EDU-ARCTIC2 TOOL-KIT

TUNDRA ANIMALS AND CLIMATE CHANGE

The tundra is a harsh and brutally cold place in winter. Only the thoughest survive..

Will the toughness of tundra animals be their benefit or their bane in a changing climate?

Photo shows the polar fox, by Jo Jorem Aarseth

You can always navigate back to this main menu. Look for the menu symbol.

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Step 1 Introduction

Step 2 Understand

Step 3 Explore

Step 4 Reflect

Step 5 Wrap-up

Step 1 of 5: Introduction

Tundra animals and climate change

Pst!

LEARNING GOALS

After using this tool-kit, the goal is that the Student

1. KNOWS WHAT AND WHERE IS TUNDRA
2. UNDERSTANDS ONGOING CLIMATE CHANGE ON THE TUNDRA
3. CAN OUTLINE POSSIBLE EFFECTS OF CLIMATE CHANGE ON TUNDRA ANIMALS
4. GRASPS HOW TUNDRA ANIMALS ARE WORSE OFF THAN TAIGA ANIMALS IN A CHANGING CLIMATE

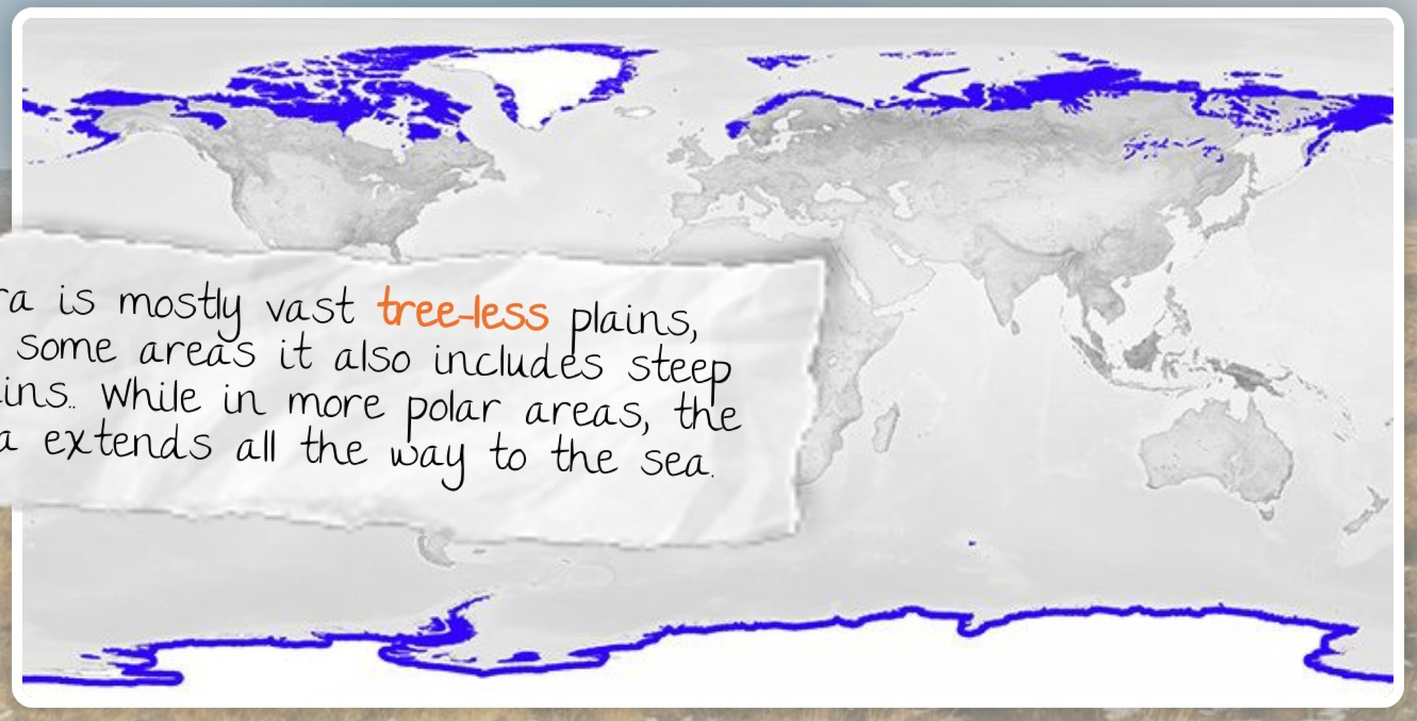
Why is this important?

THE TUNDRA IS THE LAST STOP ON LAND ON EARTH.
IF TUNDRA ANIMALS CANNOT COPE WITH CLIMATE CHANGE, THEY CANNOT GO FURTHER UP OR NORTH.
IF SO, THE SPECIES ARE AT HIGH RISK OF GOING EXTINCT

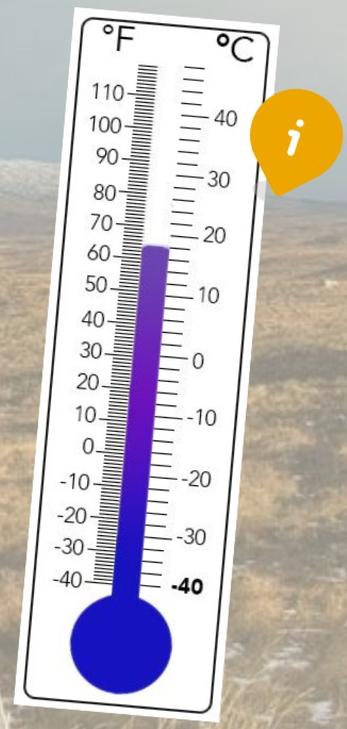
SHORT INTRO TO TOPIC

THE TUNDRA IS FOUND IN THE VERY NORTH AND THE VERY SOUTH ON THE GLOBE.

IT IS THE COLDEST BIOME ON EARTH. IT GETS LESS RAINFALL THAN MANY DESERTS, BUT THE COLDNESS CAN STILL MAKE IT A DAMP AND FOGGY AREA IN SUMMER.

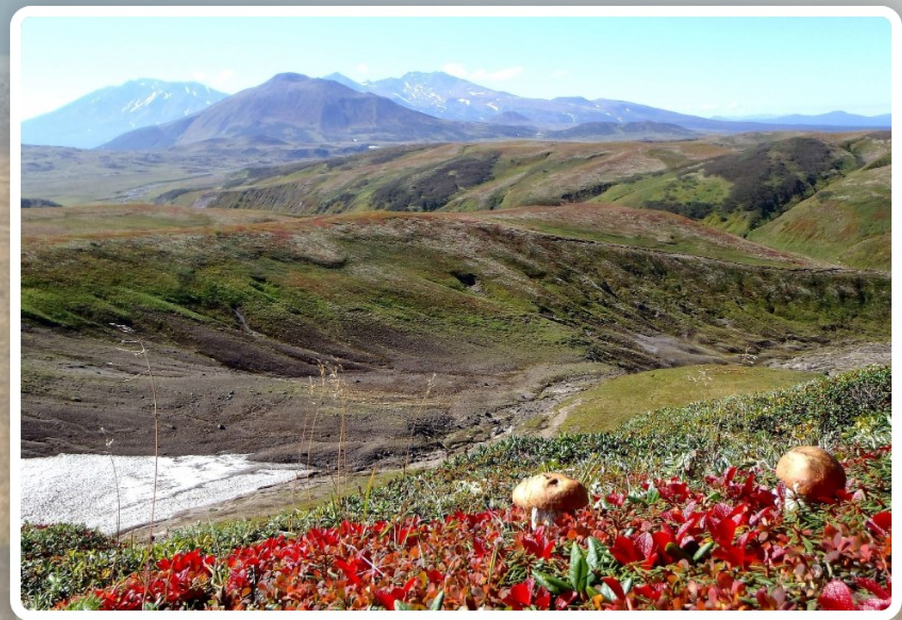


Tundra is mostly vast tree-less plains, but in some areas it also includes steep mountains. While in more polar areas, the tundra extends all the way to the sea.



What sets tundra apart from other biomes?

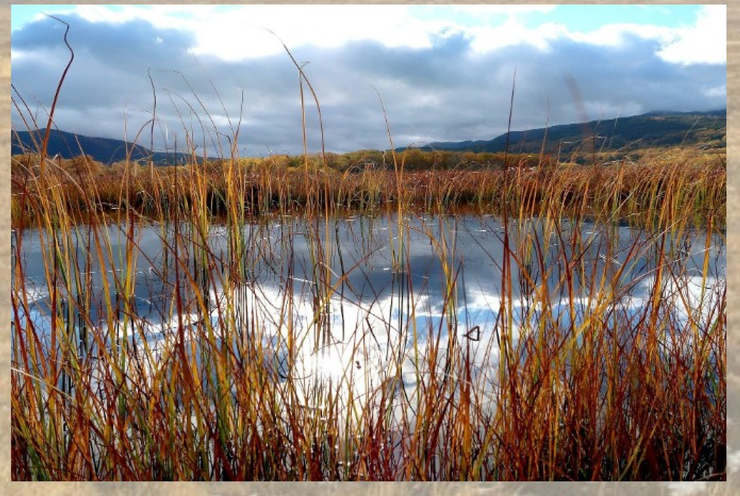
THERE ARE TWO MAIN TYPES OF TUNDRA. WHAT SEPARATES THEM IS THE REASON WHY THEY ARE SO COLD. THE ARCTIC/ANTARCTIC TUNDRA (LARGE TREE-LESS PLAINS IN POLAR AND SUBPOLAR AREAS) IS COLD BECAUSE IT IS **SO FAR NORTH OR SOUTH**. THE ALPINE TUNDRA (TREE-LESS MOUNTAIN AREAS) IS COLD BECAUSE IT IS **SO HIGH ABOVE SEA LEVEL**.



Really interested?
Here's a movie for you

THE VEGETATION ON THE TUNDRA IS SHORT. THE HARSHER THE AREA, THE SHORTER THE VEGETATION. TYPICAL PLANTS ARE DWARF SHRUBS (WILLOWS AND BIRCHES), LICHEN, SEDGE/GRAS, MOSSES, AND MORE RARELY MUSHROOMS AND FLOWERING PLANTS.

THIS MEANS FOOD IS NOT EASILY AVAILABLE TO PLANT-EATERS. IN CONTRAST TO THE TAIGA, A TUNDRA SELDOM HAS PLANTS REACHING ABOVE SNOW IN WINTER. THERE ARE NO LUSH HERB MEADOWS IN SUMMER OR FRUITFUL BILBERRY FIELDS IN AUTUMN.

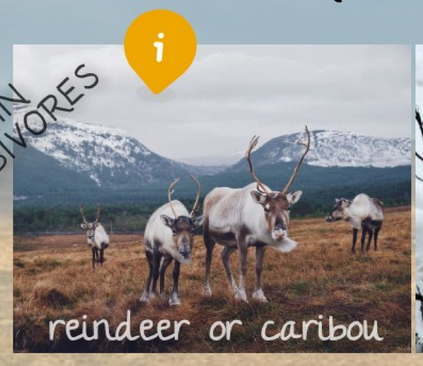


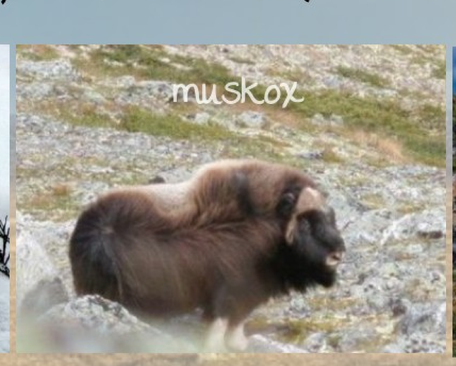
Cold is also beauty?

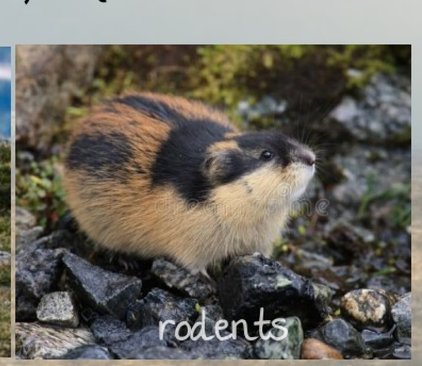
WITH SCARCE FOOD FOR PLANT-EATERS (HERBIVORES), THERE CAN NEITHER BE MANY MEAT-EATERS (CARNIVORES). BECAUSE THE CARNIVORES LIVE OFF THE HERBIVORES. MANY SPECIES LIVE ON THE TUNDRA ONLY IN SUMMER, AND THEN MIGRATE SOUTH.

THE "TRUE" TUNDRA ANIMALS, THAT LIVE ON THE TUNDRA YEAR-ROUND, ARE FEW.

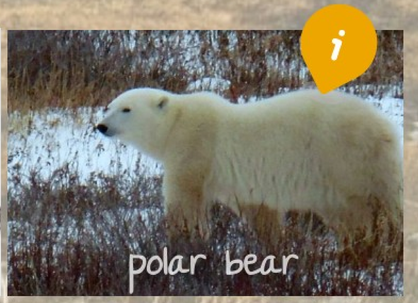
MAIN HERBIVORES







MAIN CARNIVORES



Tap the words!

Terms to learn

KEY-STONE SPECIES

SCAVENGER

SNOW CRUST

POPULATION CYCLE

TREE-LINE

PERMAFROST

Click here for a plain text version

Prepared to see if you understood the TUNDRA terms?

Step 2 of 5: Understand

Tundra animals and climate change

CLIMATE CHANGE ON THE TUNDRA

THE TEMPERATURES ARE RISING

THIS IS THE BASIS OF ALL CLIMATE CHANGE ON THE TUNDRA.

CLIMATE CHANGE EFFECT

#1

PERMAFROST IS MELTING

= BAD NEWS FOR MOST OF THE TUNDRA ANIMALS

?

CLIMATE CHANGE ON THE TUNDRA

CLIMATE CHANGE EFFECT

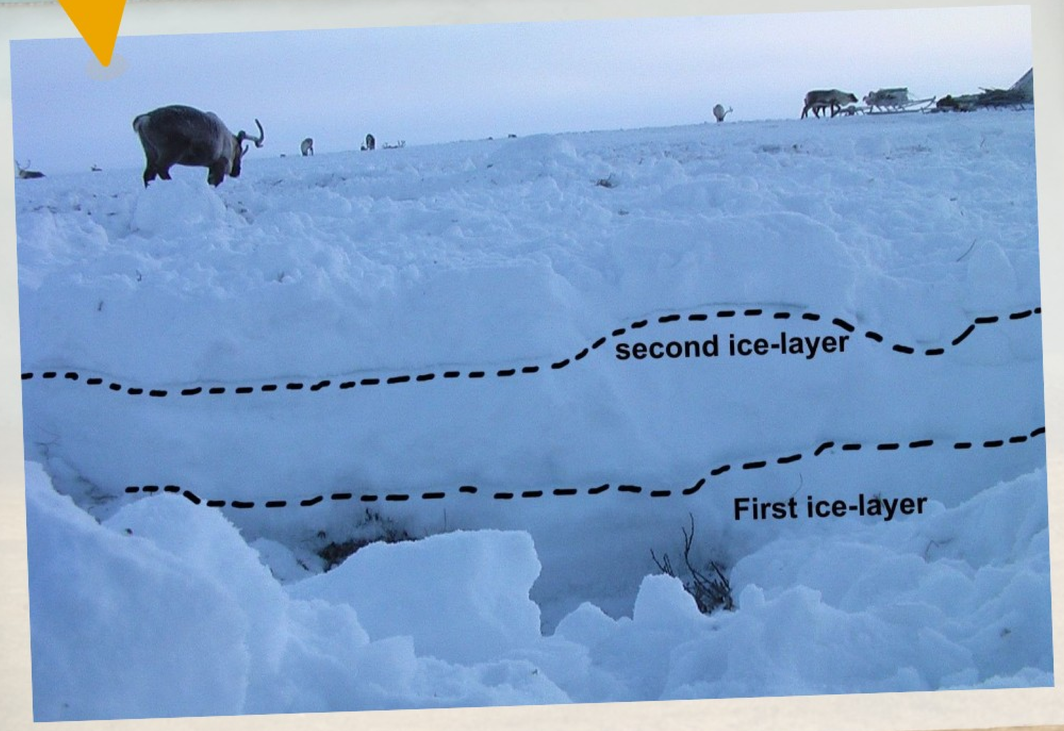
#2

THE TAIGA (BOREAL FOREST) EXPANDS INTO THE TUNDRA .

SO THERE WILL BE LESS TUNDRA!

= BAD NEWS FOR TUNDRA ANIMALS

CLIMATE CHANGE ON THE TUNDRA



CLIMATE CHANGE EFFECT

#3

PRECIPITATION IS CHANGING

ESPECIALLY SNOW CONDITIONS CHANGE CHARACTERISTICS

= BAD NEWS FOR TAIGA ANIMALS

MORE ABOUT THIS EFFECT OF CLIMATE CHANGE LATER!

CLIMATE CHANGE ON THE TUNDRA

CLIMATE CHANGE EFFECT

#4

SHORTER WINTERS

AND LONGER SUMMERS.

?

= BOTH GOOD AND BAD NEWS
FOR THE TUNDRA ANIMALS

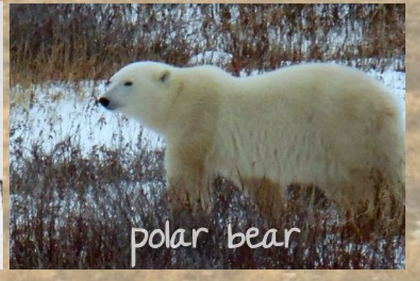
_____:

HERE ARE SOME VIDEOS FOR THOSE WHO WANT TO STUDY THE NORMAL BIOLOGY OF TUNDRA ANIMALS BEFORE WE LOOK AT EFFECTS OF CLIMATE CHANGE

CLICK THE PHOTO TO SEE VIDEO

HERBIVORES

CARNIVORES



TYPES OF POSSIBLE EFFECTS ON THE ANIMALS

- MISMATCH OF SPRING ARRIVAL
- EXHAUSTION FROM MOVING THROUGH MORE SNOW
- MORE DANGEROUS SITUATIONS (AVALANCHES, ICE, DROWNING, LIGHTENING)
- CHANGES IN FOOD AVAILABILITY
- INCREASED INSECT ATTACKS
- MORE PRONE TO (NEW) DISEASES
- CHANGES IN COMPETITION BETWEEN SPECIES

WHICH EFFECTS ON WHICH ANIMALS?

LARGE AND SMALL HERBIVORES (= PLANT EATERS)

- MISMATCH OF SPRING (SHEDDING WINTER COAT AFTER SNOW HAS MELTED AND GIVING BIRTH AFTER PLANT BUD BURST).
- NEEDING MORE FOOD IF THEY MUST WALK IN DEEPER SNOW THAN HAS BEEN THE NORMAL
- LIKELY BETTER ACCESS TO FOOD IN SUMMER (LONGER SEASON WITH FRESH PLANTS).
- BUT WORSE ACCESS TO FOOD IN AUTUMN/WINTER (DUE TO E.G. ICING)
- ALTERED SNOW CHARACTERISTICS CAN AFFECT HOW VULNERABLE THEY ARE TO PREDATORS.

HERBIVORES

reindeer or caribou

ptarmigan

muskox

mountain goats / sheeps

rodents

WHICH EFFECTS ON WHICH ANIMALS?

LARGE AND SMALL HERBIVORES (= PLANT EATERS)

- MEETS MORE NUMEROUS AND NEW SPECIES OF INSECTS AND MICROBIOTA, WHICH BITE, SUCK BLOOD AND SPREAD DISEASES (DETTE HAR DE TIL FELLES MED KJØTT-ETERNE)
- MEETS MORE OPEN WATER AND LARGER QUANTITIES OF WATER IN THE SPRING WHEN THEY MIGRATE. MAY LEAD TO MORE DROWNING OR THEY HAVE TO FIND OTHER WAYS TO MIGRATE
- MEETS LIGHTNING MORE OFTEN BECAUSE WARMER AIR IS HYDROLOGICALLY MORE UNSTABLE
- MEETS MORE OFTEN ICED AREAS AND AVALANCHES BECAUSE THE SNOW BECOMES MORE LAYERED AS A RESULT OF THE CHANGES IN WHICH PRECIPITATION FALLS WHEN

HERBIVORES

reindeer or caribou

ptarmigan

muskox

mountain goats / sheeps

rodents

WHICH EFFECTS ON WHICH ANIMALS?

LARGE AND SMALL CARNIVORES (= MEAT EATERS)

- MISMATCH OF SPRING (SHEDDING WINTER COAT AFTER SNOW HAS MELTED).
- DEEPER SNOW CAN MAKE IT BOTH EASIER OR MORE DIFFICULT TO CATCH PREY.
- SAME WITH MORE BOGS (FORMING WHEN PERMAFROST IS MELTING)
- INCREASING HEAT STRESS IN SUMMER
- MAY ENCOUNTER NEW DISEASES, IF NEW SPECIES MOVES INTO THE TUNDRA (THIS CHALLENGE IS SHARED BY BOTH HERBIVORES AND CARNIVORES)
- STRONGLY DEPENDENT UPON WHAT HAPPENS TO THEIR PREY

Caribou has a secret weapon against wolves!

CARNIVORES

PROGRESS METRE

60%

YOU HAVE NOW COMPLETED THIS MUCH OF THE INTERACTIVE ROOM

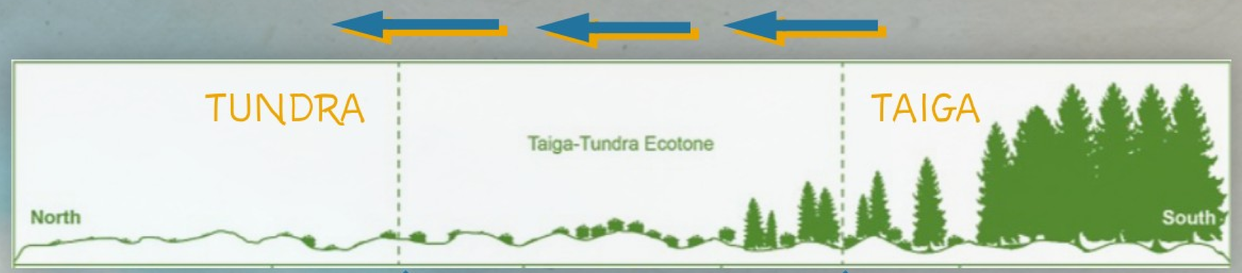
WHY TUNDRA IS WORSE OFF THAN TAIGA

TUNDRA ANIMALS ARE LIVING IN A HARSHER ENVIRONMENT THAN TAIGA ANIMALS.

NOT ONLY WEATHER-WISE, BUT THEY ALSO HAVE TO TRAVEL VAST DISTANCES TO OBTAIN FOOD, INCLUDING RIVER CROSSINGS AND HORDS OF INSECTS.

THEY DO NOT HAVE AS MUCH MARGIN TO HANDLE ADDITIONAL CHALLENGES FROM A CLIMATE THEY ARE NOT ADAPTED TO.

WHY TUNDRA IS WORSE OFF THAN TAIGA



THE AREA OF TUNDRA IS DECREASING.

IT CANNOT INCREASE.

AS SOON AS THE TUNDRA HAS BECOME WARM ENOUGH FOR TREES TO GROW, IT TURNS INTO TAIGA.

SO, TUNDRA ANIMALS ARE LOSING THEIR LAND

how are scientists studying this? Click photo to see

CONCLUSIONS

"THE AREA OF TUNDRA IS DECREASING. THIS IS OF COURSE BAD NEWS FOR ALL TUNDRA ANIMALS.

"WITH CLIMATE CHANGE, THERE IS ALSO MORE FREQUENT ICING IN AUTUMN/WINTER, WHICH BLOCKS THE ONLY ACCESS TO FOOD FOR PLANT EATERS, ALTHOUGH ALSO A LONGER SUMMER, WITH EASIER ACCESS TO FOOD. EARLIER SPRING CREATES MISMATCH IN TIMING OF BIRTH AND MIGRATIONS, OR PREY CAMOUFLAGE. PERMAFROST IS MELTING = MORE INSECTS. WITH THE HIGHER TEMPERATURES POSSIBLY ALSO COME NEW MICROBIOTIC DESEASES.

"IMPORTANTLY, THE TUNDRA IS THE LAST STOP ON LAND ON EARTH IF TUNDRA ANIMALS CANNOT COPE WITH CLIMATE CHANGE,

THEY CANNOT GO FURTHER UP OR NORTH.

IF SO, TUNDRA SPECIES ARE AT HIGH RISK OF GOING EXTINCT

Step 3 of 5: Explore

Tundra animals and climate change

THE MOON IS RISING OVER THIS TUNDRA LESSON. GO TO THE EXPLORER'S LAB TO SORT YOUR FIELD NOTES. THEN YOU WILL SEE THE FINAL TAKE-HOME MESSAGE!

Afterwards there is also an exercise to do in groups

Be the source-scrutinizing researcher!

NOW IT IS YOUR TURN TO SCRUTINIZE THE SOURCE DILIGENCE OF THE AUTHORS OF THIS TOOL-KIT (WHO ARE, AMONG OTHERS, RESEARCHERS IN WILDLIFE BIOLOGY). WRITE YOUR FINDINGS IN FULL SENTENCES OR MAKE A CREATIVE FILE (AUDIO, VIDEO, DRAWING ETC.).

THIS EXERCISE IS BEST DONE IN SMALLER GROUPS. YOU CAN ALSO DO IT INDIVIDUALLY, BUT YOU SHOULD COME TOGETHER IN CLASS FOR A GROUP DISCUSSION WHEN YOU HAVE COMPLETED THE QUESTIONS.

IN THIS TOOL-KIT, WE TOLD YOU THAT REINDEER/CARIBOU NOW ENCOUNTERS MORE DANGEROUS SITUATIONS THAN BEFORE, DUE TO CLIMATE CHANGE. WE MENTIONED SPECIFICALLY: RIVER CROSSINGS, ICE, AVALANCHES AND LIGHTENING.

1) IDENTIFY ALL THE PLACES WHERE THIS WAS STATED IN THE TOOL-KIT, AND COPY THE STATEMENTS INTO A LIST, ALONG WITH ANY EVENTUAL REFERENCING TO SOURCE MATERIAL THAT WAS GIVEN FOR THE STATEMENT.

2) LOOK CLOSELY AT THE CHOICE OF WORDING IN THE STATEMENTS. ARE THE STATEMENTS SAYING THIS IS A FACT, OR ARE THEY SAYING THIS COULD BE HAPPENING (NOW OR IN FUTURE)?

3) LOOK UP THE REFERENCES THAT WERE GIVEN AS SOURCES. EVALUATE IF YOU THINK THESE ARE SCIENTIFICALLY SOUND REFERENCES TO BACK UP THE STATEMENTS.

4) AFTER LOOKING AT SOURCE MATERIAL, AND MAYBE GOING EVEN FURTHER AND LOOK UP OTHER SOURCES TOO, GIVE YOUR VERSION OF WHETHER REINDEER/CARIBOU ARE EXPERIENCING MORE FREAK ACCIDENTS NOW THAN BEFORE, DUE TO CLIMATE CHANGE. BE DILIGENT IN BACKING UP YOUR OWN STATEMENT!

NOW, DON'T BE HESITANT TO BE CRITICAL! SCIENTISTS CAN BE SLOPPY, FORGETFUL OR EVEN IF THEY ARE GREAT SCIENTISTS, THEY MAY JUST NOT BE SO GOOD AT EXPRESSING THEMSELVES.

Step 4 of 5: Reflect

Tundra animals and climate change

Look at the learning goals again

- KNOWS WHAT AND WHERE IS TUNDRA
- UNDERSTANDS ONGOING CLIMATE CHANGE IN THE TUNDRA
- CAN OUTLINE POSSIBLE EFFECTS OF CLIMATE CHANGE ON TUNDRA ANIMALS
- GRASPS HOW TUNDRA ANIMALS ARE WORSE OFF THAN TAIGA ANIMALS IN THE CHANGING CLIMATE

PICK THE LEARNING GOAL THAT YOU THINK IS THE MOST IMPORTANT. THEN WRITE A SHORT ESSAY OF AT LEAST 200 WORDS OR MAKE A CREATIVE FILE (AUDIO, VIDEO, DRAWING ETC.) ABOUT WHY THIS LEARNING GOAL IS SO IMPORTANT. WHY IS IT IMPORTANT THAT YOU LEARNT IT? WHY IS IT IMPORTANT FOR THE SOCIETY OR THE EARTH?

Step 5 of 5: Wrap-up

Tundra animals and climate change

Four learning goals and a take-home-message

5

KNOWS WHAT AND WHERE IS TUNDRA 1

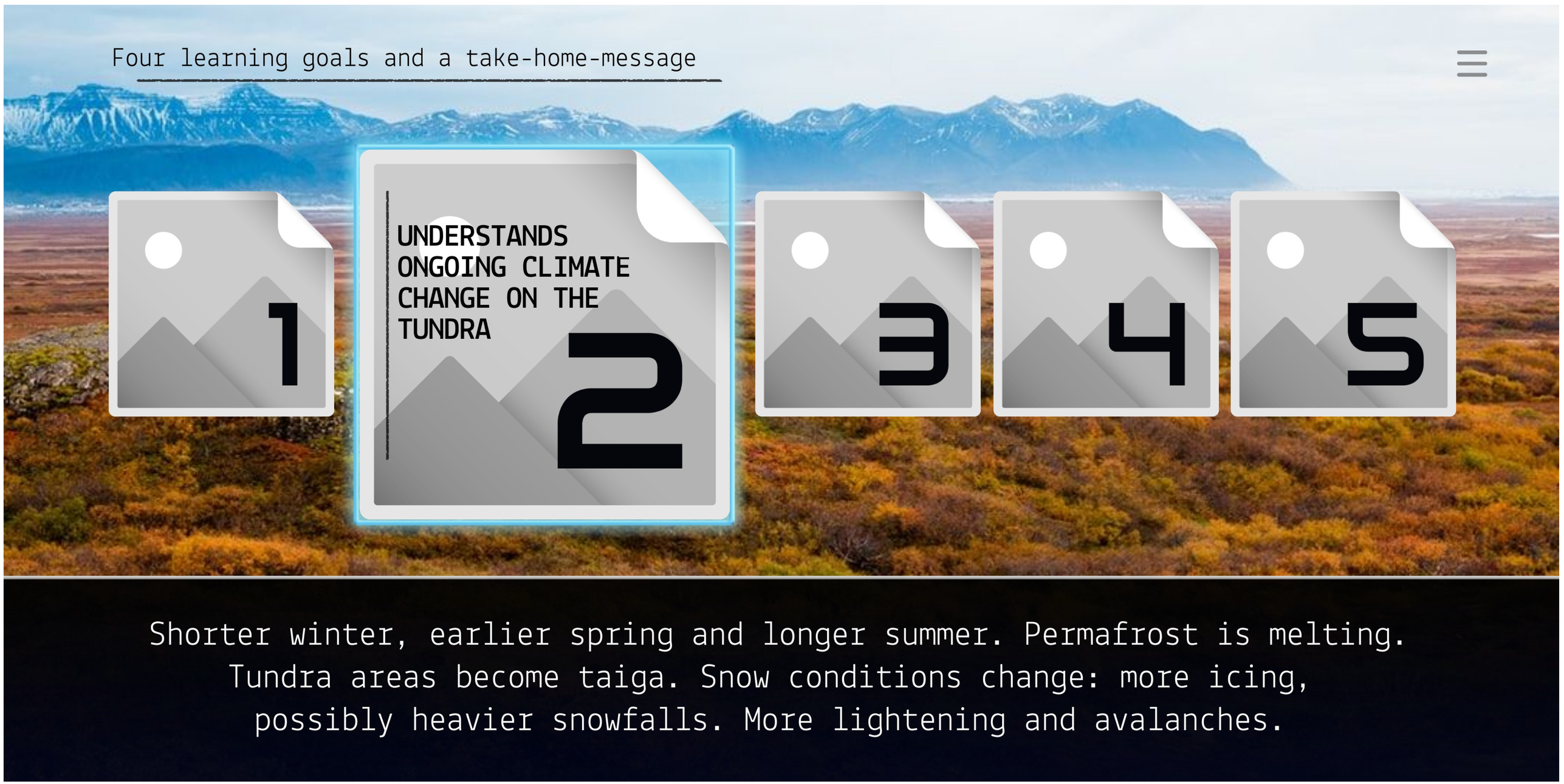
2

3

4

Muscic courtesy by Alexander Blu https://orangefreesounds.com/

Tundra is the coldest biome. Found in the very south and the very north on Earth. Too cold for trees to grow. There are two types: alpine (mountains) and arctic/antarctic (large flat plains).



Shorter winter, earlier spring and longer summer. Permafrost is melting. Tundra areas become taiga. Snow conditions change: more icing, possibly heavier snowfalls. More lightening and avalanches.

Four learning goals and a take-home-message

2

CAN OUTLINE POSSIBLE EFFECTS OF CLIMATE CHANGE ON TUNDRA ANIMALS

3

4

5

1

Mismatch of spring, exhaustion in unusual snow depths, more freak accidents (avalanches, ice, drowning, lightening), changes in food access, increased insect attacks and (new) deseases, altered species competition (who gets to eat or will be eaten).

They live in a harsher environment, with less margins to handle new challenges. Must travel vast and increasingly dangerous distances for food (e.g., river crossings, high mountains). Perhaps most importantly, they are losing land as tundra turns into taiga...

Four learning goals and a take-home-message

Tundra is the last stop on land on Earth. If tundra animals cannot cope with climate change, they cannot go further up or north. If so, the species are at high risk of going extinct.

Tundra animals and climate change

Tundra on Iceland. Photo: Einar H. Reynis

END OF TOOL KIT