Science Olympiad
Green Generation Test
Seven Lakes High School Invitational Tournament

Team Name: _____**KEY**_____

Team Number: _____

Directions:

- There are no penalties for incorrect or skipped questions. If you are unsure on a question, skip it or choose a random answer.
- You will get partial credit for attempting and/or giving a reasonable answer to free response questions.
- All multiple choice questions have only one answer.
- The use of external resources other than 2 non-programmable, non-graphing calculators and a singular page is not permitted.
- Good luck on the test!

For grading use only

Page:	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Points:	30	18	24	27	26	10	18	25	5	29	23	27	20	282
Score:														

Section A: General Ecology

1. (1 point) What is the process where carbon dioxide and water are used to create sugar known as?
A. Photosynthesis B. Respiration C. Evaporation D. Acidification

2. (1 point) Which of the following groups are not autotrophs?
A. Plants B. Cyanobacteria **C. Fungi** D. Algae

3. (2 points) Fish produce many offspring each breeding cycle. Most eggs die almost immediately, so very few make it to maturity. This is an example of a(n):
A. K-selected species **B. r-selected species** C. Producer D. Endotherm

4. (2 points) Freshwater fishes constantly drink water to maintain a constant water potential. This process makes these fish an example of a(n):
A. K-selected species B. r-selected species C. Osmoconformer **D. Osmoregulator**

5. (1 point) A frugivore would likely have a diet mostly composed of:
A. Fruit B. Seeds C. Grasses D. Leaves

6. (1 point) A saprotroph would likely have a diet mostly composed of:
A. Small animals B. Leaves C. Aquatic plants **D. Decaying organic matter**

7. (1 point) What type of survivorship curve would be best represented by an elephant?
A. Type I B. Type II C. Type III D. Type IV

8. (6 points) Describe the difference between r-selected and K-selected species. Provide an example of each.

Solution: r - small, have a lot of offspring at once, live in unstable environments, short life (1 point each for a max of 2) (example: crickets (1 point for anything similar))
K - large, have few offspring at once, live in stable environments, long life (1 point each for a max of 2)(example: humans (1 point for anything similar))

9. (1 point) How much energy (in percent) is lost, if any, between trophic levels?
A. 0% B. 10% C. 20% D. 50% **E. 90%** F. None of the above

10. (3 points) Which law states that two species cannot coexist if they are in the same ecological niche? (Hint: there are two names for this law)
Gause's Law or Competitive Exclusion

11. (3 points) What is the division of resources by species with similar niches is known as?
Resource Partitioning

12. (2 points) Giant Pandas are used by a variety of organizations to raise support for conservation. Which of the following best describes Giant Pandas?
A. Keystone species B. Indicator species **C. Flagship species** D. Foundation species

13. (2 points) Common loons are only found in clear lakes of low turbidity. They are an example of a(n):
A. Keystone species **B. Indicator species** C. Flagship species D. Foundation species

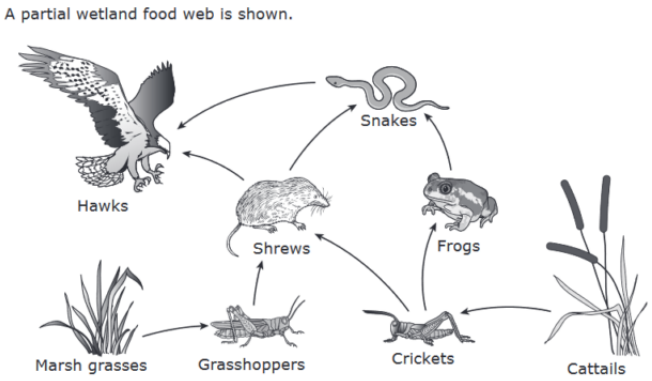
14. (2 points) Invasive species generally have **generalist** diets.

15. (2 points) In the Amazon Rainforest, special groves of trees known as devil's gardens can be found. In these, ants and trees live together. The trees provide shelter for the ants, and the ants kill other trees nearby. What type of interaction is occurring between the ants and the trees?
A. Comensalism **B. Mutualism** C. Parasitism D. Competition

16. (2 points) Is the above example an example of symbiosis?
A. Yes B. No

17. (2 points) In coral reefs, some species of shrimp can be found eating parasites off of larger fish. What type of interaction is occurring between the shrimp and the fish?
A. Predation B. Parasitism **C. Mutualism** D. Comensalism

18. (2 points) Is the above example an example of obligate symbiosis?
A. Yes **B. No**
Use the figure below for the next five (5) questions.



A typical marsh food web. Credit: A&M University

19. (1 point) Which of the following organisms is a quaternary consumer?
A. Shrews B. Snakes C. Frogs **D. Hawks**

20. (1 point) Which of the following organisms is a primary consumer?
A. Cattails **B. Crickets** C. Frogs D. Snakes

21. (2 points) If 100,000 kilojoules of the sun's energy enter the ecosystem, then how much energy do the frogs receive (in joules)? Assume that the producers are 1% efficient.
A. 10 B. 100 C. 1,000 **D. 10,000** E. 100,000

22. (3 points) Imagine that most of the marsh grass was cut down, leaving only a small patch of brown grass. Grasshoppers use this grass to camouflage, and range in color from green to brown. As a result of the clearing of grass, most of the grasshoppers become more brown as generations pass. This is an example of:
A. Stabilizing selection B. Disruptive selection **C. Directional selection**

23. (2 points) If all of the hawks were removed from the community, which of the following populations would most likely decrease?
A. Shrews B. Snakes C. Cattails **D. Grasshoppers**

24. (1 point) Which nutrient cycle does not have a major atmospheric component?
A. Phosphorus B. Nitrogen C. Hydrological D. Carbon

25. (1 point) About how much of the Earth's freshwater is stored in glaciers and ice caps?
A. 2% B. 40% C. 60% **D. 70%** E. 80%

26. (1 point) A water molecule above the ocean turns into a gas and then moves through the air to be above land. What is the name of the first of the two processes described?
A. Transpiration **B. Evaporation** C. Precipitation D. Infiltration

27. (2 points) What is the name of the second of the two processes described in the previous question?
A. Percolation B. Guttation C. Interception **D. Advection**

28. (2 points) What is the largest carbon sink on Earth?
A. Soil B. Organic Matter C. The Atmosphere **D. Oceans**

29. (1 point) A tree captures carbon dioxide molecules and stores them in its trunk. This is best described as an example of:
A. Evaporation B. Respiration **C. Carbon Sequestration** D. Decomposition

30. (2 points) The process of gaseous nitrogen being converted to ammonia or other nitrogenous compounds by organisms is known as:
A. Denitrification B. Nitrification **C. Nitrogen fixation** D. Decomposition

31. (2 points) Ammonification is carried out mostly by:
A. Fungi B. Algae C. Trees D. Mosses

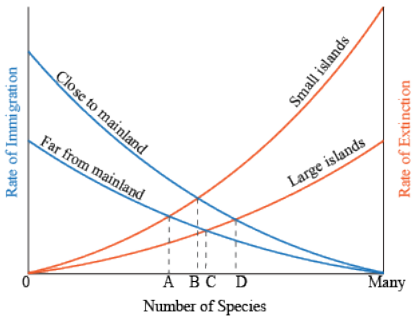
32. (2 points) Which group of plants have special structures which house nitrogen fixing bacteria?
A. Orchids B. Roses C. Cacti **D. Legumes**

33. (2 points) Which of the following modes of photosynthesis would an agave, a desert dwelling plant, most likely use?
A. C_3 B. C_4 **C. CAM** D. None of the above

34. (2 points) Beech trees produce special chemicals that inhibit the growth of other nearby plants. This would likely result in which distribution pattern?
A. Clumped **B. Uniform** C. Random

35. (3 points) Which of the following is not a density dependant factor?
A. Disease B. Competition **C. Food** D. Waste

Use the below graph for the next two (2) questions.



The Island Equilibrium Model

36. (1 point) The intersections of the lines corresponds when the community is:
A. In equilibrium B. Disrupted C. Unsustainable D. None of the above

37. (1 point) Which of the intersections represents when a small island far from the shore is in the above state?
A. A B. B C. C D. D

38. (2 points) Which of the following types of estuary is Chesapeake Bay?
A. Fjord B. Bar Built **C. Coastal plain** D. Tectonic

39. (2 points) Estuaries are also known as _____**nurseries**_____ of the sea.

40. (2 points) The phrase "Lake Superior never gives up her dead" is a common saying in regards to Lake Superior. Why don't dead bodies float to the surface specifically in Lake Superior?
A. The cold prevents growth of bacteria that produce gases. B. The cold freezes the water C. The low salt content reduces buoyancy D. The cold makes the bodies more dense

41. (2 points) A trophic state index of 43 best describe which type of lake?
A. Oligotrophic **B. Mesotrophic** C. Eutrophic D. Hypereutrophic

42. (3 points) A hypereutrophic lake would likely contain:
A. High trout populations B. High nutrient levels C. Low turbidity **D. None of the above**

43. (2 points) Approximately how much of the world's surface freshwater is found in the Great Lakes? (Provide a percentage, guesses within 5% will be given half credit) **21%**

44. (6 points) List and give and example of the 4 types of ecosystem services

Solution: Supporting services (1): nutrient recycling, primary production
Provisioning services (1): food, crops, raw materials
Cultural services (1): painting, national symbol
Regulating services (1): climate regulation
.5 points for the example of each service

45. (4 points) List 4 services estuaries provide.

Solution: Habitat, nursery, productivity, water filtration, flood control (1 point each)

46. (2 points) Briefly explain the difference between interspecific competition and intraspecific competition.

Solution: interspecific is between individuals of different species(1), intraspecific is between individuals of the same species(1).

47. (3 points) What is the most common distribution pattern, and why?

Solution: clumped (1 point); travelling/hunting in groups increases efficiency and can help organisms survive (2 points for anything similar)

48. (3 points) A volcano erupts and smothers the surrounding ecosystem. The soil is all covered in igneous rock, so no life has colonized it yet. What is the name of the process that follows, and what are the likely first species to colonize the land? What are these species called?

Solution: Primary succession (1) ; lichens and mosses (1 for either); pioneer species (1)

Use the following information for the next 3 questions.
Lycanrocs have 3 different forms: midday, dusk, and midnight. Many people pretend that this is due

to the time that they evolve, but it is actually due to their genes! The t^d allele, when homozygous, creates midday Lycanrocs, while the t^n allele, when homozygous, creates midnight Lycanrocs. When heterozygous, the alleles create dusk Lycanrocs. The population of Lycanrocs is in Hardy-Weinberg equilibrium.

49. (5 points) What are the 5 requirements for a population to be in Hardy-Weinberg equilibrium.

Solution: No mutation, random mating, no gene flow, very large population size, no natural selection (1 point each)

50. (5 points) If the number of midday Lycanrocs is 345 and the total number of Lycanrocs is 1786, what is the frequency of the 2 alleles in this population? Write your answers rounded to the nearest 3 decimal places.

Solution: $t^n = 0.560$ (3 points)
$t^d = 0.440$ (2 points)
$t^d = \sqrt{\frac{345}{1786}} = .440$ and since $t^n + t^d = 1$ $t^n = .560$

51. (3 points) Using information from the previous question, what is the proportion of the population that is dusk Lycanrocs?

Solution: .492 or 49.2% (3)
Multiply the frequencies of the alleles together

52. (5 points) DumpsterVil has a population of 10,000 individuals. Each year, it grows by 6.3%. How many years will it be until the population exceeds 100,000? Round to the nearest year. Assume that the population grows geometrically, and that there is no immigration or emigration.

Solution: 38 years (5)
$100000 = 10000 * 1.063^t$ gives us

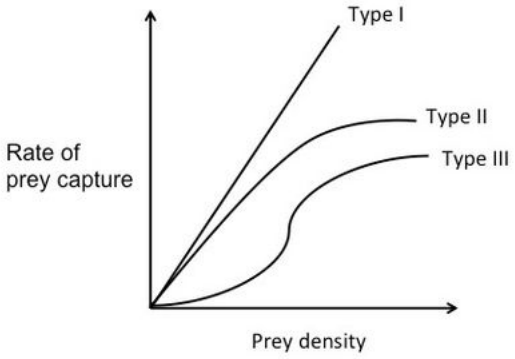
$$t = \log_{1.063} 10 = 37.689$$

53. (3 points) Briefly explain the difference between species richness and species diversity.

Solution: Richness is the number of species in an area (1 point), species diversity uses populations of each species (1 point) and richness (1 point)

54. (5 points) Explain why seasonal turnover occurs in freshwater lakes. List 2 benefits of seasonal turnover.

Solution: Due to sunlight, surface water temp begins to increase In the spring, the water surface warms. This causes the temperature of the top and bottom layers of the lake to equalize (1) . With the help of strong winds, this new equilibrium breaks the thermal stratification (1), and the lake is able to mix. Oxygen from the surface mixes with the bottom, while nutrients trapped near the bottom are free to mix throughout the lake (1). The inverse happens in the winter as surface waters begin to cool; they sink towards the bottom pushing up warmer water from the bottom which contains nutrients and oxygen. Benefits: circulates nutrients, circulates DO, (2)



Credit: Staddon, J.E.R. "Foraging and Behavioral Ecology."

Using the graph above, write the functional response best described by each predators behavior.

55. (2 points) **Type II** Predator A eats prey randomly and take 10 minutes to eat each prey animal. At low densities, it increases rate of capture very quickly. At high prey densities, it is limited by its slow handling time.

56. (2 points) **Type I** Predator B eats only prey Z, and spends much of its time searching for food at low prey densities. At high densities, it is not limited by anything and still eats the same proportion of the prey population as at low densities.

57. (2 points) **Type III** Predator C is a generalist that constantly changes prey. At low prey densities, it increases rate of capture, slowly at first. At higher densities, it slows down its rate of prey capture and frequently switches prey.

58. (4 points) Which of the functional responses is the most common, and why?

Solution: Type II (2), because almost every predator has a handling time that creates a limit to how fast it can process prey (2).

Use the below table for the next question

Species	Forest	Desert	Grassland
A	√		
B	√	√	√
C	√		√
D	√	√	√
E	√	√	√
F	√		√
G		√	
H	√	√	√
I	√		√
J	√		
K	√		√
L	√	√	√
M		√	
N		√	
O		√	√
P	√		√
Q			√
R			√
S			
T	√		√

59. (18 points) **Solve for the α, β, and γ diversity of the above ecosystems. You do not have to show work, but you may be given partial credit if your process is shown. A $\surd$ indicates that the species is found in the ecosystem. You may assume that all 3 ecosystems are in the same region.**

Solution: (2) α Diversity of the Forest: 13
(2) α Diversity of the Desert: 9
(2) α Diversity of the Grassland: 14
(2) β Diversity of the Forest and Desert: 7
(2) β Diversity of the Grassland and Forest: 5
(2) β Diversity of the Grassland and Desert: 10
(2) γ Diversity: 19
3.5 points for correct labelling of answers (0.5 each correct label), 0.5 points for effort, and 14 points for correct values (2 points each)

60. (25 points) **Calculate the abundance, species richness, species evenness (also known as Pielou index), Shannon Index, Menhinick Index, Margalef Index, and Simpson Diversity (Also known as Inverse Simpson Index) for the below hypothetical community. Write your answers rounded to 3 decimal places. You do not need to show work, but you may be awarded partial credit for work.**

Species	Number
A	16
B	33
C	3
D	48

Where S is the species richness and N is the abundance:

Margalef Index
$D = \frac{S-1}{lnN}$

Meninick Index
$D = \frac{S}{\sqrt{N}}$

Solution: (2 points) Abundance = 100
Calculated by counting the total number of individuals.
(2 points) Species Richness = 4
Calculated by counting the number of species.
(2 points) Meninick Index = .4

$$D = \frac{S}{\sqrt{N}}$$

where S is the number of species and N is the number of individuals. Therefore $D = \frac{4}{\sqrt{100}}$. Simplifying, we get

$$D = \frac{4}{10} = .4$$

(2 points) Margalef Index = .651

$$D = \frac{S-1}{lnN}$$

gives us $D = \frac{3}{ln100}$. Simplifying gives us

$$D = \frac{3}{4.605} = .651$$

(6 points) Shannon Index = 1.373

$$H = -\sum_{i=1}^{S} p_i \; ln \; p_i$$

where p_i is the relative concentration of species i and S is the number of species.
Therefore we get that the Shannon index is $H = -(-0.293 - 0.366 - 0.361 - 0.352)$
(6 points) Simpson Index = 2.198

$$D = \frac{1}{\sum_{i=1}^{S} {p_i}^2}$$

Simplifying gets us $D = \frac{1}{.4549} = 2.198$
(5 points) Species Evenness = .990

$$J = \frac{H}{H_{max}}$$

where H is the Shannon Diversity Index and H_{max} is the natural log of the richness

61. (2 points) If all species were equally likely, what would the Shannon Index be?

1.386

62. (3 points) Based only off of the Shannon Index, is the above community diverse? Why?

Solution: Yes (1 point) because the Shannon Index is very close to $ln(S)$, or the previous answer, (1 point for either), which represents the community if all species were equally likely (1 point)

Section B: Human Impacts on the Environment

63. (1 point) Which of the following is most likely not a limiting nutrient in aquatic environments?
A. Iron B. Nitrogen C. Phosphorus **D. Aluminum**

64. (1 point) Which of the following has a slight cooling effect on the atmosphere?
A. Ozone **B. Sulfur Dioxide** C. Carbon Dioxide D. CFCs

65. (1 point) Which of the following is known to deplete the ozone layer?
A. Methane B. Carbon Dioxide **C. CFCs** D. Water Vapor

66. (2 points) Which nutrient, when in excess amounts in water supplies, can cause methemoglobinemia, or blue baby syndrome?
A. Nitrites **B. Nitrates** C. Ammonia D. Ammonium

67. (1 point) A factory dumps toxic waster into a river. This is an example of which type of pollution?
A. Point source B. Nonpoint source C. Thermal D. Light

68. (1 point) Water from rain runs over a farm and picks up excess fertilizer, which enters a nearby river. This is an example of which type of pollution?
A. Point source **B. Nonpoint source** C. Thermal D. Light

69. (2 points) A stream next to a reactor has warm water from the reactor constantly being added. This warm water increases the productivity of the plant species in the water. This scenario is best described as an example of:
A. Thermal pollution **B. Thermal enrichment** C. Thermal enhancement D. Light pollution

70. (2 points) Ocean garbage patches are composed of mostly what material?
A. Wood B. Rubber C. Large plastics **D. Microplastics**

71. (2 points) At or below what dissolved oxygen value is water considered hypoxic?
A. <1 mL/L B. 1 mL/L **C. 2 mL/L** D. 3mL/L

72. (3 points) Fish A is a fish species which is being hunted by humans for food. Humans have caught almost all of the adults of breeding age, so the species is having trouble maintaining its population. This is best an example of:
A. Growth overfishing **B. Recruitment overfishing** C. Ecosystem overfishing

73. (2 points) Which of the following is not a benefit of mangroves?
A. Coastal protection B. Water filtration **C. Reduced transpiration** D. Tourism

74. (1 point) Which of the following areas has had a net increase in mangrove area over the last 20 years?
A. Northwest Mexico B. Southeast Asia C. Northeast Brazil D. Sri Lanka

75. (7 points) A rain droplet you sampled has an OH^- concentration of $5.34 * 10^{-12}$. What is the pH of this rain droplet? Would this be considered acid rain, and why?

Solution: pH = 2.728 (4)
Calculating pOH gets us $pOH = -\log_{10}[OH^-] = -\log_{10} 5.34 * 10^{-12} = 11.272$
$pOH + pH = 14$ so therefore $11.272 + pH = 14$, $pH = 2.728$
This would be considered acid rain (2), since precipitation below about 5 in pH (1) is considered acid rain

76. (3 points) Eutrophication of aquatic and marine environments results in what condition, and why?

Solution: hypoxic/anoxic waters (1 point), decomposition of algal blooms (1'point for mentioning algal blooms) uses up too much oxygen (1 point for realizing decomposition of blooms uses oxygen)

77. (6 points) Explain the difference between natural eutrophication and cultural eutrophication.

Solution: Natural Eutrophication: Natural eutrophication is a process that occurs as a result of a gradual buildup of nutrients and organic matter in water resources over a very long period of time.(3 points for anything similar)
Cultural Eutrophication: Cultural eutrophication of anthropogenic eutrophication is the process of accumulation of excess nutrients in water ecosystems as a result of human activities. (3 points for anything similar)

78. (1 point) List one direct cause of ocean acidification.
increased carbon dioxide levels in the atmosphere

79. (5 points) Write out the main 3 chemical reactions of ocean acidification. (hint: which molecule enters water from the atmosphere). What effect does this have on the shell formation of corals?

Solution: 1 point each
$CO_2 + H_2O \longrightarrow H_2CO_3$
$H_2CO_3 \longrightarrow H^+ + HCO_3^-$
$HCO_3^- \longrightarrow H^+ + CO_3^{2-}$

80. (4 points) Which 2 gases are the main causes of acid rain, and what are 2 sources of each of them?

Solution: Sulfur dioxide (1) Sources: volcanoes, coal burning, copper extraction (1)
Nitrogen oxides (1) Sources: cement production, fossil fuel burning, volcanoes, lighting, bacterial respiration, decomposing grain, nuclear detonation, smoking (1)

81. (7 points) Explain how temperature affects dissolved oxygen concentration in freshwater. Name the principle that most directly influences the way dissolved oxygen changes with water temperature.

Solution: Temperature increases, DO decreases (1) Temperature decreases, DO increases (1). Warm water holds less dissolved oxygen than cold water because the molecules are moving faster than in cold water (1) and thereby allow oxygen to escape from the water(1) . This mixing is aided when the density of water changes due to a change in water temperature. Le Chatelier's principle (3)

Section C: Solutions to Human Problems

82. (3 points) The addition of iron into the oceans to increase biological productivity is known as: **Iron fertilization/seeding**

83. (4 points) Willow has the ability to absorb large amounts of cadmium from soil. Willow is a(n) **hyperaccumulator** for cadmium and a plant used for the process of **phytoextraction** (be specific).

84. (4 points) Describe the process of enhanced bioremediation.

> **Solution:** involves the addition of microorganisms or nutrients (2)(e.g. oxygen, nitrates) to the subsurface environment to accelerate the natural biodegradation process (2)

85. (1 point) Which of the following is not an advantage of a bioswale?
A. Increasing infiltration to groundwater B. Concentrating stormwater **C. Stormwater storage** D. Removing debris and pollution

86. (1 point) Which of the following is not a type of green infrastructure?
A. Artificial Lawns B. Permeable Pavement C. Rain Gardens D. Downspout Disconnection

87. (1 point) Which of the following are used industrially to desulfurize waste?
A. Haber Bosch Process **B. Wet Scrubbers** C. Aeration basins D. Flocculation

88. (4 points) Briefly describe the Urban Heat Island effect, and 2 ways to mitigate its effects.

> **Solution:** The replacement of natural land with human structures such as roads and building increases temperatures in urban areas. (2)
> Solutions: green infrastructure, planting trees, green roofs (1 point each for a max of 2 points)

89. (1 point) Which city's fire in 1969 lead to the passing of the Clean Water Act?
A. Cleveland B. New York C. Austin D. Boston

90. (2 points) What is the difference between *in situ* and *ex situ* bioremediation

> **Solution:** *in situ* treats contaminants at the site (1), while *ex situ* treats contaminants after moving to a new location (1)

91. (2 points) Which of the following is not a type of phytoremediation?
A. Rhizofiltration B. Phytoextraction **C. Phytoabsorbance** D. Phytodegredation

92. (2 points) Over the last 25 years, sun-blocking aerosol levels have **decreased** steadily.

93. (2 points) The use of fungi in bioremediation is:
A. Mycoremediation B. Phytoremediation C. Dendroremediation D. None of the above

Matching

Match each of the following environmental laws or agreements to its description. Use each of the following choices for the next fourteen (14) problems. You will only use each answer once.

(a) Clean Air Act
(b) Clean Water Act
(c) Safe Drinking Water Act
(d) Comprehensive Environmental Response, Compensation, and Liability Act
(e) Pollution Prevention Act
(f) Oil Pollution Act
(g) Toxic Substances Control Act
(h) Federal Insecticide, Fungicide, and Rodenticide Act
(i) Endangered Species Act
(j) Marine Mammal Protection Act
(k) Kyoto Protocol
(l) Montreal Protocol
(m) Madrid Protocol
(n) Paris Agreement

94. (1 point) __**j**__ Prohibits the killing, capture, and collecting of marine species in US waters.
95. (1 point) __**a**__ The first piece of legislature controlling air pollution passed in the US.
96. (2 points) __**m**__ A global agreement to protect the natural environment of Antarctica.
97. (2 points) __**d**__ Established a "Superfund" to clean up sites contaminated with toxic substances.
98. (1 point) __**f**__ Created a fund that could be used to clean up oil spills.
99. (1 point) __**b**__ Regulates discharges of pollutants into surface waters.
100. (2 points) __**k**__ 1997 global convention where countries agreed to lower greenhouse gas emissions.
101. (2 points) __**e**__ Focused on reduction of pollution at the source through changes in US industry.
102. (1 point) __**g**__ Addresses production, importation, use, and disposal of toxic substances in the US.
103. (1 point) __**i**__ Created a program for conservation of threatened or endangered species
104. (2 points) __**n**__ Global agreement to limit global warming to under 2 degrees Celsius.
105. (1 point) __**c**__ Regulates the drinking water supply and protects drinking water sources.
106. (2 points) __**l**__ International agreement that regulates release of ODPs (Ozone depleting substances).
107. (1 point) __**h**__ Regulates the production, sale, and consumption of pesticides in the US.