Life Zones Reflect Climate: Climate Change Demands Future Planning

Category

Art, Science, Geography

Materials

Colored Pencils, Ruler, Scissors, Glue

Holdridge Life Zones Templates (Included)

Real World Connection

Ecosystems, Climate, Future Planning

Problem Question

How can the knowledge of Earth's life zones help us to prepare for changes in the habitat of various plant species?

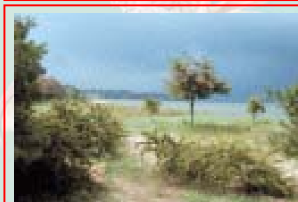
Prior Knowledge What I Know	Conclusion What I Learned
Based on your prior knowledge, answer the problem question to the best of your ability.	*Answer the problem question after completing the activity. Include an example in your answer.*

Background – Part 1

More and more often, casual hikers exploring the outdoors are noticing plants that are out of place — plants growing in places where they did not survive in the past — and others disappearing from places where they had once been plentiful. Plants are appearing in the desert and disappearing from the rain forest — appearing at high altitudes and disappearing from oceans. Why?

Vegetation growing, or not growing — in a natural setting, either on land or at sea — causes curiosity, but not much concern ... that is, until we realize how a changing plant environment might personally affect us: plants provide food, shelter, medicine, recreation — virtually touching all areas of our lives!

By carefully collecting and analyzing data, researchers can help us to better understand and react to changes that we observe.



Pre-Procedure

Describe the climate in each picture as dry or wet, warm or cool, high altitude or sea level. Use the space below each picture.

For example...

Food!

What food might be affected?

Obviously fruits, like apples, oranges, bananas and vegetables like carrots, onions, spinach and potatoes because they are all plants.

Not so obviously, meat like hamburger, steak, chicken, and turkey. Why? Most livestock in the United States either graze on plants or are fed corn to fatten-up for market.

And surprisingly, sweets! For example, candy, cake, and gum use sugar, flour, chocolate, mint, and vanilla – all come from plants!

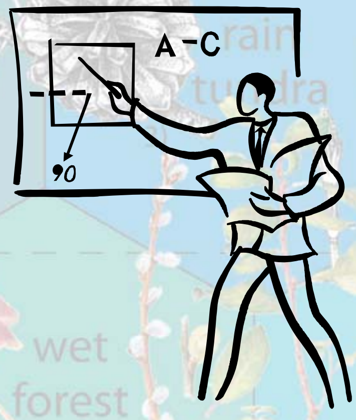
Equally surprisingly, seafood like fish, clams, and coral survive on sea plants.

Think about it ...

What effect might even a small change in plant availability have on you?

- What causes plants to change where they grow?
- How does climate affect plant growth and location?
- How will changing plant growth affect your food supply?

To help answer these and other questions, we turn to an American botanist, Leslie Holdridge, an insightful man who proposed that climate and plants form an intertwined relationship. In 1947, he developed a model to show how climate and plants are related based on three properties, temperature, humidity, and precipitation.



Today, the Holdridge Life Zones Diagram is an internationally recognized model, located at the International Institute for Applied Systems Analyses (IIASA) in Laxenburg, Austria. The Holdridge Model shows a combination of climate and vegetation (ecological) types, under "normal" climate conditions, and a doubling atmospheric CO_2.

More than a half century later, climate change and global warming have sparked public interest and concern. The amount of CO_2 in the atmosphere is rising. Since climate controls the location and distribution of plants (by determining temperature, humidity, and precipitation) the Holdridge Life Zones can be used to predict the impact of climate change on plants. For example, using the life zones as an ecological map allows us to predict where certain plants will grow as climate changes, and by inference, we can even predict where important water supplies might be located.

Holdridge originally used a three-dimensional model (a pyramid) to explain his unique version of Earth's life zones. For convenience, we now draw this famous triangle on a flat sheet of paper in two dimensions. Although converting three dimensions to two dimensions makes the Holdridge triangle look complicated at first glance, carrying a flat sheet of paper is a lot easier than carrying a three-dimensional object.

FYI

Climate is average weather over a long period of time – about 70 years.

Procedure – Part 1

Before you begin the procedure, assemble the two-page "Life Zones Reflect Climate" Template (Figure 15-1). Fold under the tab on the top half so the two pages line up and match. Tape the pages together on the back.

1. In Figure 15-1, under the term "potential evapotranspiration ratio", print the word "humidity".
2. Color each flower picture in Figure 15-2. Match the numbers on each plant to the number in the box labeled "Flower Color Key" on the next page. Color the unlabeled parts of plants by matching them with the labeled parts.
3. Carefully cut-out each flower shape along the dashed line.
4. Using the box labeled "Clues" on the next page, glue each flower to the Holdridge Life Zones Template (Figure 15-1). Be sure that each flower is in its correct environmental location.
5. Near each flower picture, write its common name using the initials from the box labeled "Flower Names Key" on the next page.

Procedure – Part 1 (Continued)

Humidity Provinces

Semi-parched
Superarid
Perarid
Arid
Semiarid
Subhumid
Humid
Perhumid
Superhumid

Flower Names Key

Hint: Initials of the scientific name are in parentheses to help you correctly identify each plant.

Gloxinia (s)
Cactus (o.r.)
Mushroom (a.m.)
Prairie Flowers (o.b.)
Fern (o.s.)
Algae (a)
Conifer (p.c.)
Orchid (a.v.)
Potato (s.t.)
Diatom (d)



Flower Color Key

1 = red	5 = lavender	9 = tan
2 = fuschia	6 = purple	10 = brown
3 = pink	7 = yellow	11 = yellow green
4 = orange	8 = white	12 = blue green

Clues

- Most of the plants on this list will grow in more than one humidity environment (Hexagon).
- For this activity, plants are placed in the humidity environment where they are most likely to grow.

Algae
below sea level

Cactus
desert
desert scrub

Conifer
wet tundra southern
wet forest northern
rain tundra southern
sub-polar
boreal

Diatom
polar region (a type of algae)

Fern
rain forest (subalpine and montane)

Mushroom
boreal
cool temperature
moist forest

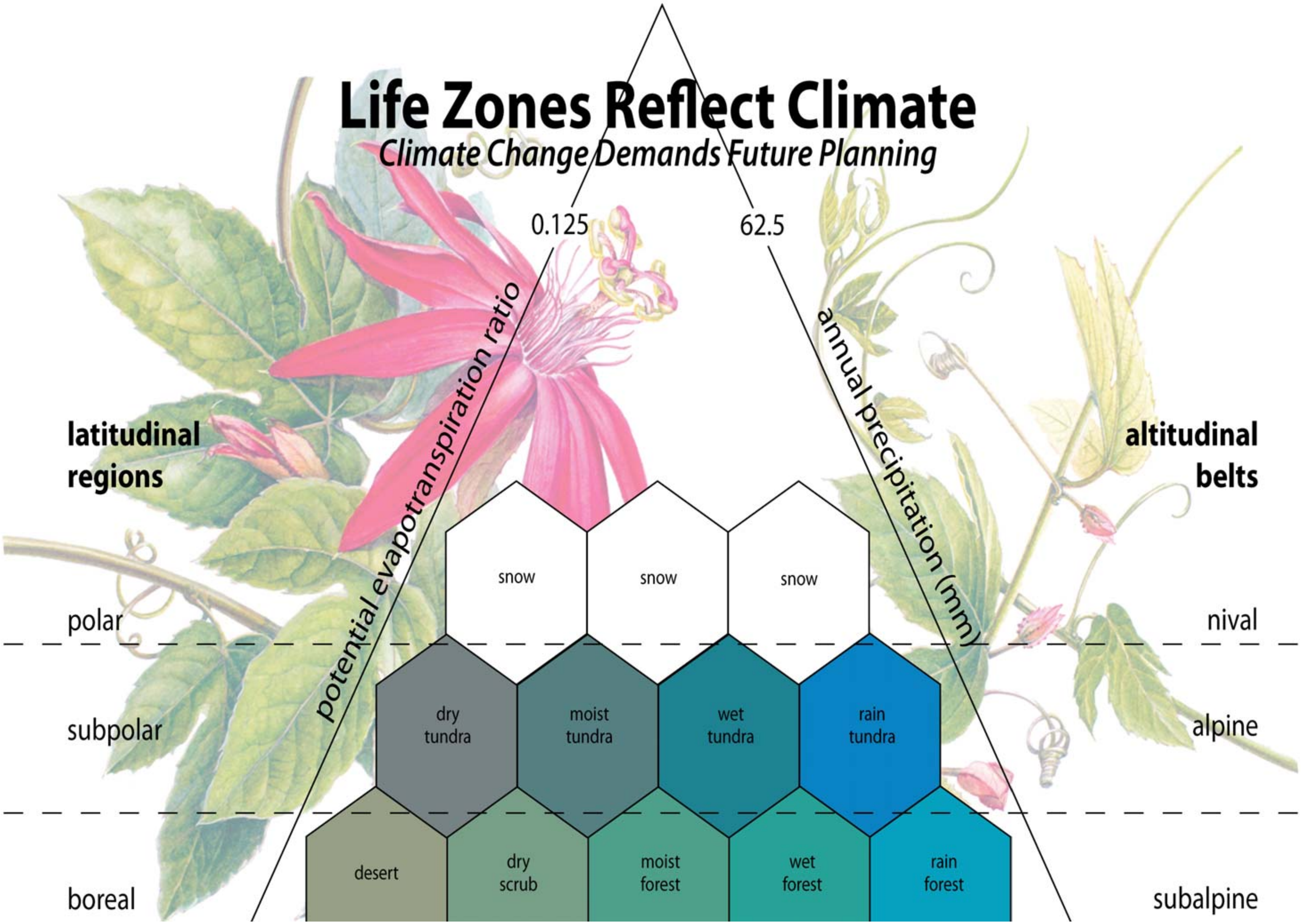
Orchid
wet forest
rain forest below frost line

Potato
dry
wide range
steppe
dry scrub
desert scrub
dry forest

Prairie Flowers
desert scrub
steppe
desert
dry scrub

Gloxinia
tropical
arid to semiarid

Figure 15-1. Holdridge Life Zones – "Life Zones Reflect Climate" Template



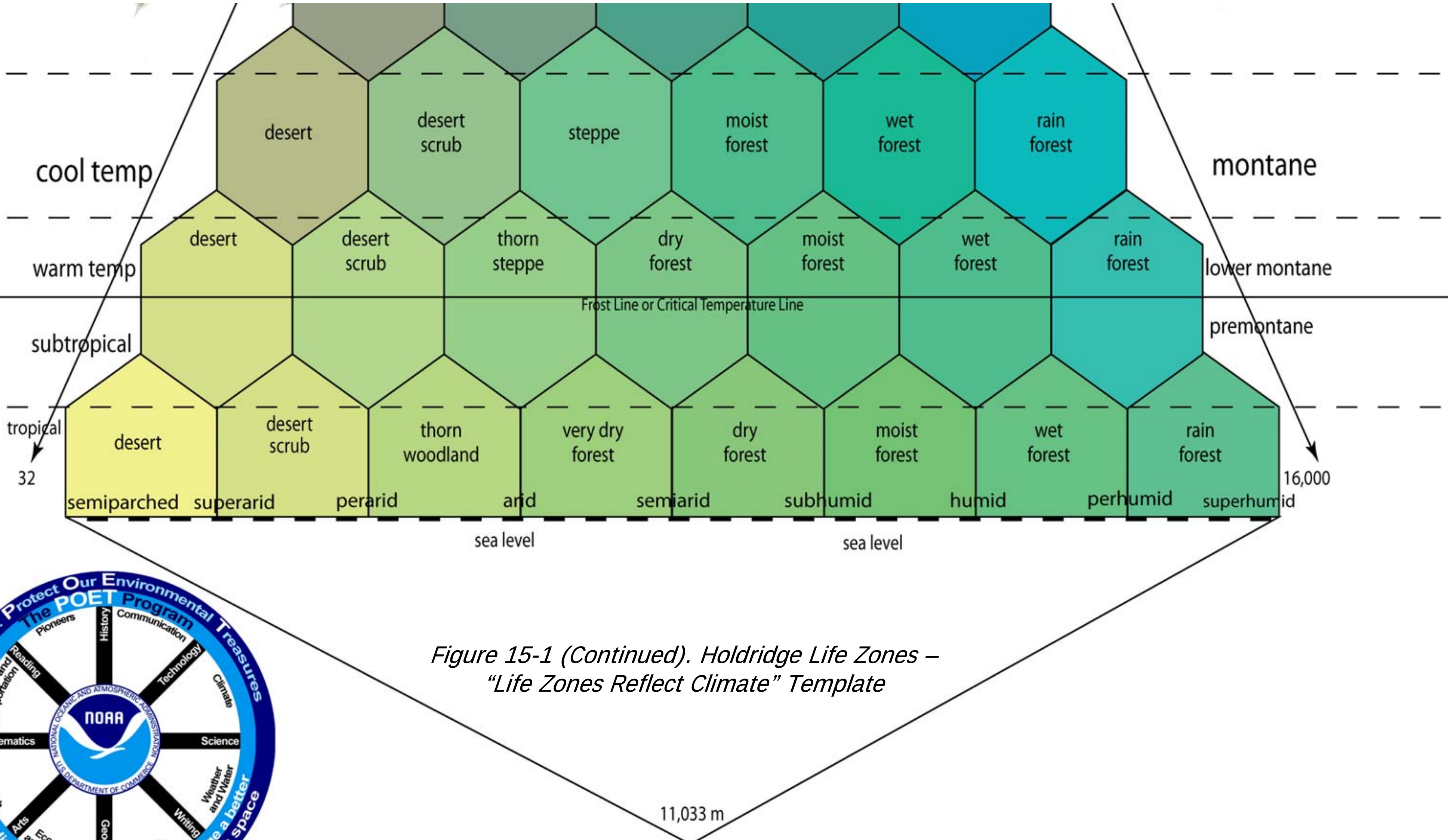


Figure 15-1 (Continued). Holdridge Life Zones –
"Life Zones Reflect Climate" Template

Floras Flourish from Mountain Peaks to Ocean Depths

From the highest reaches of the atmosphere to the bottom of the ocean, NOAA scientists conduct research to pursue a comprehensive understanding of the Earth system. This illustration of the Holdridge life zones system depicts one tool NOAA scientists use to assess potential changes in vegetation patterns due to climate change.

Coloring Sheet for "Life Zones Reflect Climate: Climate Change Demands Future Planning"

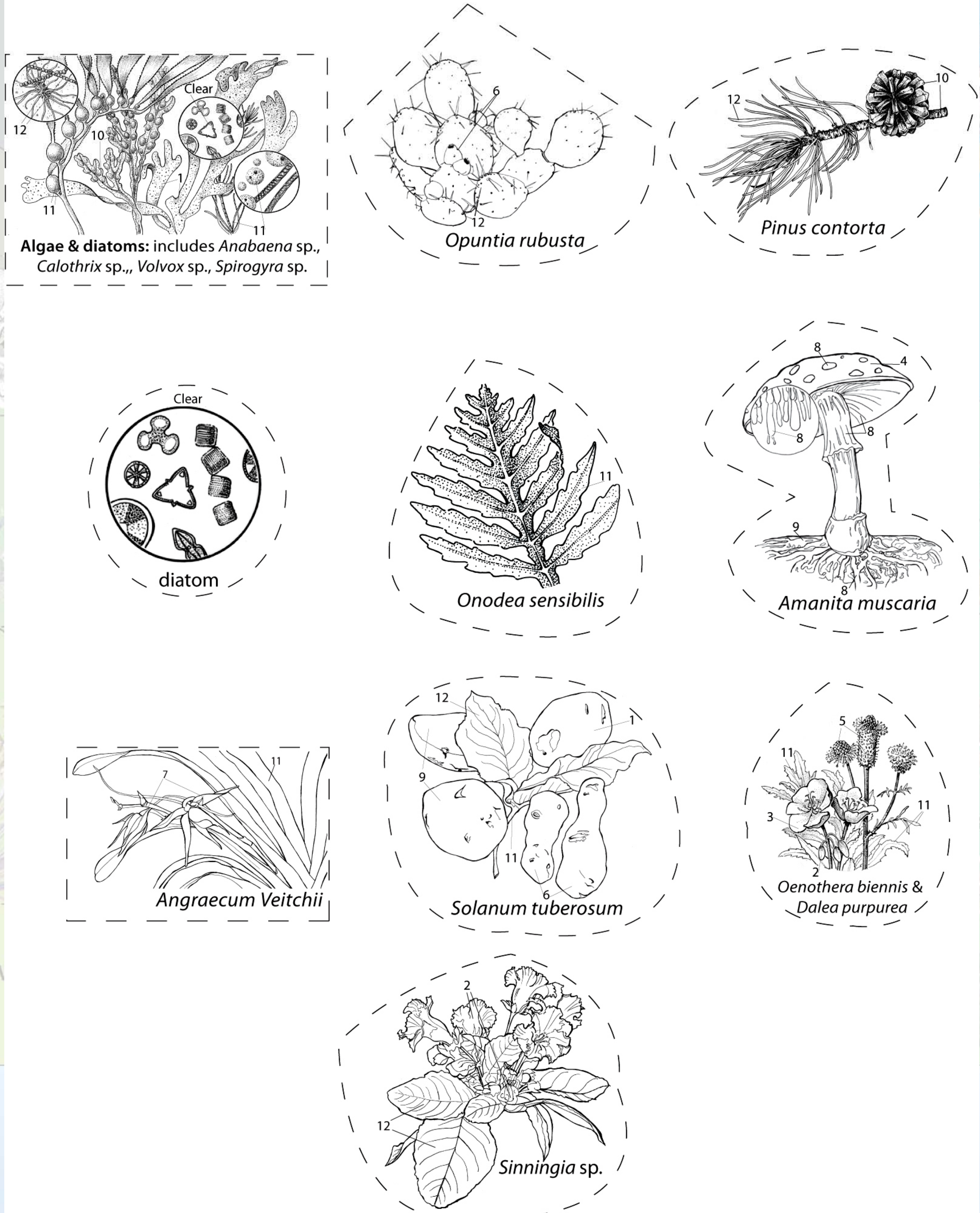


Figure 15-2. Coloring Sheet - Holdridge Life Zones – "Life Zones Reflect Climate"

Questions – Part 1

1. Name the botanist who created the life zones diagram?

Use the completed Life Zones diagram that you prepared to answer these questions.

2. In what altitude belt(s) do conifers grow?

3. In what latitude region(s) do diatoms live?

4. Name the plants from this lesson that grow in the life zone where you live.

5. How many plants or parts of plants in this lesson appear below the frost line but above sea level?

Questions – Part 1 (Continued)

6. What is the mathematical range for annual precipitation?

7. Name the plants in this lesson that grow in a cool temperate latitudinal region.

8. Approximately how much rain does an orchid require each year?

9. Using all of the features of the Holdridge Life Zones diagram, describe the environment where potatoes grow.

10. Describe the humidity range of an alpine environment.

11. If a farmer grows crops in a moist, lower montane environment and the amount of precipitation decreases slowly each year showing a downward trend, what action might (s)he take to remain in business in the same location?

Questions – Part 1 (Continued)

12. How is the climate in a region related to its life zones?

13. How might governments as well as individuals use the Holdridge Life Zones?

Did You Know That ...

Botanists of old were a lot like the bold adventure guides of today!

What we think of as boring old bookworms with magnifying glasses were actually extreme adventurers and ambitious world travelers who risked their lives for the plants they sought.

In traveling the world's far corners, botanists survived earthquakes, storms, fires, and shipwrecks. Illness, discomfort, and attacks from animals, insects, and hostile natives were routine.

Often the scientific name of a plant includes the name of the botanist who discovered it. Thus, the legacy of these heroic adventurers lives on.

Background – Part 2

Climate change, especially changes in temperature and precipitation, can have a dramatic effect on where plants grow. For an easy way to observe the effect of climate change on plants, imagine a hike, bike ride or a drive up a mountain. As you travel to higher elevations, the temperature cools and the amount of precipitation changes. You will see a change in vegetation as you travel from one life zone to another.

Now imagine how the types of plants in the geographic region where you live might respond to climate change. Keep in mind that a change in climate is very different from observing different ecosystems while on a hike or a road trip where you are in command. Climate change can be profound, causing floods in coastal areas, drought in other regions and extinction of both plant and animal species.

As the amount of greenhouse gases in Earth's atmosphere increases, changes in regional and seasonal climate patterns become more likely. In turn, these climate changes affect not only plants, but entire ecosystems. How can individual citizens and world planners anticipate and prepare for such changes?

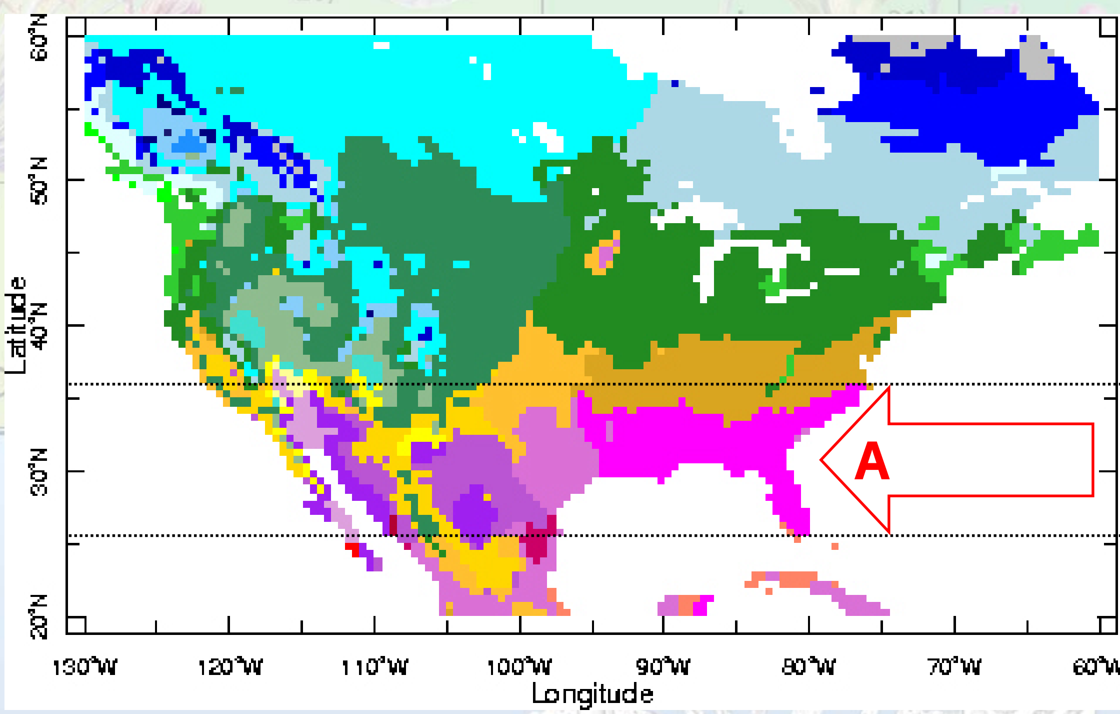
Procedure – Part 2

1. Use the Holdridge life zones maps (Figures 15-3 and 15-4) to help you visualize how ecosystems might change where you live. Created from the Holdridge Life Zones diagram, the maps show a combination of both climate and vegetation under two different conditions: 1.) CO_2 concentration under present conditions; and 2.) a doubling of CO_2 concentration. Figure 15-5 gives you a **Color and Zone Name (Life Zones Class) Key** for the two Holdridge Life Zones maps.

2. Carefully observe both maps. Notice the arrows pointing to different areas. Use the Life Zones Class Key to identify the different life zones for each arrow and fill in Table 15-1 that follows.

   To help you get started, the "Latitude Extent" for Region A under present CO_2 concentration is already filled in. Also provided is the following visual example of how this latitude extend was determined.

Ecosystems – Holdridge Life Zones – Present CO_2 Concentration (Example)



To measure latitude extent, read the southernmost latitude and the northernmost latitude, then subtract.

Northernmost Latitude Extent of Zone A (36°N)

Southernmost Latitude Extent of Zone A (26°N)

Latitude Extent of Zone A is 10°

Procedure – Part 2 (Continued)

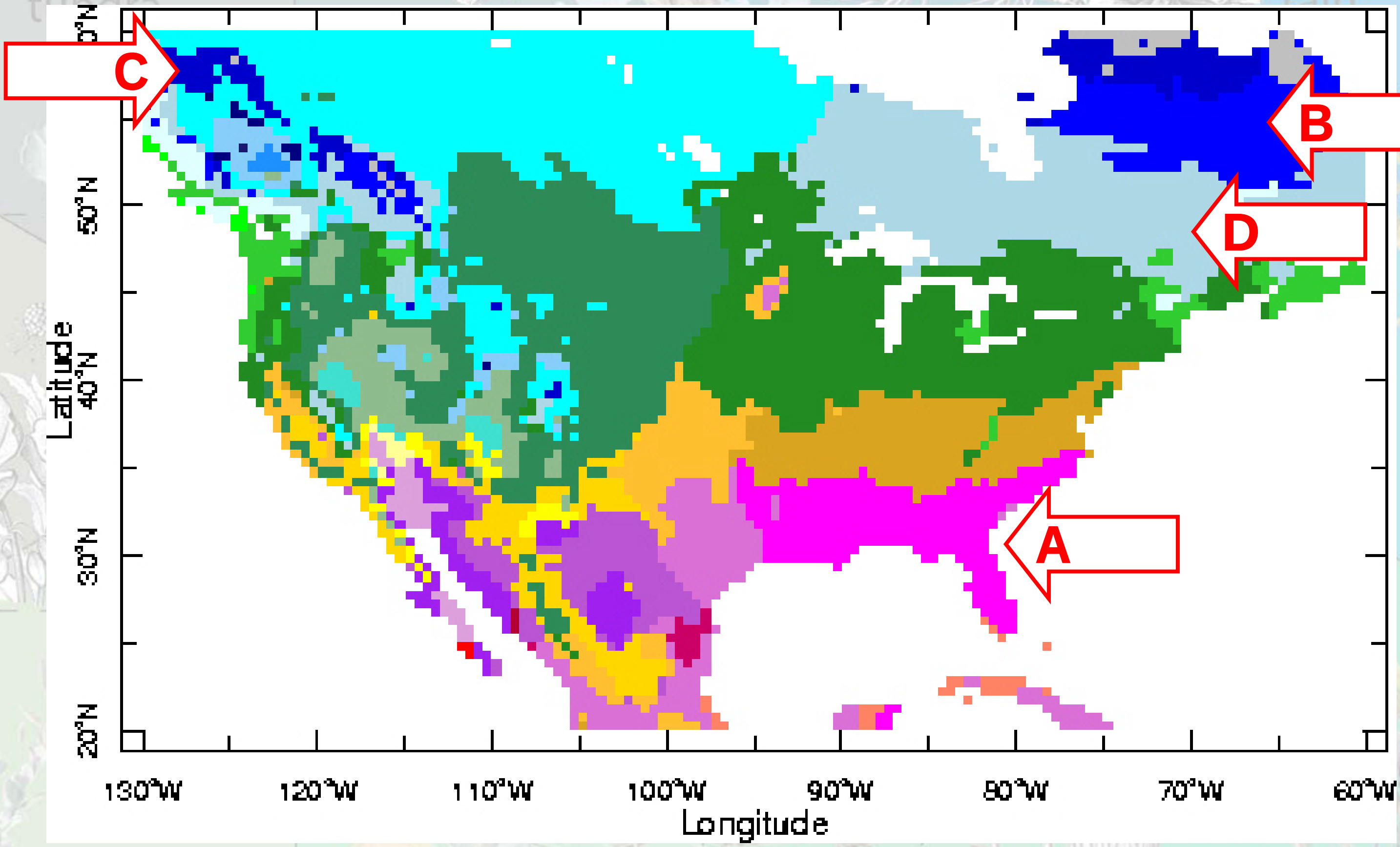


Figure 15-3. U.S. and Canada – Ecosystems – Holdridge Life Zones – Present CO_2 Concentration (same as example on Page 15-11).

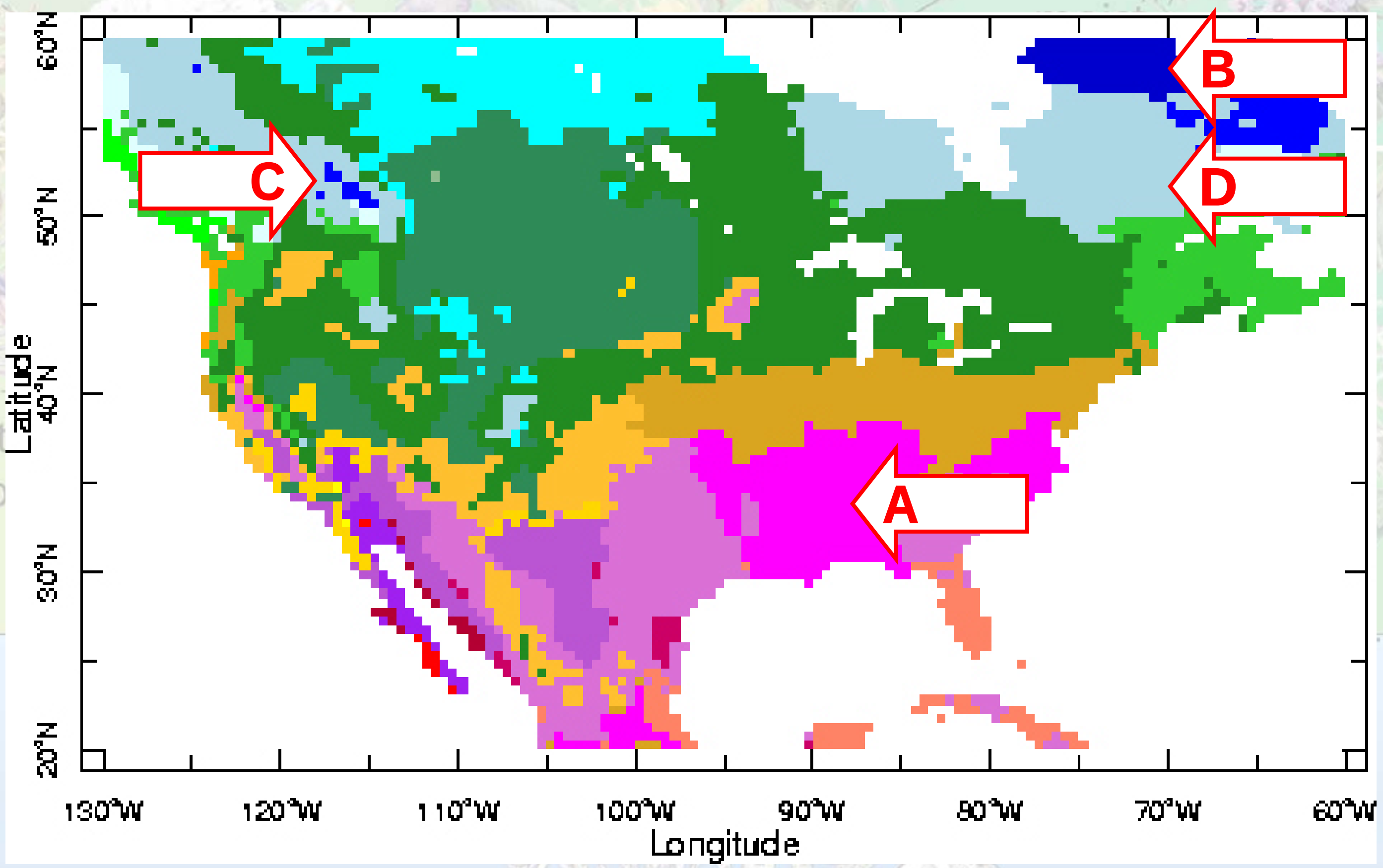


Figure 15-4. U.S. and Canada – Ecosystems – Holdridge Life Zones – Doubled CO_2 Concentration.

Procedure – Part 2 (Continued)

Life Zones Class Key

No.	Life Zone	Arrow	No.	Life Zone	Arrow
1	Polar desert -		20	Warm temperate dry forest -	
2	Subpolar dry tundra -		21	Warm temperate moist forest -	
3	Subpolar moist tundra -		22	Warm temperate wet forest -	
4	Subpolar wet tundra -	B&C	23	Warm temperate rain forest -	
5	Subpolar rain tundra -	B&C	24	Subtropical desert -	
6	Boreal desert -		25	Subtropical desert scrub -	
7	Boreal dry scrub -		26	Subtropical thorn woodland -	
8	Boreal moist forest -		27	Subtropical dry forest -	
9	Boreal wet forest -	D	28	Subtropical moist forest -	A
10	Boreal rain forest -		29	Subtropical wet forest -	
11	Cool temperate desert -		30	Subtropical rain forest -	
12	Cool temperate desert scrub -		31	Tropical desert -	
13	Cool temperate steppe -		32	Tropical desert scrub -	
14	Cool temperate moist forest -		33	Tropical thorn woodland -	
15	Cool temperate wet forest -		34	Tropical very dry forest -	
16	Cool temperate rain forest -		35	Tropical dry forest -	
17	Warm temperate desert -		36	Tropical moist forest -	
18	Warm temperate desert scrub -		37	Tropical wet forest -	
19	Warm temperate thorn steppe -		38	Tropical rain forest -	

Figure 15-5. Life Zones Class Key for the two Holdridge Life Zones diagrams.

Questions – Part 2

1. Table 15-1 for you to fill in.

Letter Key (to the Holdridge Ecosystem Maps)	Life Zone Class (Use the Key – Fig. 11-5)	Holdridge Present CO_2 ppm Latitude Extent (Measured South to North in Degrees)	Holdridge Doubled CO_2 ppm Latitude Extent (Measured South to North in Degrees)	Size Change (Increase, Decrease, Remain The Same)	Direction of Life Zone Movement (Use Cardinal Directions)	Humidity Provence (See Holdridge Life Zone Diagram)
A		26^o to 36^o = 10^o				
B						
C						
D						

Table 15-1.

Questions – Part 2 (Continued)

Refer to the Holdridge Maps of the U.S. and Canada (Figures 15-3 and 15-4) and the poster, "Life Zones Reflect Climate", to answer the following questions.

2. In what direction (north, northeast, north-northwest, etc.) do the life zones appear to shift when the CO_2 concentration doubles? How do you know?

3. Based on the latitudes for the four locations that you observed, how does the size of the life zone extent change when the CO_2 concentration doubles? How do you know?

4. How does the amount of precipitation change in Florida when the CO_2 concentration doubles?

5. Describe any changes that might occur in the geographic area where you live if the CO_2 concentration doubles?

Procedure – Part 3

Study Figures 15-6 and 15-7, in conjunction with the Life Zones Class Key (Figure 15-5) for all four Holdridge Life Zones Maps, then answer the questions that follow.

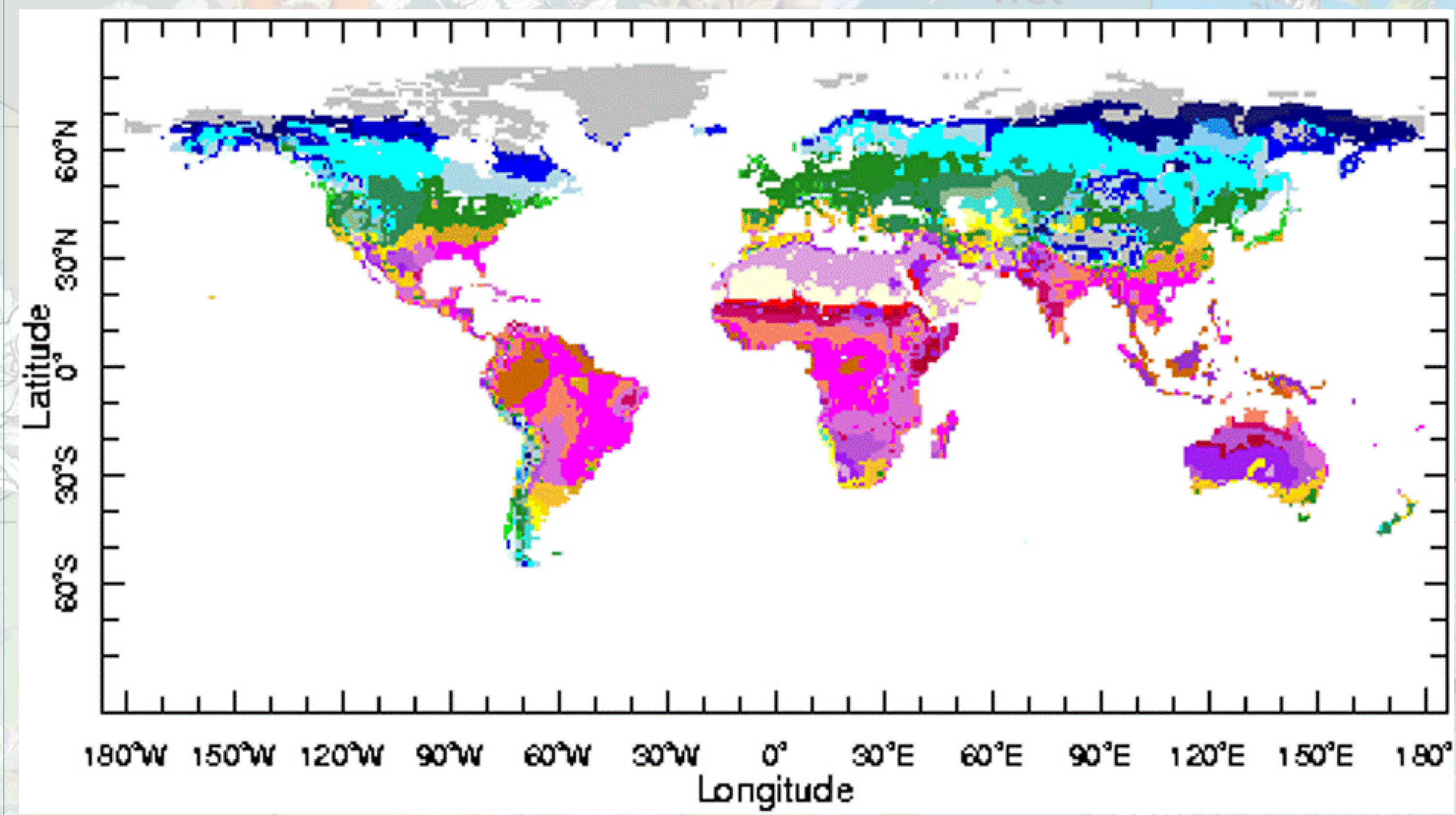


Figure 15-6. World – Ecosystems – Holdridge Life Zones – Present CO_2 Concentration.

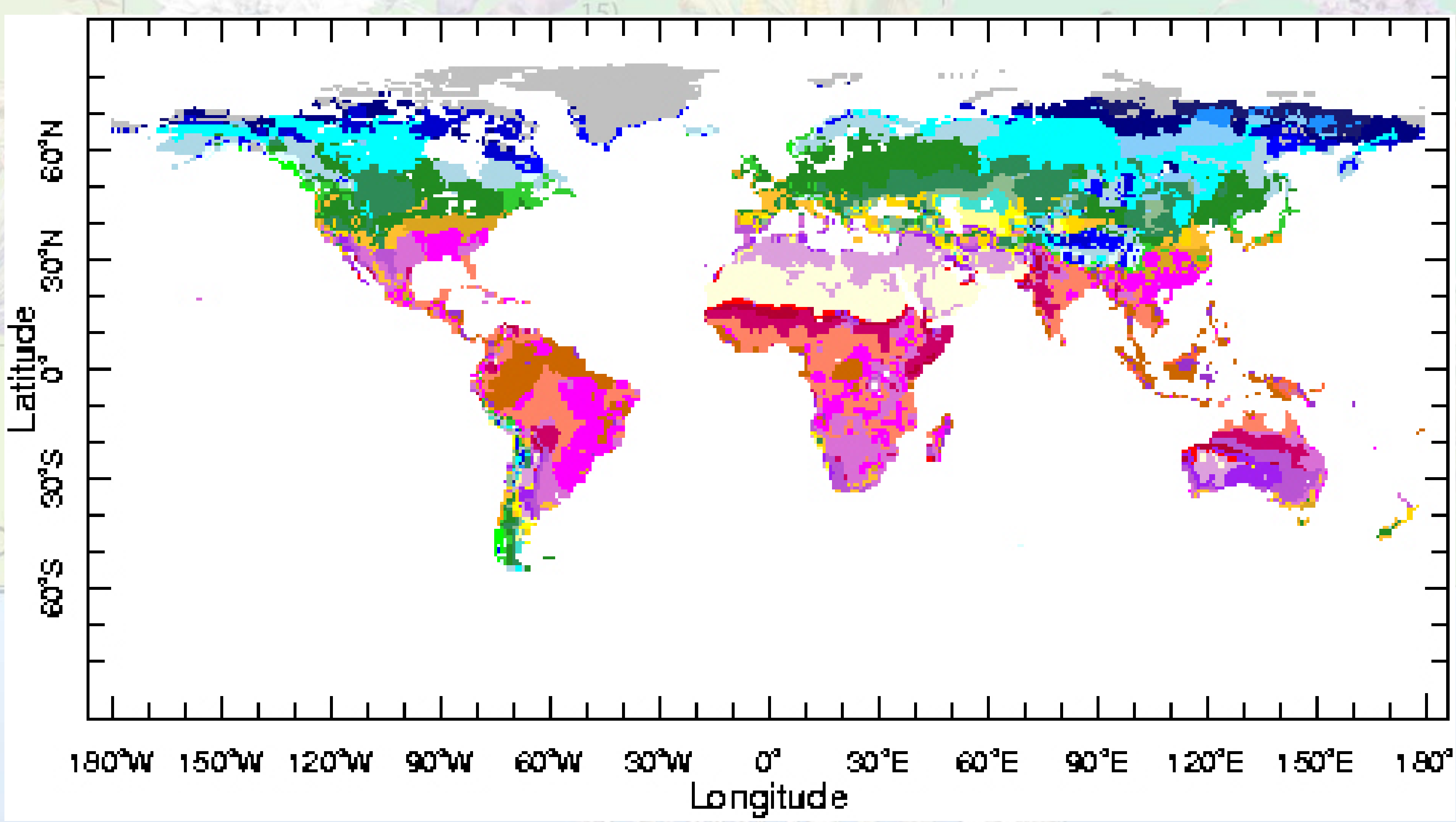


Figure 15-7. World – Ecosystems – Holdridge Life Zones – Doubled CO_2 Concentration.

Questions – Part 3

1. What continent appears to have the most tropical desert?

2. Between what latitudes are the combined tropical and subtropical life zones located on the present CO_2 concentration map? On the CO_2 doubling concentration map?

3. How does the amount of area in the subpolar zones appear to change when the CO_2 concentration doubles?

4. How can the ecosystems Holdridge Life Zone Maps be used by world leaders and planners?

Special Note

If you have access to a computer, use a web browser to locate the interactive website for the Holdridge Maps. Enter the following URL...

http://ingrid.ldgo.columbia.edu/SOURCES/.ECOSYSTEMS/.Holdridge

Now do the following...

Click on *double CO_2*.

Click on the brightly colored map image located near the top of the page labeled *ECOSYSTEMS Holdridge double CO_2 options*.

An interactive page with a map and a color key appears. Try various tabs for action.

Repeat the process to see what the life zones look like under present CO_2 conditions.