JASON V: Expedition Planet Earth

Plans are already underway for *JASON V: Expedition Planet Earth,* which focuses on the environment through the unique laboratory offered in the Central American country of Belize.

We're now putting together the teams of JASON scientists, who, with participating students and teachers, will explore several sites, each highlighting a different aspect of the fragility of our planet today. Dr. Meg Lowman, an ecologist who specializes in rain forest canopy research, will lead one team of scientists in a Belizian rain forest. Here we'll observe the interaction and interrelationships between plants, animals, and insects, concentrating on their ecology, behavior strategies, and biodiversity in the rain forest canopy. From another vantage point below, team scientists will also study these interactions, looking at their camoflauge behavior and defense strategies. Our objective is to give the students a complete picture of one of the most complex life systems in the world.

In a partially submerged limestone cave, a geologist specializing in paleo-climates will use the stalactites and stalagmites there to gain a better understanding of the climatic changes in the past. A robot, remotely controlled by student drivers from JASON sites around the world, will be used to follow the river flow and help map the area. We'll also use the robot to seek out bats in the pits above.

Belize is the custodian of the largest barrier reef in the Western Hemisphere. JASON III's Galapagos explorer "Dr. Bubblehead" -- marine biologist Jerry Wellington -- returns to Expedition Planet Earth to help students understand coral bleaching and the interrelationships between marine plants and animals. Small ROVs (remotely operated vehicles) will also be on hand to help with the exploration.

Other expedition components include an archaeology/anthropology study of the modern-day Maya and their ancestors led by Dr. Richard Leventhal, director of the Institute of Archaeology at UCLA, and a coastal ecology site where we'll study mangrove thickets and sea grasses. We also hope to learn more about tropical medicine and the roles ethnobotany and biochemistry play, particularly in AIDS and cancer research. With its total focus on our environment, JASON V will integrate a host of different scientific disciplines to excite and encourage students to learn more about our fragile planet Earth. *Dr. Robert D. Ballard*

JASON Project, Voyage V, "Our Planet Earth"
Preliminary Program Description

The students' journey of discovery is facilitated through the eyes of a raindrop.

The starting point is birth.

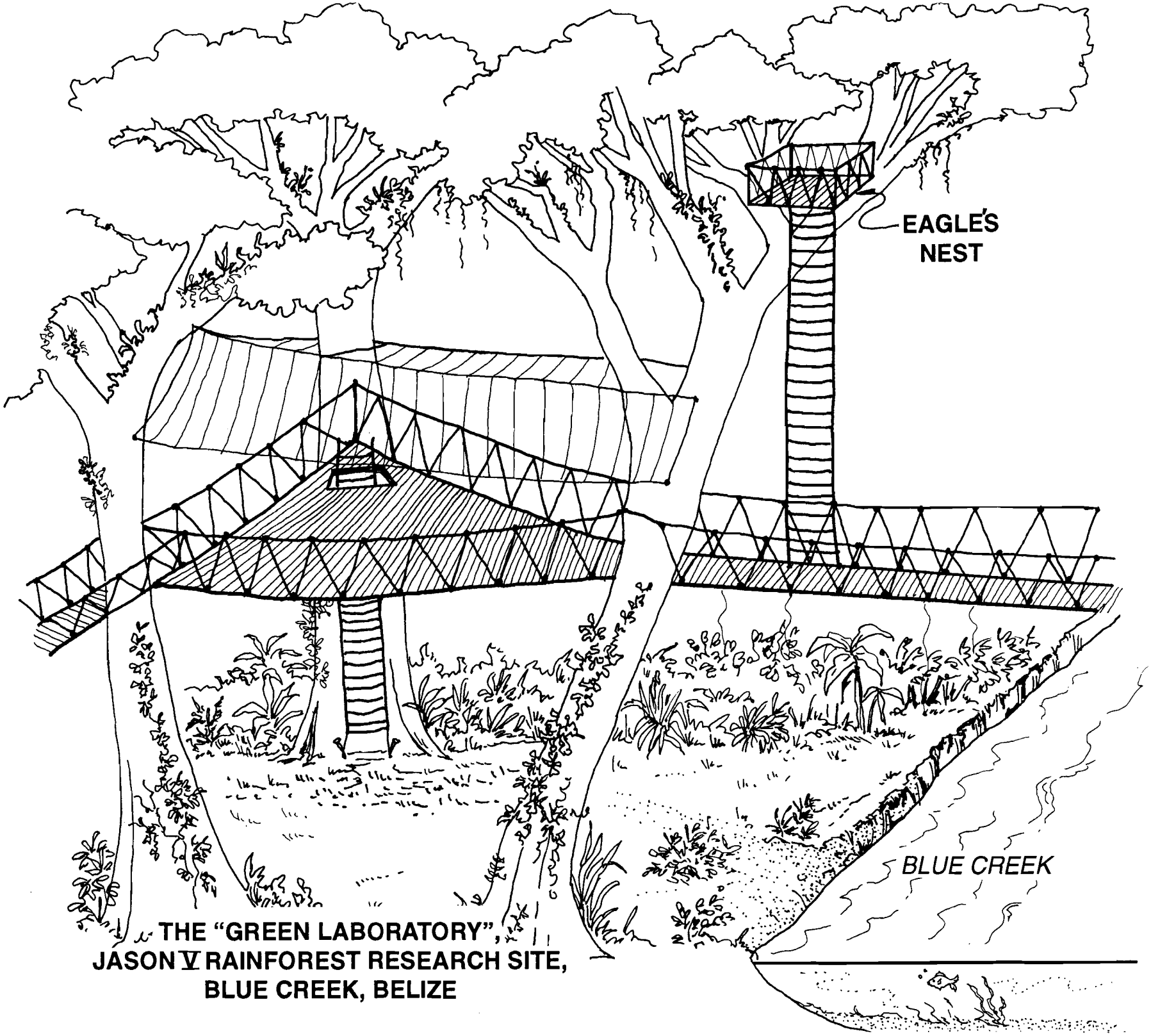
The analogy between birth and the formation of a raindrop is made and begins in the atmosphere/troposphere where a raindrop is formed. From the upper atmosphere the space shuttle is able to take photographs of the planet's surface below. This gives us a better vantage point to see the current health status of the world where the raindrop is soon to venture.

Upon maturation, the raindrop begins its journey towards earth where its fall is cushioned by the canopy layer of a rain forest. It is here where the raindrop first finds its vocation, to nourish the flora & fauna and to use its magnifying capabilities to study a feeding station. Here the raindrop finds birds, butterflies and the occasional mammal. However, soon gravity has its influence and the raindrop slowly moves below the canopy, through the understory of the lower layers of the rain forest. Here the raindrop must move very slowly through this layer to see well camouflaged lizards frozen in their tracks. Slowly as the raindrop creeps through the maze of leaf litter it begins to feel a pull and is leached through the thin soil and into a subterranean river which is flowing through a cave. In the cave the raindrop moves towards a stalactite which it grabs on to. It is able to move inside the stalactite viewing the history of its ancestors. Eventually the raindrop can no longer hold on to the stalactite and falls back into the flowing river and begins its course through the cave looking up at the bats hanging above.

As the raindrop navigates through the subterranean cave collecting nutrients as it goes, it eventually finds itself back up on the surface of the land moving past present day Maya Milpas. The past seems to be living with the present as the raindrop uses its magnifying capabilities to view the Mayan archeological sites on the hilltops above. Eventually making its way to the coast the raindrop moves into another ecosystem and begins to flow beside and around mangrove roots. However, before the raindrop can get a better look at a crocodile coming near, it is pushed out further into the Caribbean Sea. Here the raindrop notices that it begins to have Sodium Chloride clinging on to it. The raindrop feels clumsy and begins to bump into coral reefs: first a fringing reef, then an atoll and finally the barrier reef. It is at the barrier reef that the raindrop stations itself at a feeding/cleaning station and uses its magnifying ability to gain a glimpse at the relationships between the fish and corals in this community.

Finally, the raindrop is able to rest beside a coral and reviews all it has seen. It contemplates the relationships of all the living (biotic) and non-living (abiotic) parts of each ecosystem it visited and begins to connect this to the health of the planet as a whole.

Eventually the raindrop evaporates as it readies itself for its final journey back into space.



THE "GREEN LABORATORY",
JASON V RAINFOREST RESEARCH SITE,
BLUE CREEK, BELIZE

Four Lessons From Scientists
Using data from JASON V

Lesson I: Biodiversity

Data from JASON V Project Scientist Dr. Meg Lowman and the JASON Primary Interactive Network Sites

Background

Biodiversity is the relative number (diversity) of different species of plants and animals found in a given area. Different parts of the earth have higher biodiversity than others. Biodiversity is dependent on a host of factors, including latitude, climate, seasonality, moisture, elevation, soil type, and human interaction with the environment. Even within your region, species diversity can vary significantly from location to location.

The rainforest of southern Belize, where Dr. Meg Lowman has been working, is an area of high biodiversity. To measure plant biodiversity, Dr. Lowman created a quadrat, or plot, in the rainforest, measuring 5 m by 5 m, then identified, counted, and recorded each plant in the quad. This is very similar to what students did in the "Terrestrial Biodiversity Study" on page 116 of the Belize Expedition Curriculum. If you have not done this lesson already, you may want to do it.

Data

The study at Blue Creek found a high abundance—626 individual plants, including trees, seedlings, herbs, and epiphytes. The study also found a high amount of biodiversity—more than 80 different species. Dr. Lowman also found a new species of vine during her work. Dr. Lowman, with the help of Argonauts, created a side-view sketch of the plot, shown in Figure 1. This sketch, called a "profile diagram," was drawn from a 5-m-by-40-m transect that cut through the plot. (The letter codes mark individuals of the same species.)

Table One contains biodiversity data from ten different locations in North America, the United Kingdom, and Bermuda. These data represent averages from ten different JASON primary interactive network sites (PINS). The data were generated from field work by students and logged into the JASON Interactive Computer Network.

Procedure

1. If your students have not completed the "Terrestrial Biodiversity Study" lesson on page 116 of the Belize Expedition Curriculum, please have them do so. You may want to draw a profile sketch of the plot similar to the sketch drawn by Dr. Lowman in Figure 1.

2. Carefully study the data in Figure 1 and Table One. Discuss the difference in meaning between species diversity and abundance. Make sure that students have a clear understanding of these terms.

3. Discuss differences between the data from Dr. Lowman's Belize plot and those from the student plots at your school (in terms of both abundance and species). Most likely, Dr. Lowman's data in Table One reveal many more species than your class found. The rainforest also has some species (e.g., epiphytes and vines) not found at all in your area.

4. Compare Dr. Lowman's profile sketch in Figure 1 to the profile sketch produced by your students. Compare the height, width, and spacing of plants found in the two sketches. Discuss any other similarities or differences you may see.

5. On Graph One, plot the species data found in Table One as a bar graph.

6. It is possible to create color codes and place them on a map to represent varying degrees of species diversity. Similar maps were created on the JASON Interactive Computer Network at your downlink site. Map One has ten different downlink sites from the United Kingdom, Bermuda, Belize, and North America, each designated by an empty square. Using the key at the bottom of the map, color the squares the appropriate colors. The number of species at each site is found in Table One.

7. Map Two and Map Three contain precipitation and temperature data. Map Two shows various precipitation zones. Students should color the zones different colors so they can be distinguished easily. Map Three portrays annual average temperatures. You may want to make a copy of Maps One, Two, and Three on overhead transparencies so they can be overlaid on one another. This will help students see the relationships between species diversity, precipitation, and temperature.

8. Use the three maps to identify how the abiotic conditions of precipitation and temperature affect species diversity.

Questions

1. Explain the difference between species diversity and abundance.

2. Which of the downlink sites had the lowest species diversity? Which had the highest?

3. How did the number of species in the plot at your school compare to that of Dr. Lowman's plot in Belize? What reasons can you give to account for these differences?

4. Use Map Two and Map Three to find the average annual precipitation and temperature at each of the downlink sites. (You can also find out this information for your town by contacting the National Weather Service in your area.) Carefully compare this information to the species diversity data at the downlink sites, found on Map One. What generalizations can you make regarding the relationships between species, precipitation, and temperature?

5. List some other factors that may affect species diversity and abundance.

6. Considering these data on a global scale, why is preserving the rainforest so important in terms of species diversity?

Answers

1. Species diversity refers to the number of different *kinds* of organisms. Abundance refers to the number of *individuals*. For example, if a plot of forest contains 2 oak trees and 5 maple trees, the species diversity is 2, and the abundance is 7.

2. The downlink site reporting the lowest species diversity was the Ontario Science Centre. The site with the highest species diversity was Dr. Lowman's plot in Blue Creek, Belize. Bermuda had the second highest number of species.

3. Most likely the plot outside your school has many fewer species than the plot in Belize. This is to be expected, because most JASON Expedition participants live in latitudes more northern than Belize. In general, these more northern latitudes have lower biodiversity, generally cooler temperatures, and less precipitation.

4. Generally speaking, high species diversity is correlated to high temperatures and high precipitation. Look for inconsistencies in this relationship and develop hypotheses to account for differences.

5. Other factors that may affect species diversity are length of growing season, soil type, elevation, and human disturbance.

6. The rainforests of the world represent the greatest concentration of species diversity in the world. Destruction of the rainforests leads to the extinction of endless numbers of species—many of which have not even been discovered, much less identified or assessed for their possible benefit to society.

Adaptations

For Older Students

When considering species diversity and abundance from one place to another, a mathematical formula called a species index provides a relative measure of these two types of data combined. The species index uses a location's number of species and its abundance to assess biodiversity from one area to another. The Simpson's Index is a formula which allows us to compute a species index:

Washington, D. C.

Species	Abundance
onion grass	215
yellow poplar	14
silver maple	13
sweetgum	3
grapevine	21
arrowwood	43
wild rose	36
periwinkle	32
poison ivy	3

Toronto, Ontario, Canada

Species	Abundance
dandelion	113
chestnut	1
weeds	126
oak tree	1
sphagnum moss	1
violet	7

$$D = \frac{(N)(N-1)}{\Sigma\ (n)(n-1)}$$

In the equation, D is diversity, N is the total number of species, and n is species abundance (number of individuals). Σ is the symbol for sum, which means the denominator of the equation needs to be summed for the abundance value of each species before dividing it into the numerator. Perform this operation for the biodiversity data obtained by your class. Then use data from the table at left and compare them to your data.

For Younger Students

To illustrate the concept of counting and species diversity go on a scavenger hunt with your students. Spend 15 to 25 minutes collecting and identifying plants and animals outdoors near the school. Make a list of all the different organisms you find. Have students draw pictures of the organisms, and make a class scrapbook or bulletin board of these plants and animals. If you cannot go outside, then photocopy pictures of plants and animals that you can place on the floor for a scavenger hunt. Discuss as a class the meaning of the terms species and biodiversity. Ask students which parts of your area (and the world) have higher biodiversity. Talk about how human actions can reduce biodiversity on a local and global scale.

FIGURE 1

PROFILE DIAGRAM OF BLUE CREEK RAINFOREST BELIZE (JASON V, 1994)

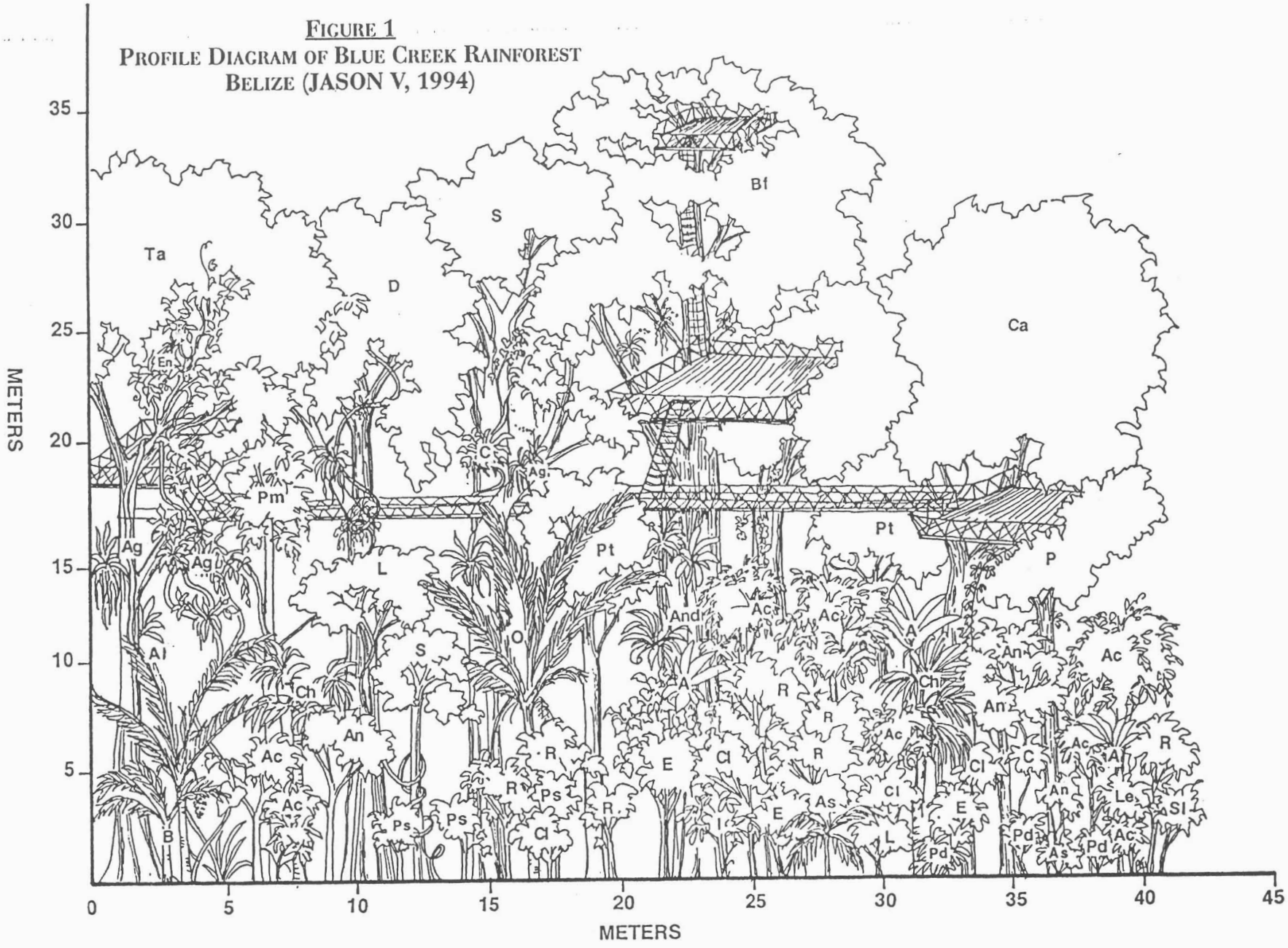
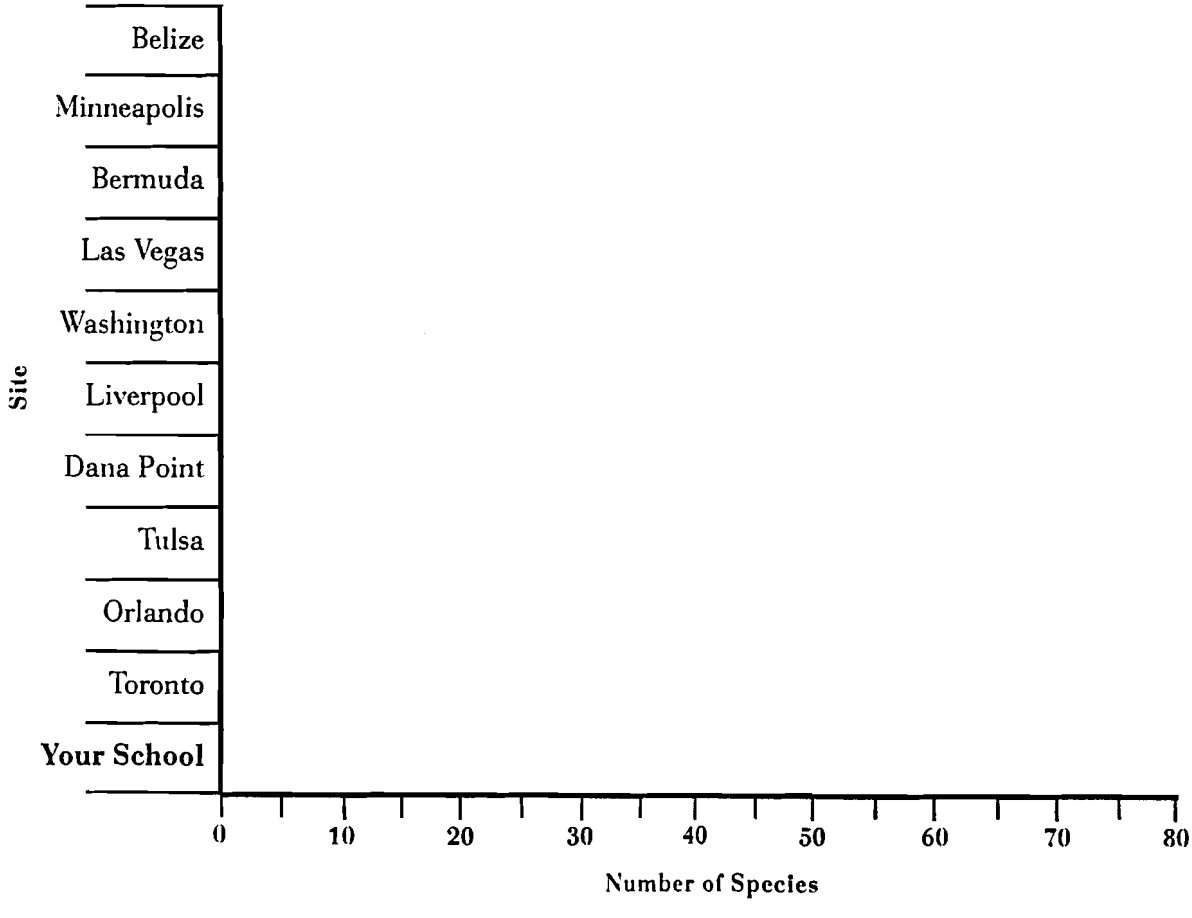


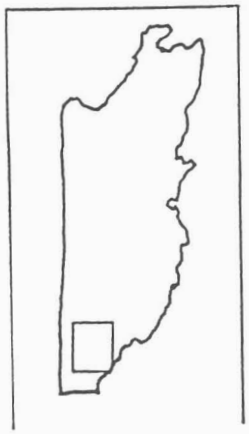
TABLE ONE

Location	Number of Species	Abundance
Blue Creek Reserve		
Belize	80	626
Bell Museum		
Minneapolis, MN	9	257
Bermuda Biological Station		
Bermuda	36	1,296
Clark County Schools		
Las Vegas, NV	9	128
National Geographic Society		
Washington, DC	14	221
National Museums & Galleries		
Merseyside, Liverpool, England	16	225
Orange County Marine Institute		
Dana Point, CA	30	1,799
The Williams Co.		
Tulsa, OK	13	335
Orange County Schools		
Orlando, FL	11	323
Ontario Science Centre		
Toronto, Ontario, Canada	6	251
Your School	___	_____

GRAPH ONE: Species Data From Selected JASON Sites



MAP ONE
Biodiversity at Selected JASON Sites

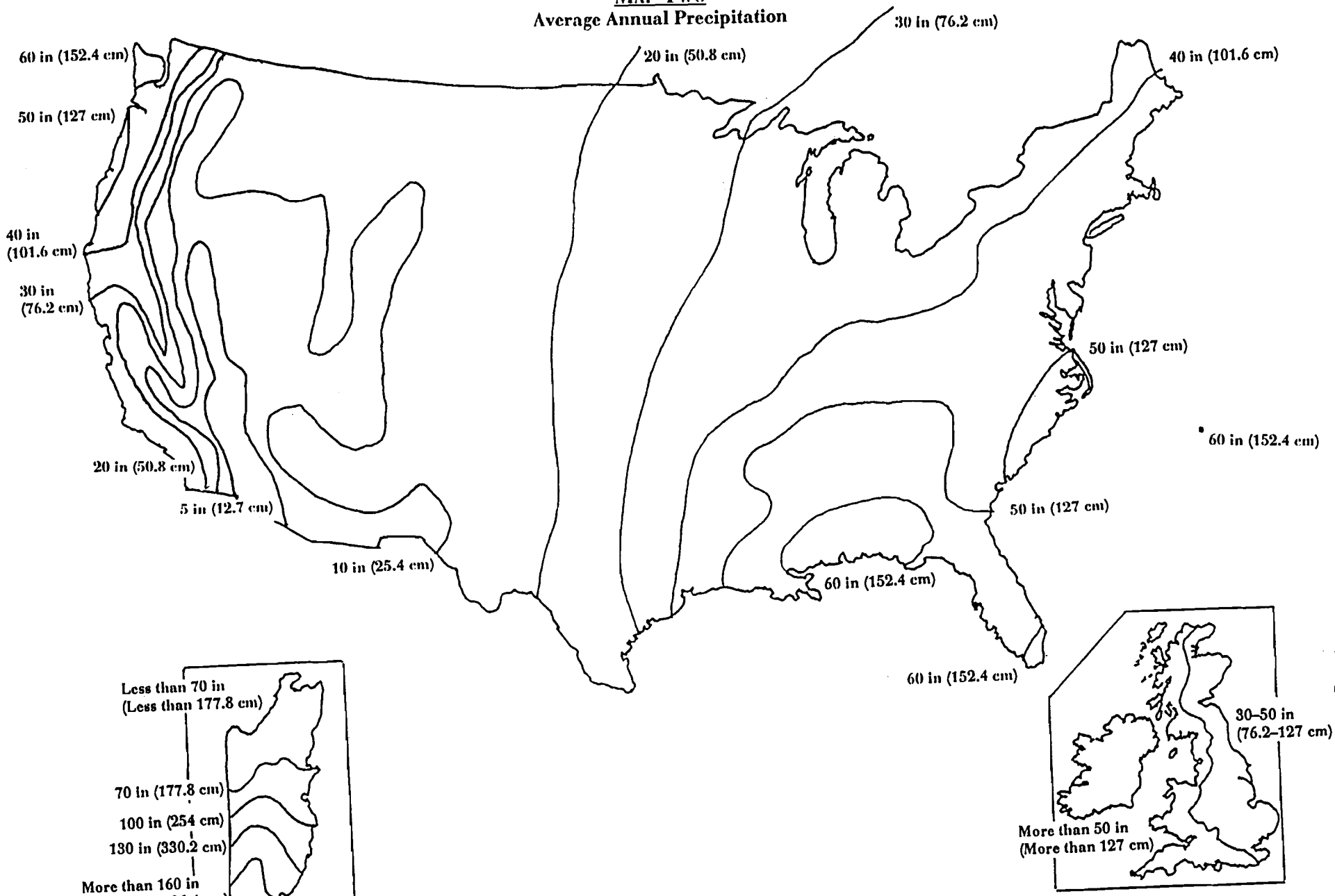

Blue Creek Reserve, Belize

Color Key

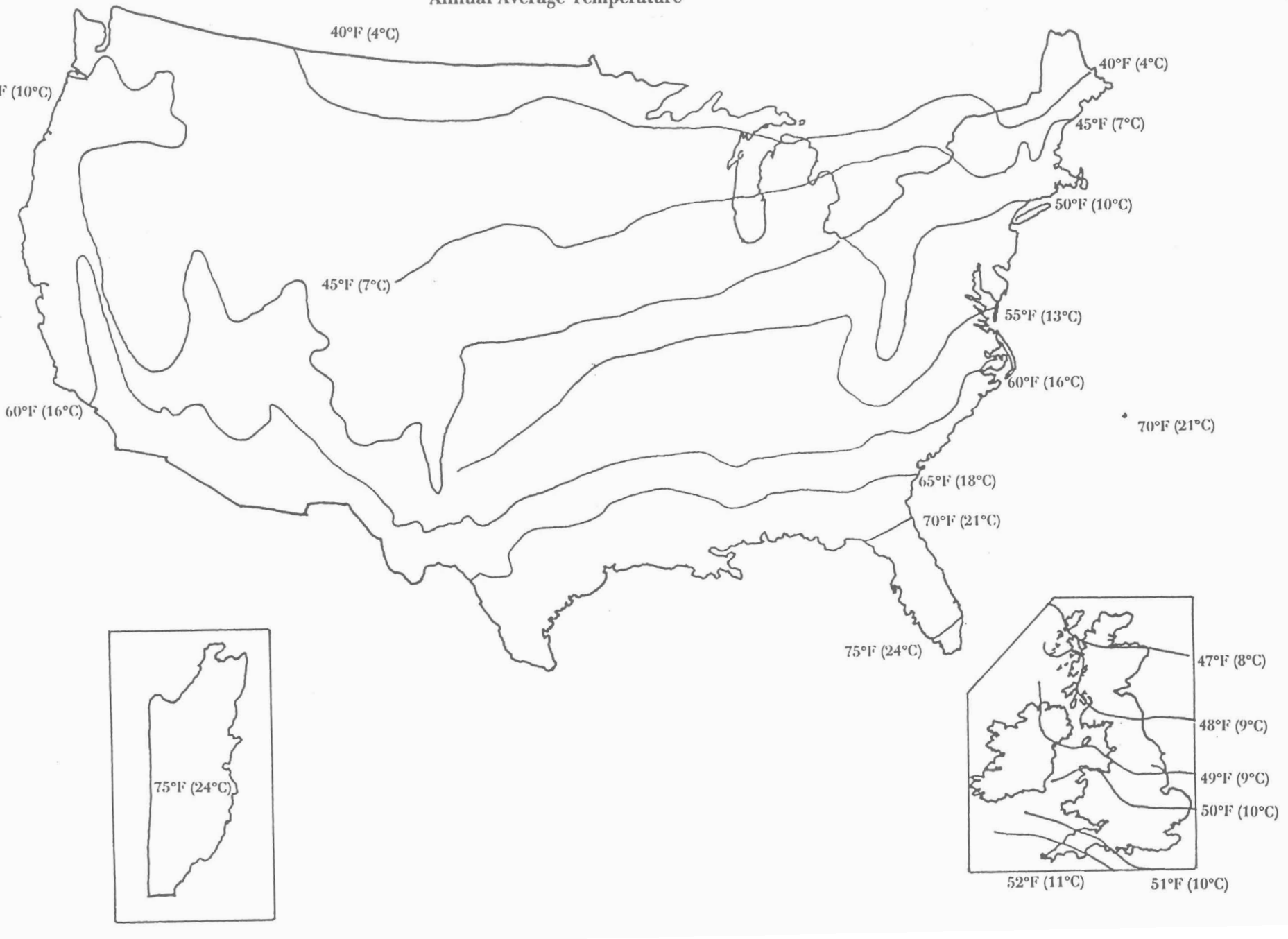
1–10 species	=	Blue
11–15 species	=	Purple
16–20 species	=	Red
21–40 species	=	Yellow
More than 40 species	=	Green


National Museums & Galleries, Merseyside, Liverpool, England

MAP TWO
Average Annual Precipitation



MAP THREE
Annual Average Temperature



FREQUENT QUESTIONS

Students asked some 2,000 questions via the Interactive Computer Network during the two-week JASON Broadcast. Following are some of the questions, with their corresponding answers.

To Dr. Richard Leventhal:
Q: Have you been able to decipher the hieroglyphs at Xunantunich?
A: Most of the hieroglyphs, or writing, at Xunantunich are badly eroded, and we are unable to decipher them. However, we are able to decipher some of the iconography, or pictures, on the frieze.
Q: How many different languages are spoken in Belize?
A: Eight primary languages are spoken, including the official language—English. Other languages include Spanish; Garifuna; Creole; an archaic Low German dialect spoken by the Mennonites; and three Maya languages: Mopan, Kekchi, and Yucatec.

To Dr. Tom Miller:
Q: How big are the pools of water in the caves in Belize?
A: The longest pool we've found in a cave is in northern Belize—it's approximately 1,200 m (about 3,600 ft) long. We're not sure which cave has the deepest pool of water.
Q: Have you found any artifacts in the cave?
A: Yes, some potsherds and the rim of a jar were found in the Hokeb Ha entrance. Hokeb Ha (Maya for "where the water goes out") is the upper entrance to the Blue Creek Cave. There were several Maya artifacts found in this entrance in 1973 that are now kept for safe-keeping at the Department of Archaeology in Belmopan. In addition, a calcified bone resembling a rib from a large animal was found in the cave. The bone will remain in the cave until permission is granted for its removal for further research.

To Dr. Meg Lowman:
Q: How often does it rain in the rain forest?
A: In Blue Creek Preserve, the amount of rain depends on the time of year; it is seasonal. In January, during the wet season when I began my studies in Blue Creek, it rained almost 33 cm (about 13 in) a day. However, in March it rained just before the first JASON broadcast on Monday morning, and then not again until Thursday of the next week, ten days later.
Q: Are the sizes of the leaves related to their height in the canopy?
A: Leaves tend to be bigger at the bottom of the canopy and smaller at the top. This may be related to the fact that leaves at the bottom need to be bigger in order to capture light as it comes through the top layers.

To Dr. Jerry Wellington:
Q: Do you put the coral back after it has been researched?
A: Yes, we put most of the corals back after we have studied them. A small number of the pieces of coral colonies are taken back to the lab for further analysis. The remainder are brought back to their original depth and location and wedged between coral heads. They eventually re-attach themselves and grow.

To Jeff Corwin:
Q: What is the most common animal you have been seeing lately?
A: The most common animals we have seen are insects—mainly flies and beetles. We also have seen a large number of spiders, hummingbirds, and bats.

To Bart Bouricius (Canopy Construction):
Q: What impact do all of the platforms and equipment have on the rain forest?
A: The walkway, which consists of the platforms and bridges, provides additional traveling space for animals—they seem to use the walkway system as a highway. We know this because of other studies we have done in other rainforests. The walkway also provides additional space for vines to grow on. It does not seem to affect birds, which tend to ignore the system (including any researchers on the platform).