North Carolina Science Olympiad 2018 Ecology State Event - C **FINAL SCORE**_____

School: _____ **Team #**_____

Student names: _____ _____

Each question is worth one point until noted. Tiebreaker question numbers are bolded.

Station 1	
1	A
2 2 pts	Acceptable responses include: • snakes – The owl would compete with the snakes for the mouse population. • hawks – The owls feed on much of the same food as the hawks, so there would be fewer hawks. • mountain lions – The owls would compete for the rabbit population. • grasses – The owls would eat rabbits and mice, and there would be more grass.
3 2 pts	2 pts for Acceptable responses that include: lack of food; fewer lemmings; overpopulation of snowy owls; changes in temperature; loss of habitat / deforestation; increased competition
4 2 pts	1 point for: Level C 1 point for any of the following acceptable responses: • At each level, as you go up from the plants to the herbivores to the carnivores, energy is lost. • Energy enters the ecosystem with green plants capturing energy from sunlight. There is less energy available as it is passed on to the consumers. • Energy is lost at each feeding level.
5	B

Station 2	
6	A
7	E
8	D
9	A
10	C
11 2 pts	Acceptable responses include: component of nucleotides, energy storage, form DNA and RNA, found in bone, teeth, etc.

Station 1 **# Correct** _____ **/8** **Station 2** **# Correct** _____ **/7**

Page 1: Total Pts. _____ **Max 15 pts.**

ECOLOGY: NC State 2018

Station 3	
12	B
13	D
14	C
15	A
16	C
17	D
18	C

Station 4	
19	C
20	D
21	C
22	B
23	E
24	A
25	D
26	C
27	C
28	C

Station 3 **# Correct** _____ **/7**

Station 4 **# Correct** _____ **/10**

Page 2: **Total Pts.** _____ **Max 17 pts.**

ECOLOGY

Station 5	
29. 5 pts	1.07
30. 5 pts	0.66

Station 5 **# Correct** _____ **/10**

Station 6	
31 5 pts	74.4%

Station 6 **# Correct** _____ **/5**

Station 7	
32.	D
33.	C
34.	B
35.	Rodents, Insects, Woods
36. 2 pts	Stable environment, longer life, larger size More energy efficient
37.	B and D

Station 7 **# Correct** _____ **/7**

Station 8	
38.	B
39.	D and I
40.	F
41.	E
42.	A
43.	F
44.	J

Station 6 **# Correct** _____ **/7**

Page 3: Total Pts. _____ **Max 29 pts**

ECOLOGY: NC State 2018

Station 9	
45 2 pts	386
46 2 pts	467
47 2 pts	41 fish/month
48 2 pts	.08779
49 2 pts	546
50 2 pts	E

Station 10	
51	E
52	C
53	B
54	F
55	A
56	D
57 2 pts	Organisms must constantly adapt, evolve, and proliferate to survive, and eventually gain reproductive advantage in a system where other organisms are trying to do the same.

Station 9 **# Correct** _____ **/12**

Station 10 **# Correct** _____ **/8**

Station 11	
58	B
59	D
60	A
61	B
62 3 pts	An area with just a few species (alpha) in each place, but as you move across a gradient (precipitation, altitude, etc.) the species are readily replaced with different species (beta).

Station 12	
63	38%
64	Agricultural Practices
65	South America
66	Land not suitable for farming
67 2pts	Petroleum hydrocarbons, heavy metals, pesticides, solvents

Station 9 **# Correct** _____ **/7**

Station 10 **# Correct** _____ **/6**

Page 4: Total Pts. _____ **Max 33 pts**

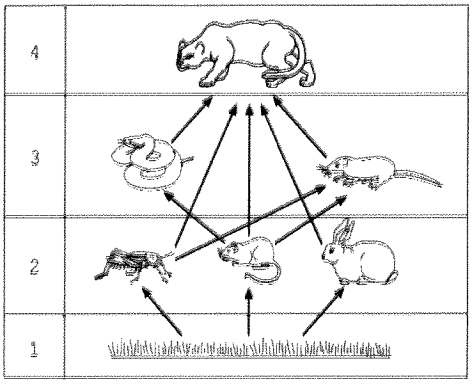
Station 13	
68 2 pts	More mobile, cleaner nests/ lesser ability for harmful bacteria and parasites to grow, better able to control nest humidity
69	A
70	A
71	C
72	B
73	C

Station 9 **# Correct** _____ /7

Page 5: Total Pts. _____ **Max 7 pts**

Test: Total Pts. _____ **Max 101 pts.**

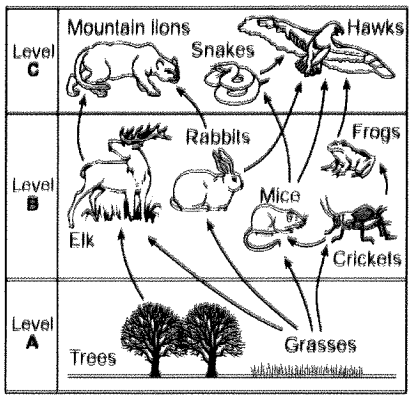
Station 1 – Food Webs and Trophic Pyramids



The diagram above represents a food web.

1. Which level contains organisms that carry out autotrophic nutrition?
   a. 1
   b. 2
   c. 3
   d. 4

Snowy Owls Move to the South Snowy owls are large white birds that normally inhabit the cold northern regions of Canada. Recently, scientists and birdwatchers have sighted the snowy owls much farther south than usual. When snowy owls are in northern areas, they feed on lemmings (small rodents). When lemmings are not available, as in the areas further south, the owls will seek out mice or rabbits as their food source. Several snowy owls migrated into an area represented by the food web below.



2. Identify one population of organisms shown in the food web, other than rabbits or mice, that would likely be affected by the introduction of the snowy owls and explain why their population would be affected.

Station 1 – Food Webs and Trophic Pyramids Continued...

3. Identify two conditions that might cause snowy owls to leave their usual habitat and move to another area.

4. State which level, A, B, or C, contains the least total available energy. Support your answer.

5. Fungi are decomposers that play an important role in the maintenance of an ecosystem. The role of fungi is important because they:
   a. synthesize energy-rich compounds that are directly used by producers;
   b. break down materials that can then be used by other organisms;
   c. limit the number of plants that can perform photosynthesis in an area;
   d. are competitors of other consumers such as herbivores

Station 2 – Nutrient Cycling

6. How are matter and energy used in ecosystems?
    a. Matter is cycled through ecosystems, energy is not
    b. Energy is cycled through ecosystems, matter is not
    c. Energy can be converted into matter, matter cannot be converted into energy
    d. Matter can be converted into energy, energy cannot be converted into matter

7. Which of the following is cause by excessive nutrient runoff into lakes?
    a. Depletion of atmospheric ozone
    b. Biological magnification
    c. Greenhouse effect
    d. Eutrophication

8. Which of the following is NOT one of the common phosphorous reservoirs?
    a. Water
    b. Rocks
    c. Organisms
    d. Atmosphere

9. Mineralisation of phosphorous is most similar to which process?
    a. Nitrogen fixation by mycorrhizae
    b. Complexation of methylmercury
    c. Photosynthesis in prokaryotes
    d. Tectonic plate movement

10. Which of the following is closest to the usable, ionized form of phosphorous commonly used by organisms?
    a. PO_2^{-3}
    b. PO_3^{-3}
    c. PO_4^{-3}
    d. H_3PO_3

11. Name 2 ways phosphorous is used in biological or physiological processes.

Station 3 - Deserts

12. Which of the following make up the largest biomass in the desert?
    a. mammals
    b. Plants
    c. Insects
    d. Reptiles

13. During which season does it generally rain most in a cold desert?
    a. Fall
    b. Summer
    c. Spring
    d. Winter

14. All of the following are common adaptations of desert organisms EXCEPT:
    a. Living underground during the heat of the day
    b. Waxy cuticles for preventing water loss
    c. Drinking and storing large amounts of water
    d. All are common desert animal adaptations

15. The primary environmental factor used to classify a desert is:
    a. Evapotranspiration
    b. Species richness
    c. Soil type
    d. Temperature

16. Which of the following is the largest North American desert?
    a. The Sonoran Desert
    b. The Sahara Desert
    c. The Chihuahuan Desert
    d. The Mojave Desert

17. This is the greatest cause of desertification:
    a. Overgrazing
    b. Wild fires
    c. Drought
    d. Human Impact

18. What is one way the saguaro cactus has adapted to the desert environment?
    a. It grows underground where the temperature is cooler.
    b. Its spikes are poisonous.
    c. When it rains, its trunk can expand to hold water.
    d. It has tiny bowl-shaped leaves that capture dew and rainwater

Station 4 – Grasslands

19. While the grass can live without the fungi, the fungi cannot live without the association (i.e., it has no other source of carbon). This type of relationship is a _____.
    a. Interspecific Competition
    b. Intraspecific Competition
    c. Obligate Symbiosis
    d. Facultative Symbiosis

20. Short-grass grasslands are characterized by _____ while tall-grass grasslands are characterized by _____.
    a. More rain; less rain
    b. Tall plants; short plants
    c. Seasonal grazing patterns; steady grazing patterns
    d. Drought resistance; sensitivity to rain

Match the description given in questions 21-25 with the correct grassland below:
a. Prairie b. Plains c. Savannah d. Temperate e. Steppe

21. Grassy ecosystem with a significant component of woody-plant cover; "tropical grassland"
22. A topographic label, referring to relatively level terrain
23. A region drier, cooler and less humid than other grasslands
24. A common synonym for grassland used in North America
25. Grassy ecosystem with moderate rain fall with trees typically in riparian zones

26. Which of the following is an invasive species to North American Grasslands that was first seen in Texas?
    a. Kudzu
    b. Burmese Python
    c. Africanized Bee
    d. Giant African Snail

27. What kinds of grasslands are there?
    a. Tropical and desertified
    b. Tropical and temperate
    c. Temperate and desertified
    d. Transitional and tropical

28. In the winter, when there is snow on the ground, is there anything for large herbivores to eat?
    a. Yes, there are ants and other insects they can survive on
    b. No, they all migrate to where it is warmer
    c. Yes, they can find dormant grasses and other plants under the snow

Station 5 – Shannon-Weiner Index

The samples of 5 species are 60, 10, 25, 1, and 4.

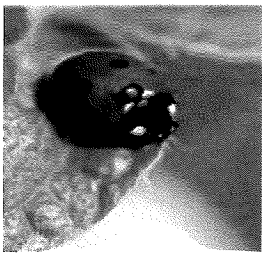
29. Calculate the Shannon diversity index for these sample values.

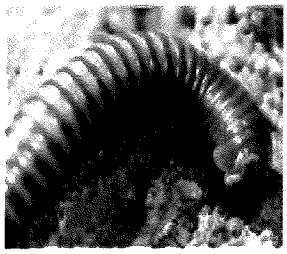
30. Calculate the Evenness for these sample values.

Station 6 – Species Richness

An ecologist goes out into the field and collects information from two separate plots of the same size but with one big difference: Plot 1 is in the woods and Plot 2 is in a pasture. The ecologist is interested in the types of insects that are found in the plots and whether there is a difference between the two plots. The table below shows the data for each plot.

Species	Plot 1 Woods	Plot 2 field
Centipedes	50	10
Millipedes	36	50
Butterflies	35	0
Lady bugs	55	39






31. Using Simpson's Index of Biodiversity, what is the percent chance an individual picking two individuals in plot 1 would pick two different species.

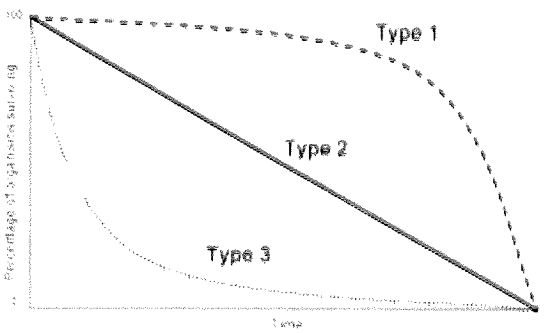
$$D = 1 - \frac{\sum_{i=1}^{S} n_i(n_i - 1)}{N(N-1)}$$

Station 7 – Life History Strategies

32. Which of the following is true?
    a. K-selection operates in populations where it fluctuates well below the carrying capacity
    b. r-selection occurs in populations whose densities are very near the carrying capacity
    c. Different populations of the same species can be r- or K-selected
    d. r- and K-selection are two extremes of a range of life history strategies
    e. r-selection tends to maximize papulation size, not the cate of increase of population

33. Which dispersion pattern is most common in nature?
    a. Uniform
    b. Random
    c. Clumped
    d. All are common
    e. None can be found in nature

34. K-organisms are characterized by _____ while r-organisms are characterized by _____.
    a. Small size; large size
    b. Large litters; small litters
    c. More intelligence; less intelligence
    d. Fast maturation; slow maturation



35. Name one example of an r-organism.

36. Explain two benefits of being a k-organism

37. Survivorship data depends on which of the following two variables?
    a. Males produced
    b. Females produced
    c. Total population birthed
    d. Surviving number of females for a given time
    e. Surviving total population for a given time

Station 8 – Biotic Interactions

Determine what type of relationship is described in each scenario below. Use the terms:

a. commensalism
b. amensalism
c. mutualism
d. parasitism
e. parasitoidism
f. interspecific competition
g. intraspecific competition
h. obligate symbiosis
i. facultative symbiosis
j. keystone predation

38. *Penicillium* fungus does not allow the nearby growth of *Staphylococcus* bacteria. This is an example of _____.

39. Scarlet Indian Paintbrush can connect its roots to other plants to steal nutrients from them. While it can survive on its own, when tapped into another plant, the Paintbrush shows a 40-fold increase in productivity. This interaction between the Paintbrush and the other plant is an example of _____ & _____.

40. In the desert, a Saguaro Cactus and an Organ Pipe Cactus have been growing 30 feet apart for the past 10 years. Both of these plants have a specialized root system for maximizing water absorption from the soil. What type of relationship exists between them?

41. Aphids consume many agriculturally important plants. While pesticides are effective means of controlling aphid populations, certain types of wasps also attack aphids and lay their eggs inside of the aphids. The adult wasps do not eat the aphids, but only lay their eggs. The wasp larvae however, eat the aphid from the inside out. This relationship between the wasp and the aphid is known as _____ and can be used as a form of biocontrol.

42. In many grasslands, cattle egrets can be seen trailing behind cattle. When cattle graze, they disturb the insects living in the grass, essentially flushing the insects out. The egrets then eat these insects. The egrets get the benefit of easier hunting, and the cattle seem to not be bothered by the egrets even though they do not benefit from their presence. The relationship between the cattle and egret is an example of _____.

43. Two hungry red-tailed hawks were scouting for food when they both saw the same western diamondback rattlesnake. This relationship between the hawks is an example of _____.

44. A mountain lion eats a large portion of the black tipped jackrabbit population, allowing the Edith's checkered moths to increase proliferation. This is an example of a _____ relationship.

Station 9 – Population Estimation

One way that ecologists can estimate populations is by using a technique called "mark and recapture." Below is a table with data from a pond of fish where the initial marked and released population was 46 fish.
[Hint: $N = (captured_t \times marked_i)/marked_x$]

Trial	Marked	Unmarked	Population Estimate
1	8	74	472
2	7	87	618
3	4	19	265
4	7	81	578
5	6	57	483
6	10	74	???

45. Estimate the population for Trial 6.

46. Based on the statistical law of averages, how many fish would you expect to be in the pond?

47. If the birth rate for this pond is 14 fish a week, and the death rate is 1 fish every two days, what is the population growth rate of this pond in one month (30 days)?

48. If this pond followed an exponential model, what would the monthly per capita growth rate be?

49. How many fish will be in the pond at the start of the third month?

50. Which of the following assumptions have to be made regarding the capture-recapture estimate of population size
    - I. Marked and unmarked individuals have the same probability of being trapped
    - II. The marked individuals have thoroughly mixed with the population after being marked
    - III. No individuals entered or left the population during the estimate by any means

        a. I only
        b. II only
        c. I and II
        d. II and III
        e. I, II and III

Station 10 – Ecological Theories

For questions 51-56, match each of the following to the best answer choice; your choices are:

a. Metabolic Theory of Ecology b. Gaia Hypothesis c. Bateman's Principle

d. Bergmann's Principle e. Altitude Latitude Theory f. Liebig's Law of the Minimum

51. A bird migrates from Montana to Washington with little to no difficulty
52. In most species, reproductive variance is greater in males than in females
53. Living organisms interact with inorganic surroundings to create and maintain a self-regulatory system for life on Earth
54. Population growth is dictated by limiting factors, not by total resources available
55. The rate of this biological processes within organisms is the fundamental biological rate that governs observed patterns
56. Organism size is inversely related to environmental temperature

57. Define the Red Queen Hypothesis and provide an example of it in nature.

Station 11 – Conservation Biology

58. Which of these things does not seem to change much whether you are talking about, in the ocean, a top predator, an omnivore, or a photosynthetic primary producer?
    a. necessary habitat size as some multiple of body size
    b. extinction rate over geological time
    c. amount of mercury in fatty tissues
    d. risk of overexploitation by humans

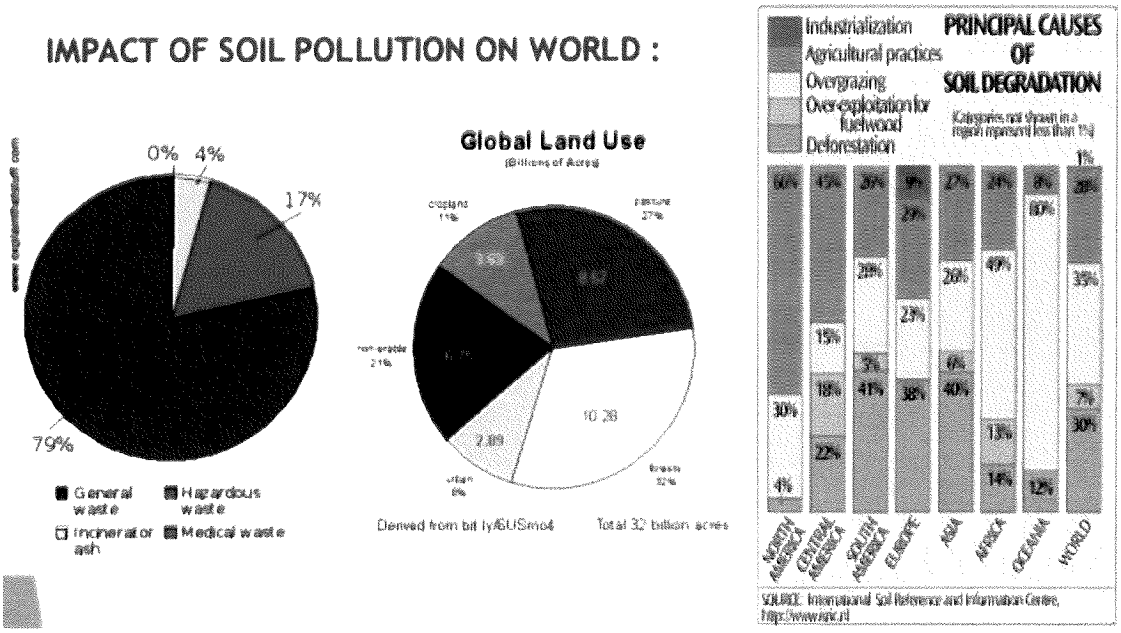
59. Many conservation biologists would argue that we are
    a. as a species, more in touch with our environment than we were 1000 years ago.
    b. in the midst of the 4th great extinction event.
    c. in the midst of the 5th great extinction event.
    d. in the midst of the 6th great extinction event.
    e. in the midst of the 7th great extinction event.

60. Which of these would have the highest Shannon Diversity Index value? An area with
    a. 3 cardinals, 5 wrens, 8 pigeons, 2 eagles, 7 ducks
    b. 30 cardinals, 5 wrens, 8 pigeons, 2 eagles, 7 ducks
    c. 300 cardinals, 50 wrens, 80 pigeons, 20 eagles
    d. None of the above

61. What U.S. state is home to the greatest number of threatened or endangered species?
    a. California
    b. Hawaii
    c. Alaska
    d. Florida
    e. Montana

62. Describe an ecosystem that has low alpha diversity and high beta diversity.

Station 12 – Soil Pollution



http://image.slidesharecdn.com/soilpollution-151016112421-lva1-app6892/95/soil-pollution-17-638.jpg?cb=1444994822

Refer to the charts above.

63. Cropland and pasture account for what percentage of global land use?

64. The principal cause of soil degradation in North America is _____.

65. Deforestation most greatly impacts this region.

66. Twenty one percent of global land is non-arable. What does this term mean?

67. Seventeen percent of soil pollution is caused by hazardous waste. List two of the top four types of chemicals that most commonly cause soil pollution.

Station 13 – Case Study

M. mexicanus is a species of the ant family commonly known as the "Honeypot Ant". These ants live in the southwestern United States and parts of Mexico and have adapted special elates that house sugars and water in their social stomachs, for sharing with the colony, in an effort to combat the pressures of living in the desert. One study was conducted on several colonies of ants by the University of Notre Dame from 1958 to 1993 investigating changes in founding rates of new colonies of several ant species.

68. What is one benefit that the colony has for having these special elates?

Use the table below, to answer questions 69 – 71.

TABLE 3.—Estimates of rate of disappearance (K_d) and mean life span according to census cohorts. Overall K_d is calculation from beginning of cohort to 1993. n = number surviving/original number; mean is weighted for size of each cohort

Species	Cohort	n	Overall K_d	t (yr)	Mean life span (yr)
M. depilis	1958	2/21	−0.067	35	10.3
	1972	12/59	−0.073	21	9.5
	1976	3/12	−0.086	17	8.1
	1978	3/19	−0.130	15	5.3
	1981	6/19	−0.092	12	7.5
				Weighted mean =	8.6
M. mexicanus	1958	0/3	−0.038*	29	18.2*
	1972	3/21	−0.093	21	7.5
	1976	6/24	−0.082	17	8.5
	1978	5/11	−0.053	15	13.8
	1981	7/23	−0.099	12	7.0
				Weighted mean =	8.9
A. cockerelli	1958	0/8	−0.090*	23	7.7*
	1972	0/16	−0.154*	18	4.5*
	1976	0/6	−0.138*	13	5.0*
	1978	0/2	−0.231*	3	3.0*
	1981	0/4	−0.154*	9	4.5*
				Weighted mean =	5.2*

69. Colonies of what cohort had the longest life spans for all species
    a. 1958
    b. 1972
    c. 1976
    d. 1978
    e. 1981

Station 13 – Case Study

Continued

70. The mean life span of _____ Species of ant progressively declined with each younger cohort.
    a. M. depilis
    b. M. mexicanus
    c. A. cockerellie
    d. Both A and C
    e. A, B, and C

71. Which Species of ant had an average life span of 5.2 years
    a. M. depilis
    b. M. mexicanus
    c. A. cockerellie
    d. Both A and C
    e. A, B, and C

72. Members from the study suggested that one of the reasons for the trend in colony foundation rates was due to interspecific competition. Which of the following observations may have led them to this conclusion?
    a. Changing foraging times
    b. Evenly spaced entrances to nests between colonies
    c. Increase in natural predators around the enclosure
    d. Greater frequency of ants near the walking trails

73. During their research, the university found that *M. Mexicanus* had a greater sensitivity to changes in the temperature of the soil around the entrance to their nests. Which of the following changes in the environment may have led to their observed trend?
    a. Less nuptial flights
    b. Decreased rain in the fall
    c. Increased plant cover over time
    d. None of the above