

PART A Station 2 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

Questions 7-10 refer to Figure 2. Smallmouth bass and rock bass have been introduced to pristine Canadian lakes, disrupting the food web in these lakes. Changes that can be seen in the role of native lake trout in the community. Vander Zanden, M. Jake, John M. Casselman, and Joseph B. Rasmussen. "Stable isotope evidence for the food web consequences of species invasions in lakes." *Nature* (1999): 464.

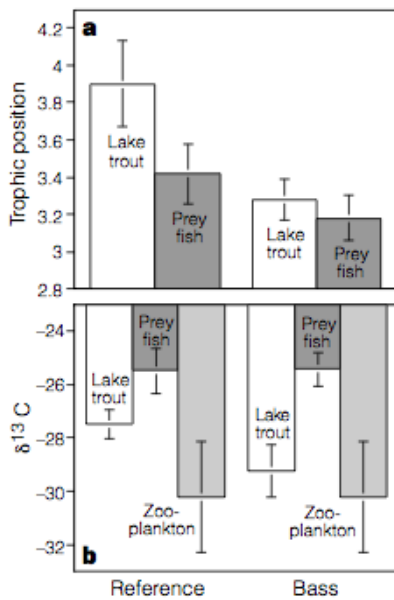


Figure 2: Trophic position and $\delta^{13}\text{C}$ values. **a.** Comparison of mean trophic position of lake trout and pelagic forage from invaded and reference lakes. **b.** Comparison of mean $\delta^{13}\text{C}$ values of lake trout, littoral prey and zooplankton from invaded and reference lakes. Error bars represent 1 s.e.m.

7. In the lakes, the trophic position of lake trout was measured by stable nitrogen isotope ratios. The ratios become enriched between predator and prey tissues. The trophic position of lake trout was _____ in invaded lakes, compared to _____ in reference lakes.
8. Given this change in trophic position, which of the following might be true?
 - a. Lake trout populations decreased in number.
 - b. There was probably no difference in the diet of lake trout between invaded lakes and reference lakes.
 - c. In invaded lakes, the lake trout ate more fish.
 - d. In invaded lakes, the lake trout ate more plankton.
 - e. None of the above.
9. Stable carbon isotope ratios ($\delta^{13}\text{C}$) can be used to identify the source of production in a lake because benthic algae are enriched in $\delta^{13}\text{C}$ compared to phytoplankton. Enrichment is reflected by less negative $\delta^{13}\text{C}$ values. Therefore, as shown in Figure 2b, we know that _____ was a greater source of production for lake trout populations in reference lakes than in invaded lakes.
 - a. Phytoplankton
 - b. Benthic algae
 - c. More data is needed to make a conclusion.
10. Lake trout in reference lakes relied more on _____ prey than trout in invaded lakes.
 - a. Littoral
 - b. Pelagic
 - c. Limnetic
 - d. Hypo-limnetic
 - e. Abyssal
11. A lake that has $<0.95 \mu\text{g/L}$ Chlorophyll and a Secchi depth of 9 m would be called _____.
12. The metalimnion in a lake is analogous to the _____ of the ocean.
13. The global pattern of ocean currents driven by density gradients is known as _____.

PART A Station 3 Division C

Choose the best answer and mark it on your answer sheet.

1 point each question

DO NOT WRITE ON THE TEST

14. Which of the following equations can be used to describe density-independent population growth?
15. Which of the following equations would most likely be used to describe the population of a single K-selected species?
16. Which of the following equations would most likely be used to describe population size if you wanted to include interspecific competition?

- | | |
|--|-----------------------|
| a. $\frac{dN}{dt} = rN$ | d. $N_t = N_0 e^{rt}$ |
| b. $\frac{dx}{dt} = ax - bxy$ and $\frac{dy}{dt} = cxy - gy$ | e. Both a and d. |
| c. $\frac{dN}{dt} = r_m N \left(1 - \frac{N}{K}\right)$ | |

Please refer to Figure 3 to answer questions 17-19.

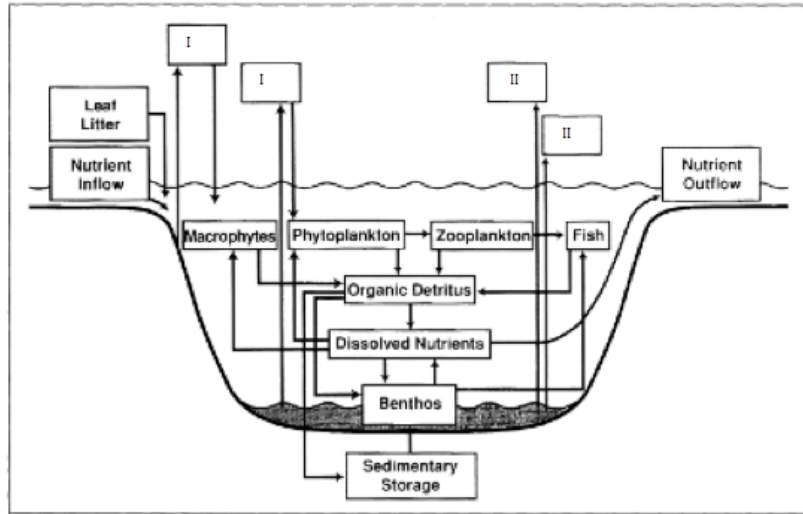


Figure 3: The roles of benthic macroinvertebrates in cycling nutrients and controlling nutrient outflows from ecosystems. Covich, Alan P., Margaret A. Palmer, and Todd A. Crowl. "The role of benthic invertebrate species in freshwater ecosystems: zoobenthic species influence energy flows and nutrient cycling." *BioScience* (1999): 119.

17. Which of the following pairs are most likely to be the correct labels for the boxes marked "I"? The first term in the pair belongs to the box on the left.
18. Which of the following pairs are most likely to be the correct labels for the boxes marked "II"? The first term in the pair belongs to the box on the left.

a. H ₂ O and F ₂	d. H ₂ and CaCO ₃
b. Sunlight and water	e. N ₂ and CO ₂
c. CH ₄ and H ₂ S	
19. Which of the following statements about macrophytes is not true?
 - a. Large populations of macrophytes can have a negative effect on aquatic ecosystems.
 - b. They are organisms that can be seen with the unaided eye.
 - c. They can be used to assess lake quality.
 - d. Water striders are an example of a type of macrophyte.
 - e. All of the above are true.
20. Which of the following are examples of a lotic system?

a. Stream, river, brook	d. Ditch, seep, estuary
b. Lake, cenote, river	e. None of these are examples of a lotic system.
c. Vernal pool, marsh, pond	

PART A Station 4 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

21. _____ estuaries are found in large, shallow estuaries where there are strong tidal currents.
- Salt-wedge
 - Freshwater
 - Fjord
 - Partially mixed
 - Vertically mixed
22. The relatively shallow part of the ocean, above the continental shelf, is called the _____.
23. The open ocean is also called the _____.

Please refer to Figure 4 to answer questions 24-27.

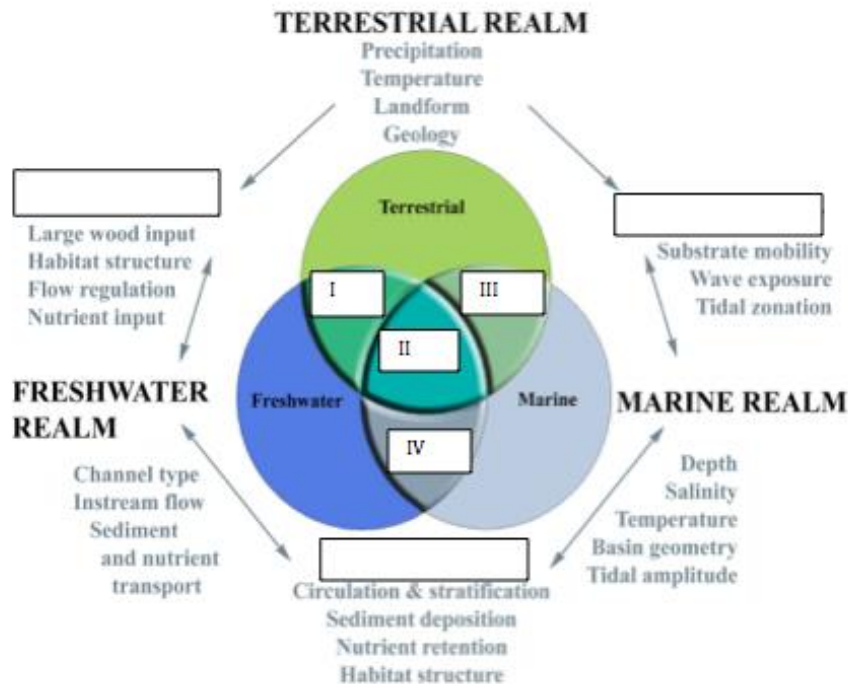


Figure 4. <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/alaska/explore/estuary-teaching-graphic.jpg>

24. Which of the following labels should be in the box labeled I?
25. Which of the following labels should be in the box labeled II?
26. Which of the following labels should be in the box labeled III?
27. Which of the following labels should be in the box labeled IV?
- Atmosphere
 - Wedge
 - Estuary
 - Wetland
 - Intertidal

PART B Station 5 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

1. Hypoxia naturally occurs in all of the following EXCEPT
 - a. Fjords.
 - b. Deep basins.
 - c. Coastal areas.
 - d. Open ocean oxygen minimum zones.
 - e. Western boundary upwelling systems.
2. The largest human-caused hypoxic zone affecting the US is
 - a. Along the coast of California.
 - b. In the Gulf of Mexico.
 - c. Along the Northeastern coast.
 - d. Along the western Florida coast.
 - e. In the Great Lakes.
3. Hypoxia in the Gulf of Mexico has been attributed to
 - a. An increase in the use of fertilizer.
 - b. Nitrogen fixation by legumes.
 - c. Deposition of nitrogen from the combustion of fossil fuels.
 - d. a and c
 - e. All of the above.
4. Which of the following is NOT true?
 - a. In the spring the water column in the Gulf of Mexico near the Mississippi is stratified with the new nutrient rich water staying near the top.
 - b. Oxygen consumption rates at the bottom of the ocean in the spring and under high nutrient levels are very high.
 - c. The bottom of the ocean, once hypoxic, can remain so for months.
 - d. Warm fronts in the summer can replenish hypoxic areas of the ocean.
 - e. All of the above are true.
5. Hypoxic ocean zones are called “dead zones” because
 - a. All organisms have died.
 - b. All organisms have left.
 - c. No organisms are found there ever.
 - d. Organisms either left or died.
 - e. The area is toxic.
6. Hypoxia decreases _____ in fish.
 - a. Growth
 - b. Reproduction
 - c. Survival
 - d. a and b
 - e. a, b and c
7. Data on hypoxia in the Gulf of Mexico is gathered by
 - a. Instrumentation on stationary moorings.
 - b. Routine cruises offshore on transects.
 - c. Occasional shelfwide cruises.
 - d. a and b
 - e. a, b and c

PART B Station 6 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

The Nuclear Plant in Fukushima Japan was damaged by an earthquake on March 11, 2011. One of the radioactive materials released was iodine 131. Several areas in California were monitored in the following months. Use the figures below to answer the following questions. (Figures from Manley and Lowe. 2012. Canopy-Forming Kelps as California's Coastal Dosimeter: ^{131}I from Damaged Japanese Reactor Measured in *Macrocystis pyrifera*. Environ. Sci. Technol. 46: 3731)

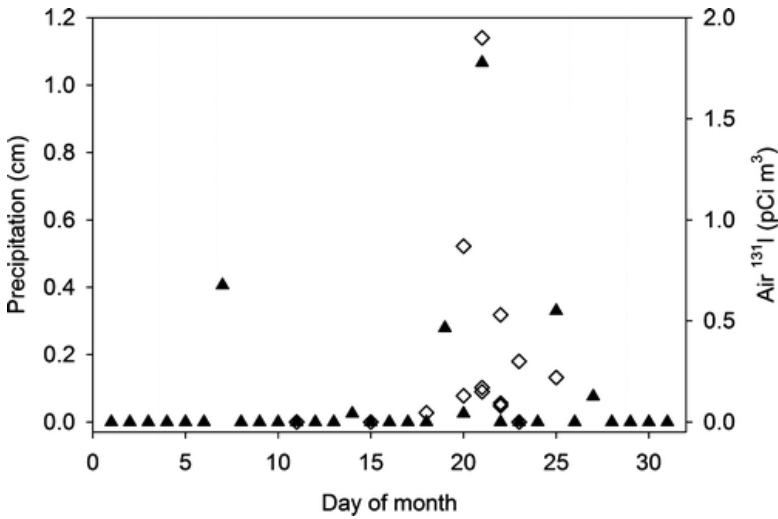


Figure 5. Precipitation (▲) at Newport Harbor, and concentration of ^{131}I (◇) in air measured for the month of March 2011 in Anaheim (both in Orange County, CA.)

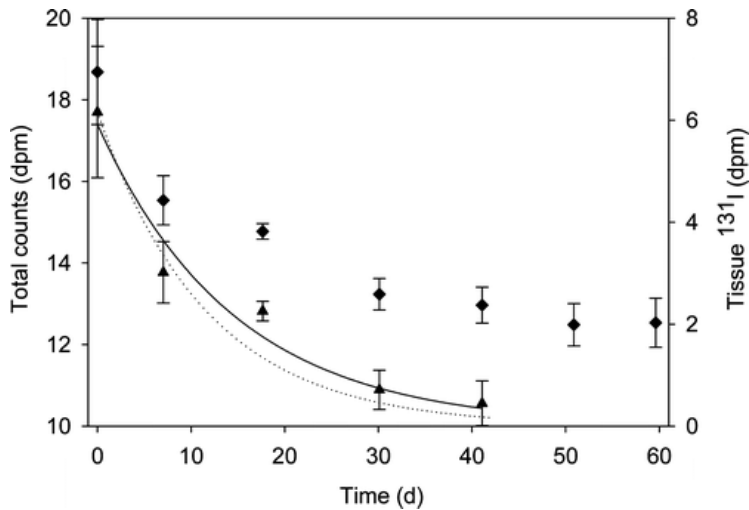


Figure 6. Gamma emission \pm sd ($n = 3$) from kelp collected April 22, 2011 from Lunada Bay CA (◆). Gamma emissions, \pm sd minus residual activity of 12.5 dpm (▲). Solid line shows exponential regression ($r^2 = 0.97$, $p < 0.01$). Dashed line shows expected decay for tissue ^{131}I .

PART B Station 6 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

8. When did levels of iodine 131 peak in the atmosphere in Anaheim?
 - a. 1 day after the earthquake
 - b. 5 days after the earthquake
 - c. 10 days after the earthquake
 - d. 15 days after the earthquake
 - e. Not enough information
9. What was the level of gamma emission from kelp collected in Lunada Bay at the time of the atmospheric peak in Anaheim?
 - a. 2 dpm
 - b. 12 dpm
 - c. 14 dpm
 - d. 15 dpm
 - e. 18 dpm
10. There was a period of significant rain at the same time that iodine 131 peaked in the atmosphere. This is what likely resulted in the uptake by aquatic plants including kelp. Is the increased uptake of iodine 131 likely a problem?
 - a. Yes iodine 131 has a long half-life.
 - b. Yes the dose of iodine 131 received was significant.
 - c. No iodine 131 has a short half-life.
 - d. No iodine 131 does not harm cells.
 - e. No the dose of iodine 131 was not significant.
11. What organ in fish would iodine 131 most likely affect?
 - a. Eyes
 - b. Heart
 - c. Lungs
 - d. Kidneys
 - e. Thyroid
12. What radioactive material would have been released in the highest amounts?
 - a. Cesium
 - b. Radium
 - c. Neptunium
 - d. Curium
 - e. Uranium
13. What is the half-life of plutonium 239
 - a. 1000 years
 - b. 24,000 years
 - c. 45,000 years
 - d. 100,000 years
 - e. 1,000,000 years
14. The Yucca Mountain Nuclear Waste Repository in _____ was proposed as a solution to safe nuclear waste disposal, but never utilized.
 - a. Nevada
 - b. Colorado
 - c. Utah
 - d. Wyoming
 - e. Montana

PART B Station 7 Division C

Choose the best answer and mark it on your answer sheet.
DO NOT WRITE ON THE TEST

1 point each question

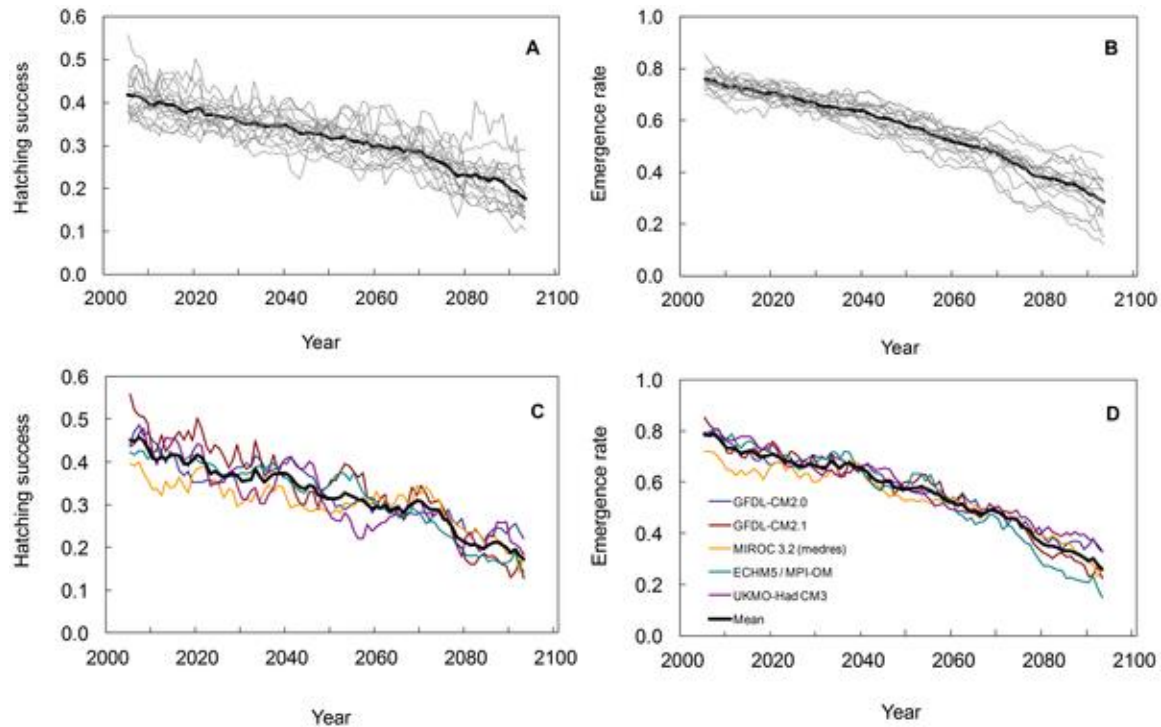


Figure 7. Hatching success and emergence rate projections of leatherback nests in 100 years of climate change. Projections are based on (a,b) each of the 17 bias-corrected CMIP3 models (grey lines) and the ensemble mean (black line) and (c,d) 5 of the bias-corrected CMIP3 models that are skillful at resolving present-day ENSO climate variability (coloured lines) and their ensemble mean (black line). Time-series projections are presented as 10-year moving averages (from PLOS One).

<http://www.earthtimes.org/climate/climate-change-turtles/2017/#4KPQb3Gshaj40okt.99>

15. Leatherback turtles have to dig through sand once they hatch on a beach. What is the most logical reason for the projected trend in hatching success if global warming is ultimately the cause?
16. What is the most logical reason for the projected trend in emergence rate if global warming is ultimately the cause?
17. Using the mean in panel c for the year 2020, if 100,000 eggs are laid on a beach, how many are expected to hatch? Show your work.
18. Using the mean in panel c, if those same 100,000 eggs are laid in 2060, how many FEWER are expected to hatch? Show your work.
19. Which of the following is true?
 - a. The greenhouse effect is bad.
 - b. The primary natural greenhouse gas is nitrous oxide.
 - c. CFCs destroy ozone.
 - d. Global warming deals with local weather patterns.
 - e. All of the above.
20. Which of the following is a natural greenhouse gas?
 - a. hydrofluorocarbons
 - b. sulfurhexafluoride
 - c. perfluorocarbons
 - d. chlorofluorocarbons
 - e. nitrous oxide

*** TIE BREAKER 2**

PART B Station 8 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

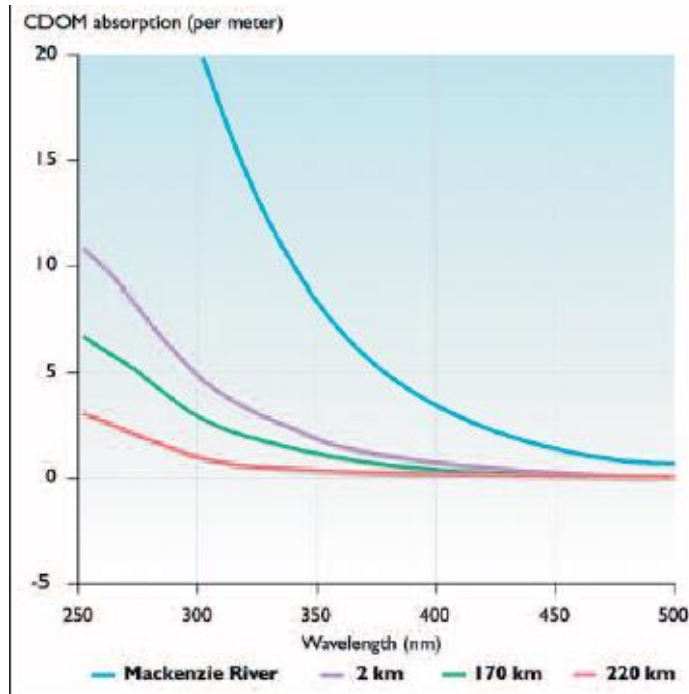


Figure 8. Ultraviolet (<400 nm) and blue-light (400–500 nm) radiation absorption by CDOM (colored dissolved organic matter) in the Mackenzie River (Inuvik, October 2002). The lower curves are for surface samples near the same date in the Beaufort Sea showing the CDOM influence at 2, 170, and 220 km offshore from the mouth of the river. Vincent, W.F. and C. Belzile, 2003. Biological UV exposure in the polar oceans: Arctic-Antarctic comparisons. In: A.H.L. Huiskes, W.W.C. Gieskes, J. Rozema, R.M.L. Schorno, S.M. van der Vies and W.J. Wolff (eds.). Antarctic Biology in a Global Context. Proceedings of the VIIIth SCAR International Biology Symposium, 27 August –1 September 2001, pp. 176–181.

21. How much 350nm light is absorbed by CDOM in the Mackenzie River versus at 170km offshore?
Show your work.
22. If this river undergoes acidification, how will this affect the amount of UV absorbed by CDOM?
 - a. Increase
 - b. Decrease
 - c. Stay the same
 - d. Cannot determine
23. Acidification is caused by an increase in _____ while UV absorption is affected by the levels of _____.
 - a. Ozone, carbon dioxide
 - b. Acid, ozone
 - c. Acid, base
 - d. Carbon dioxide, ozone
 - e. Methane, ozone
24. Increased exposure to UV will impact
 - a. DNA
 - b. Photosynthesis
 - c. Palatability of prey
 - d. Primary productivity
 - e. All of these.
25. Arctic ecosystems may be especially sensitive to increased UV because
 - a. Of limited nutrient supply
 - b. Of low temperatures
 - c. Of low photosynthetic rates
 - d. a and b
 - e. a, b and c
26. In response to increased exposure to UV some algae and zooplankton practice an avoidance mechanism referred to as _____ migration.
27. UV protecting compounds produced by aquatic organisms include, carotenoids, MAAs, and _____, the last of which is also found in humans.

PART C Station 9 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

1. The _____ protocol placed a temporary ban on mineral exploration in Antarctica. * **TIE BREAKER 3**
2. The _____ act attempted to minimize non-point source pollution.
3. The _____ act protects threatened and endangered animals in the US.
4. The _____ Convention on Persistent Organic Pollutants targets the 12 most toxic chemicals.
5. The _____ protocol is an attempt to phase out ozone-depleting substances.
6. The _____, held in the 1970's in South Africa, focused on clear air and water.
7. The _____ Ban Act applies to sewage, sludge and industrial waste.

PART C Station 10 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

Match each of the fishing techniques with its level of sustainability.

- | | |
|----------------------|-------------|
| 8. Midwater trawlers | A. Good |
| 9. Longlines | B. Varies |
| 10. Hook and line | C. Poor |
| 11. Bottom trawlers | D. Very low |
| 12. Pots and traps | |
| 13. Purse seine nets | |
| 14. Gillnets | |

PART C Station 11 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

The choices for the following questions are:

- A. Bacterial Bioremediation B. Phytoremediation C. Mycoremediation

15. As a result of this process, carbon dioxide and water are released.
16. This process could potentially be used to remove cesium 137 from Fukushima.
17. This process takes advantage of the fact that mycelium contain oil degrading enzymes.
18. This type of remediation was used in the former Union Pacific Laramie, WY facility.
19. Hyper accumulators are used to clean heavy metals using this process.
20. This type of remediation could potentially be used to break down toxins in sewage if the power of enzymes like laccase can be harnessed
21. This is currently the most common type of bioremediation used.

PART C Station 12 Division C

Choose the best answer and mark it on your answer sheet. 1 point each question
DO NOT WRITE ON THE TEST

WaterSense is an EPA partnership program focused on water-efficient products, homes, and services. (www.epa.gov/watersense) One such product is the water-efficient showerhead. Approximately 17% of the water used in households is for showering. Standard showerheads use 2.5 gallons of water per minute (gpm). WaterSense showerheads must use no more than 2.0 gpm. The average shower lasts 8 minutes.

22. If the average family uses 40 gallons of water a day to shower with a standard showerhead, how many gallons of water a day would they use with a WaterSense showerhead?
a. 35 b. 32 c. 28 d. 25 e. 20
23. What is the difference in water used during a shower with a standard showerhead versus a WaterSense showerhead?
a. 5 b. 4 c. 3 d. 2 e. 1
24. Assuming you use a standard showerhead and shower every day, how many gallons of water will you save by showering for 1 minute less than the average shower time?
a. 500 b. 1040 c. 1450 d. 2015 e. 2555

Partnering with WaterSense is free and connects your company to a network of resources.

25. It makes the most sense **economically** to join such an organization if
 - a. You need to reduce research costs.
 - b. You want to increase consumer confidence in your product with the WaterSense standards and labels.
 - c. Support the messaging of water efficiency.
 - d. You want to gain recognition from the EPA.
 - e. All of the above.

Using less water for showering also means using less power to heat that water. Saving 2,900 gallons per year per family could save 370 kilowatt hours of electricity each year. On average 1 kilowatt hour of electricity produces 1.13 pounds of carbon dioxide.

26. Using the given figures, approximately how many kilowatt hours are used to heat 1 gallon of water? Show your work.
27. How much less carbon dioxide is released then if you do not heat 1 gallon of water each day for one year? Show your work.

Part A- 27 points

1. A B C D E

2. A B C D E

3. A B C D E

4. A B C D E

5. A B C D E

6. A B C D E

7. 3.3, 3.9

8. A B C D E

9. A B C D E

10. A B C D E

11. oligotrophic

12. thermocline

13. Thermohaline circulation

14. A B C D E

15. A B C D E

16. A B C D E

17. A B C D E

18. A B C D E

19. A B C D E

20. A B C D E

21. A B C D E

22. Neritic zone

23. Pelagic zone

24. A B C D E

25. A B C D E

26. A B C D E

27. A B C D E

*** TIE BREAKER 1**

Part B- 27 points

1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
5. A B C D E
6. A B C D E
7. A B C D E
8. A B C D E
9. A B C D E
10. A B C D E
11. A B C D E
12. A B C D E
13. A B C D E
14. A B C D E
15. Hot and dry conditions mean the sand is drier and drier sand is harder to crawl up through.
16. Hot and dry conditions are likely to cause the baby turtles to desiccate/dry out, resulting in higher mortality.
17. $0.4 \times 100,000 = 40,000$
18. $0.3 \times 100,000 = 30,000$
 $40,000 - 30,000 = \mathbf{10,000}$
19. A B C D E
20. A B C D E * **TIE BREAKER 2**
21. $\sim 8/2 =$ approx. 4 times more (check math)
22. A B C D E
23. A B C D E
24. A B C D E
25. A B C D E
26. vertical
27. melanin

1. Madrid * **TIE BREAKER 3**
2. Water quality
3. Endangered species
4. Stockholm
5. Montreal
6. Earth summit
7. Ocean dumping
8. A **B** C D
9. A B **C** D
10. **A** B C D
11. A B C **D**
12. **A** B C D
13. **A** B C D
14. A **B** C D
15. **A** B C
16. A B **C**
17. A B **C**
18. A **B** C
19. A **B** C
20. A B **C**
21. **A** B C
22. A **B** C D E
23. A **B** C D E
24. A B **C** D E
25. **A** B C D E
26. $370/2900 = \mathbf{0.128}$
27. $0.128 \times 1.13 \times 365 = \mathbf{52.8}$

Student Name(s) _____

School Name and Number _____

Part A- 27 points

Make sure for the multiple choice that you **SHADE OVER** the letter. **DO NOT JUST CIRCLE IT!!!!**

1. A B C D E

2. A B C D E

3. A B C D E

4. A B C D E

5. A B C D E ***TB1**

6. A B C D E

7. _____

8. A B C D E

9. A B C D E

10. A B C D E

11. _____

12. _____

13. _____

14. A B C D E

15. A B C D E

16. A B C D E

17. A B C D E

18. A B C D E

19. A B C D E

20. A B C D E

21. A B C D E

22. _____

23. _____

24. A B C D E

25. A B C D E

26. A B C D E

27. A B C D E

Point total part A ____

Point total part B ____

Point total part C ____

EXAM TOTAL SCORE _____

TIE BREAKER REQUIRED? _____

MODIFIED SCORE _____

Part B- 27 points

Make sure for the multiple choice that you **SHADE OVER** the letter. **DO NOT JUST CIRCLE IT!!!!**

- 1. A B C D E
- 2. A B C D E
- 3. A B C D E
- 4. A B C D E
- 5. A B C D E
- 6. A B C D E
- 7. A B C D E
- 8. A B C D E
- 9. A B C D E
- 10. A B C D E
- 11. A B C D E
- 12. A B C D E
- 13. A B C D E
- 14. A B C D E
- 15.

Point total part B _____

16. _____

17. _____

18. _____

19. A B C D E

20. A B C D E ***TB2**

21. _____

22. A B C D E

23. A B C D E

24. A B C D E

25. A B C D E

26. _____

27. _____

Part C- 27 points

Make sure for the multiple choice that you **SHADE OVER** the letter. **DO NOT JUST CIRCLE IT!!!!**

1. _____ ***TB3**

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. A B C D

9. A B C D

10. A B C D

11. A B C D

12. A B C D

13. A B C D

14. A B C D

15. A B C

16. A B C

17. A B C

18. A B C

19. A B C

20. A B C

21. A B C

22. A B C D E

23. A B C D E

24. A B C D E

25. A B C D E

26.

27. _____

Point total part C _____