING THIS IN THE POLAR REGIONS?

Sea ice is an important component of regulating global climate. Bright white ice reflects a lot of incoming solar radiation, while dark waters absorb this heat. Melting and freezing of ice also affects the way water moves throughout the oceans. As sea water freezes, the salt excluded from the crystals makes the ocean water dense. The cold dense water sinks and flows southward as a deep current that continues out of the Arctic Ocean. The water sinking in the north is replaced by warm surface waters from the south. This pattern of ocean currents is called the “conveyor belt” and it influences ocean circulation around the rest of the globe.

Locally, many people who live in Arctic depend on the ice for transportation, as well hunting. Not just polar bears and seals, but many other animals rely on Arctic sea ice for feeding, breeding, raising young, and transportation. .

HOW DOES THIS AFFECT US HERE IN THE UNITED STATES?

Arctic warming will disrupt our planet's natural air conditioner, leading to greater warming around the rest of the globe.

ACTIVITIES YOU CAN TRY:



Dr. Pfirman at the Polar Fair



The Arctic Set Up

Where will the Polar Bears go? (see script on pages 8-10)

Supplies: This can be done in a kiddie pool or a large basin. Pans marked for Svalbard and Greenland should be turned upside down in the container you select. Label these and place them so that they form the Fram Strait. Break up thin flat sections of Styrofoam to act as sea ice floes. Rubber animals can be used for fun.

Explain how the Transpolar Drift moves the sea ice from the coast of Russia across the North Pole. Then place the sea ice on the back side of the pool – representing the Arctic Ocean. Now ask the students to blow on the ice as a group and watch how the ice moves toward Greenland and Fram Strait between Greenland and Svalbard. See how some of it flows out Fram Strait into the open ocean where it melts. But also see how much of the ice circles around toward Greenland and collects there – this is the natural ice refuge, where the oldest and thickest ice accumulates.

Have students place polar bears, seals and walrus on the Styrofoam ice floes to rest. See how they naturally pick the larger floes – the smaller ones are too tippy. Explain how that is just what Arctic animals look for, and how they have trouble when they can't find floes that are large and thick enough to support their weight.

Follow Up Activity:

Have students examine the Arctic Sea Ice Extent graph below from the NSIDC (or get the most up to date graph and image at <http://nsidc.org/arcticseaicenews/>) and discuss the following. Be sure the students know this is real data:

1. The X-axis on the graph below is labeled with the summer months. The Y-axis is labeled extent cover in square kilometers. What is the graph showing? What do the different lines mean?

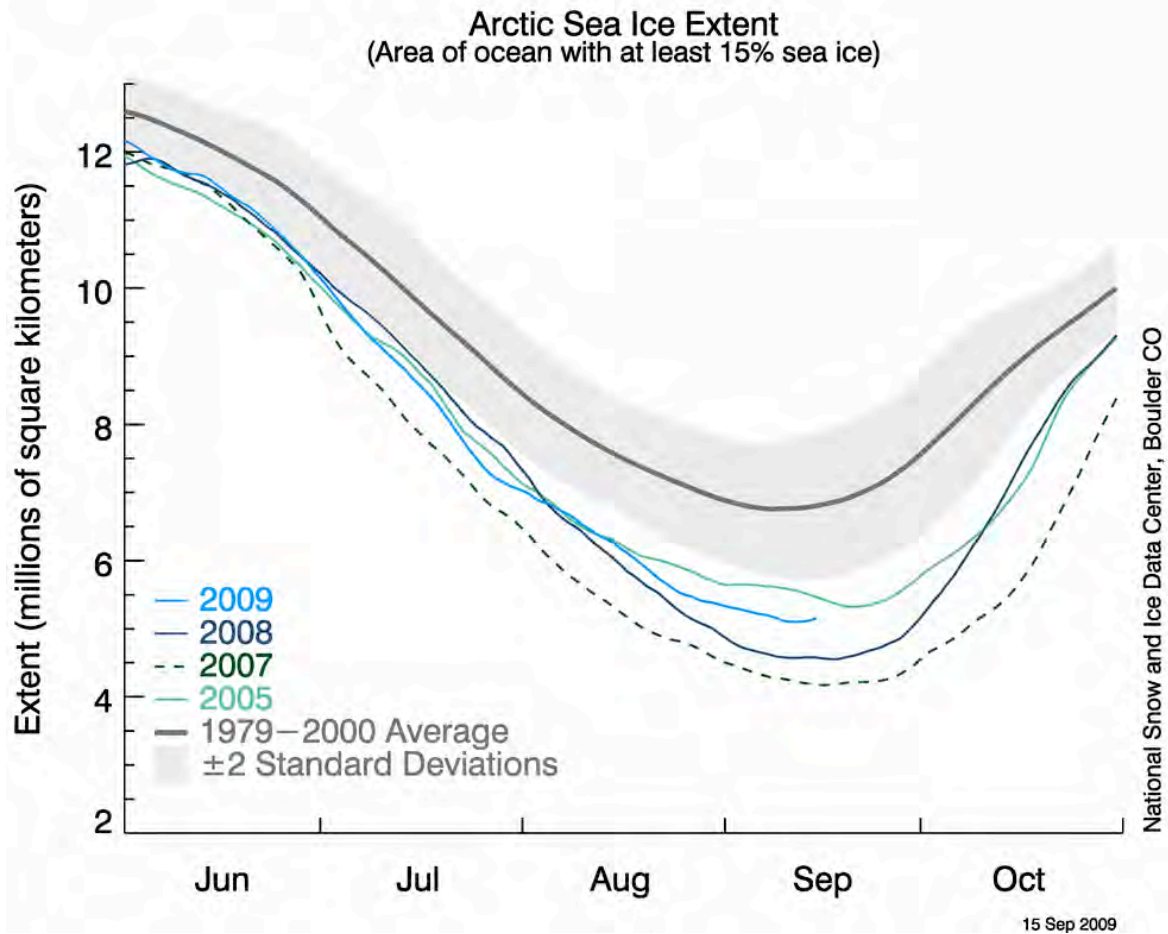
2. During what month are they at their lowest point?

3. At what month are they at their highest point?

4. Why do they change over the seasonal cycle?

5. Does 2009's data trend line higher or lower than the average 1979-2000 trend line?

3. How does the 2009 trend line compare to the data from 2007? Remember 2007 is the recorded low for Arctic Sea Ice Extent.



TO LEARN MORE ABOUT THIS TOPIC:

<http://nsidc.org/seaice/>

<http://polarbears.wwf.ca/home.html>

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Honey, We Shrunk the Ice!

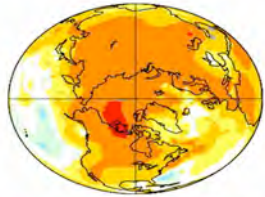
Stephanie Pfirman^{1,2}, Charles Fowler³, Bruno Tremblay^{4,2}, Robert Newton², George Durner⁵

¹Barnard College, Columbia University, ²Lamont-Doherty Earth Observatory of Columbia University, ³University of Colorado at Boulder, ⁴McGill University, Canada.

⁵U.S. Geological Survey

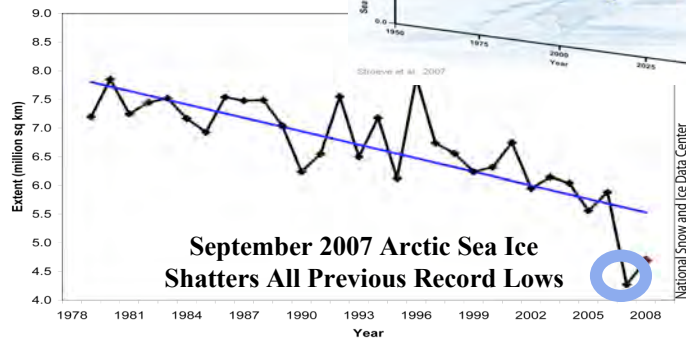
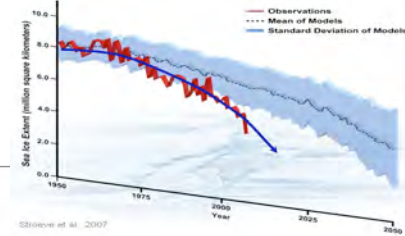
This poster is based in part upon work supported by the National Science Foundation OPP-ANS #0612455, "Vulnerability of the Arctic Marginal Ice Zone" (Pfirman, Tremblay, Newton). Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Loss of Summer Sea Ice Destroys Feeding and Breeding Habitats



Warming of Surface Air Temperature (°C) 2006-2017, NASA GISS

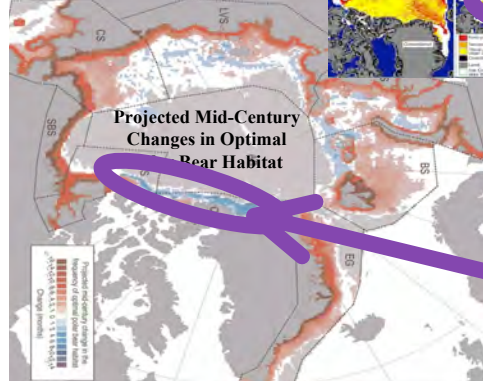
Arctic Sea Ice Melting Faster Than Any Modeled Projection



September 2007 Arctic Sea Ice Shatters All Previous Record Lows



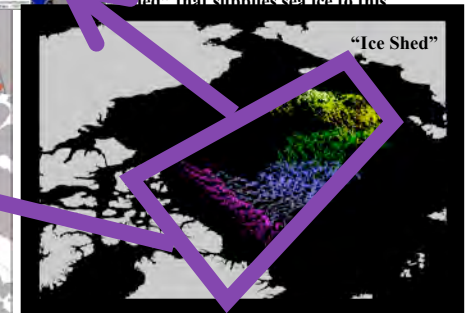
An Arctic Sea Ice Refuge?



(Durner et al., 2007 and in press)

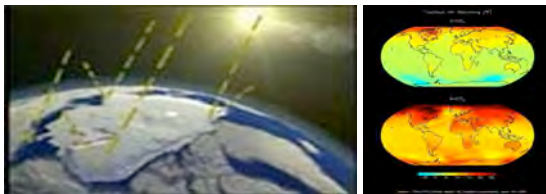
We need an integrated management plan for the Arctic as it transitions to summers without sea ice.

We need to manage development in the remaining sea ice habitat and the "ice shed" that supplies sea ice to this

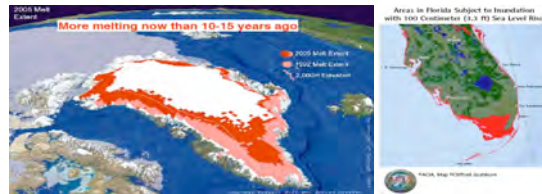


Proposed sea ice refuge, including sea ice sources. Trajectories of ice supply to the region are shown for 2007: colors change at 6 month intervals, representing 2.5 years of drift.

Arctic Sea Ice Loss Increases Warming Around the Globe



Glacier Melting Raises Sea Level Worldwide



Warming and Freshening of the Arctic Ocean Surface Could Change Global Ocean Circulation



Script for Melting Arctic Ice Demonstration

Set up kiddie pool with water, collect styrofoam pieces to represent sea ice (ca. 3" [single year ice] and some larger, and thicker ca. 5-6" diameter [multi-year ice]), 2 casserole dishes upside down to represent Greenland and Svalbard (label the bottoms)

Hold out polar bear and walrus and ask "Do you want to be a polar bear or a walrus?"

Have them pick one or the other.

Say "This exhibit is about melting Arctic ice – you've heard about that right?"

"Let's start with the polar bear – what do you think that polar bears eat?"

They often say "fish", which is wrong, but sometimes they say "seals", which is the right answer. If they say fish, then say "no, they don't have enough fat to sustain polar bears" and see if you can get them to say seals.

Then say "OK, I'm a seal – you be the polar bear and see if you can catch me" (give them the polar bear to use for this part).

Hold the seal underwater. Get them to try to chase after you in the water—sometimes they need encouragement to really come after you--wait until they're close and then scoot away underwater really fast with a splash

This will startle them – which is what you want.

Then say – "see I'm too fast in the water – you need to find some way to slow me down"

Pick up a piece of Styrofoam where you have a small hole prepared in it and poke the head of the seal up through, then put that in the water and tell them to attack you again

Then say "see, you wait for me to come up and breathe through this hole in the ice, and then you can catch me, you need the ice to slow the seals down"

Then make the point again – "so in the future, when there isn't much sea ice and the seals can just come to the surface of the water to breathe anywhere, even if there are a lot of seals, the polar bears won't be able to catch them and so won't be able to get the food they want. That's why polar bears need sea ice, to slow down the seals and narrow their surfacing area."

Now say "ok, what about walrus – what do you think that they eat? I'll give you a hint. They are so slow and lazy that they need something even slower than polar bears, so slow that it doesn't even move. What could that be?"

People often have lots of answers, including plants (not enough protein), but don't come close – you can give another hint "when you think of a slow animal, what do you think of?"

Usually they say turtle or snail – if they say turtle, you can say even slower – finally they get to snail.

Then say "right – really close, their favorite food is actually clams!"

"Do you know how many clams they eat in 1 day? I'll give you another hint – it is a lot -- each walrus weighs about 1 ton."

See what they guess – make them come to it on their own

Then say “right – they eat 5000 clams in 1 day! (p. 28-29 ref. Born’s Walrus book)

They do this by diving down to the sea bed and using their whiskers to find food, then they create a water jet from their mouth and use one of their flippers to push away the mud to find the clam. They then take it into their mouth and – do you think that they eat the whole clam? What about the shell? Could they eat 5000 clams shells in one day?”

They all say no ...

“Right that would give them a bad stomach ache -- They actually suck the meat out of each shell and then move on to the next.

On each 5 minute dive, they can eat about 50 clams, so how many clams can they eat in 1 minute?

... wait for them to calculate

10, right

OK, now if they have to eat 5000 clams in 1 day, and they can only eat 50 clams on 1 dive, how many dives do they need to make?

... wait for them to calculate

100, right ... do you think that would make them tired?

... they say yes

So they need to find a place to rest – where would you rest if you were up in the Arctic?”

Sometimes they choose the land/glaciers and sometimes they choose the ice – which is correct, they haul out on land as well as ice – but you can say “if you found a good clam bed, would you want to swim back to shore to rest or would you rather find someplace close to take a nap and then continue?”

get them to pick a piece of ice to rest on – they will pick a large piece and then say

“Why did you choose a large piece of ice?”

They’ll say because otherwise the ice won’t support them

Then say “that was a smart choice -- that’s exactly what the walrus look for too – they need a large, thick floe – that’s 1 reason why walrus need sea ice, big and sturdy enough for them to rest on.

But there’s another reason why they need the ice – what do you think would happen in a whole herd of walrus came to one clam bed and each one wanted to eat 5000 clams a day, what do you think would happen to the clam bed?”

Everyone says “it will be gone” ...

“Right – so they need to find a way to get to a new clam bed – and remember I said that they are really lazy? Can you think of any way they can get to a new clam bed without swimming?”

Often they say the ice

“Yes -- they can just hitch a ride on an ice floe and drift to another area where the clams aren’t already eaten”

So that’s 2 reasons why we’re concerned about the future of walrus when there is less sea ice – they can’t haul out and rest, and it will be harder for them to get to new clam beds

The projection for the future is that we will keep losing sea ice as the climate continues to warm, causing problems for walrus and polar bears

– but there is 1 place where we might have ice for a long time and we are working to protect that area.

Do you want to know where it is?

... usually they say at the north pole --

“Actually it’s not there -- you can help figure it out where it will be – all the kids stand over here.” (Look at the photo of the activity in the write up and position the kids to stand where Russia is, opposite Greenland & Svalbard.) “You will be the cold north polar wind, coming from Siberia, when I say ‘blow’, I want you all to get down to the level of the pool and blow as hard as you can on the ice, and we’ll see where it goes”

As you’re saying the above, move all the ice up close to them, and on the opposite side of Greenland

“Now blow”

What will happen is that the ice will move across the pool toward Greenland and cluster there

Then say, “see what happened? All the ice moved across the Arctic to the region north of Greenland and that’s exactly what will happen in the future

When there is less and less ice, the wind will blow the ice that is left across the Arctic and it will accumulate in this one spot, so we are trying to protect it from being developed.”

Shift now to talk to the parents

Say “There is a lot of oil and gas in the Arctic, as well as major fisheries – so it could be that the region becomes more polluted in the future – and we’re trying to make sure that this one region stays free of development so that animals like polar bears and walrus that need ice can survive for as long as possible into the future”

Addressing the group of parents and kids as a family unit: “You can help by doing what you can to reduce global warming. What are some things that you can think of that your family can do?”

(They could list any number of energy saving activities – walking more, turning the heat & air cooler down at home, use energy saving appliances, take shorter showers, change your light bulbs etc.)

References:

S.L. Pfirman et al. The last Arctic sea ice refuge. American Geophysical Union annual meeting, 12/16/10.

E. Born, Walrus in Greenland, 2005, published by Ilinniusiorfik.