BIOLOGY and
BIOLOGY ACHIEVEMENT

DREY LAND FIELD STUDY GUIDE

PART 1. OZARK STREAM
PART 2. DECIDUOUS FOREST

JOHN BURROUGHS SCHOOL

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Prepared by:

Margaret Bahe
Bruce Westling
Elaine Childress
Scott Heinzel

Topographic Map of the Drey Land Area

Biology Drey Land Policies

DISHONESTY: PLAGIARISM AND CHEATING

The following statement is taken from the JBS Student - Parent Handbook.

> "John Burroughs School believes that dishonesty, cheating, and plagiarism are not honorable and cannot be tolerated. Plagiarism is an act to pass off as one's own the ideas, writings, etc. of another."

In addition, the following two guidelines are taken from the Science Department Policies Statement:

> "1. When you have been assigned to work together, it is natural that your team will share the labor and the data....... This is acceptable scientific practice.
>
> and
>
> "2. You must write your own conclusions or experimental summary. You may want to discuss your results with others but the final report must be your own words."

These guidelines are in effect at the Drey Land Camp as well as at the main school campus.

STUDENT EXPECTATIONS

In addition to normal school rules, students are expected to meet the following guidelines while at Drey Land:

- Volunteer and participate fully in all all aspects of the Biology Drey Land Ecology Program including classes, K.P., cookouts, and the float trip.
- Be on time to all activities.
- Be in your cabin and stay in your cabin at the end of the day as instructed by the camp director.
- Always tell the camp director if you leave the main lodge and cabin area.
- Wear shoes at all times.

Place Daily Schedule Here

Part 1. Ecological Study Of An Ozark Stream

Introduction: Sinking Creek is a small tributary of the Current River. Water enters the stream continuously from numerous springs located throughout the region or as runoff following periods of rainfall. Because the surrounding terrain undergoes a somewhat sudden change in elevation, the stream flows rapidly in many areas, but as you will experience, there are also stretches where it meanders along quite slowly.

In the rapidly moving areas the water has an eroding effect on the substrate over which it flows, resulting in a stream bottom composed
primarily of rocks and pebbles. The smaller particles of sand and silt are swept farther down stream to settle in those areas where the water velocity slows. Where the currents are rapid, aeration of the water takes place continuously, with oxygen from the atmosphere being mixed with the water and carbon dioxide from the water escaping readily into the air.

Where the current is swift, rooted plants are unable to establish a foothold so plants of this type are absent. Certain forms of plant life have adapted to this environment: films of one celled algae called diatoms, attached filamentous green algae and mosses. If these are absent, there is too much shade. Certain forms of animal life also have adapted to such microenvironments by living under or behind stones, others have suckers or holdfasts for attachment. A few secrete silk-like lines by which they maintain their position in the rushing torrent. Free swimming animals are usually streamlined, and dart rapidly from one quiet area to another. It is because of these adaptations that stream organisms are able to survive in such restrictive environments. Each microenvironment has a different set of biotic and abiotic factors which provide all the requirements of life as well as setting the limits of life to those plants and animals with the unique set of adaptations that allow them to live there.

Objectives: During our stream study we will be looking for relationships between the aquatic organisms we find and their unique environment. The Sinking Creek investigations related to this objective will include:

1. How do the physical factors (such as light, temperature, dissolved oxygen, etc.) vary in time and space laong the stream? Is there any correlation of these physical factors with the aquatic community?
2. How does the biotic community, both plant and animal, vary along the stream in space and time? How is the Peterson Index used to conduct an Animal Survey?
3. What is the food energy budget of the stream as evidenced by a community food pyramid?
4. What is the water quality of the stream based on 9 indicators?
5. What interactions exist between the forest and stream environments?

Methods: Assigned groups (A,B,C) will complete one major study each class period. Within your group small teams will be assigned specific tasks by the instructor. You will be responsible for <u>CONSCIENTIOUSLY</u> performing that task and for recording the data gathered on the <u>MASTER DATA TABLE</u>. This data set will be shared by all of the groups during the evening labs when you will record all data in your personal book. On the final evening of the camp you will: 1. review the data; 2. discuss the implications of the data with your classmates; 3. complete the data analysis questions; and 4. write a paper.

As you can see it is almost imperative that you begin reading the analysis questions and formulating tentative answers to those questions on the first day, and to continue to do so each day you are here. To wait until the last night to start this process is a big mistake that has no satisfactory solution. Talk to everyone and anyone about the meanings and implications of the data. Recall the hundreds of facts and more importantly the many general concepts you have learned throughout the entire year. Up until now you have been studying life out of a book....at Drey Land you are studying life in the best place possible....in a natural setting. This is were you will find out how much you have really learned this year.

You have a lot riding on this field study. So work hard at all times, do your best, work as a team and we will all be very successful!

The following table summarizes the schedule you will follow. Each group will begin their rotation the day they arrive and will meet for the class at the time shown on the MASTER SCHEDULE posted on the bulletin board. Please do not ask the instructors when you meet. Make it your responsibility to check the bulletin board for your particular meeting time.

	Group A	Group B	Group C
1st Afternoon	Riffle, Mark Crayfish, Diatoms, Snails	Water Chemistry, Diatoms	Riffle, Mark Crayfish, Diatoms, Snails
1st Evening	ID Organisms, Count Diatoms, Observe Coliforms	Cookout	ID Organisms, Count Diatoms, Setup Coliforms
2nd Morning	Water Chemistry	Volume Flow	Volume Flow
2nd Afternoon	Volume Flow, Recatch Crayfish	Riffle, Crayfish, Snails	Float
2nd Evening	Cookout	ID Organisms, Count Diatoms, Observe Coliforms	Water Chemistry, Draw Profiles
3rd Morning	Seine, Draw Profiles	Seine, Draw Profiles Recatch Crayfish	Seine, Finish Profiles

COMPLETING YOUR STREAM STUDY REPORT

Each student will be completing his / her own stream report. Although you will be using most of the data gathered during your stream study, all data pages need not be turned in with your stream study report. Your report should contain the following and be stapled **in this order**:

1. **Cover Page** (your name, your group [A,B or C], your stream teacher's name, your biology teacher's name, your session number [I, II or III])

2. Your **Stream Essay,** one page only, written in ink

3. Pages from the stream manual: **12, 22, 33, and 34**

4. Question **Pages Q1 through Q9**, including your pyramid of numbers

THE OZARK STREAM ECOSYSTEM

Abiotic Components: Physical **Notes**

1. Solar Insolation (Sunlight)
2. Temperature (air, water)
3. Water velocity and volume
4. Turbidity and color
5. Stream substrate

Abiotic Components: Chemical **Notes**

1. Dissolved oxygen
2. Carbon dioxide
3. Nitrate and Ammonium (nitrogen)
4. Phosphate (phosphorus)
5. pH
6. Alkalinity
7. Biological Oxygen Demand
8. Total Solids and Total Dissolved Solids
9. Hardness

Biotic Components **Notes**

1. Decomposers (Bacteria, fungi)
2. Producers (Diatoms, green algae)
3. Detritus (organic debris from forest)
4. Consumers 1st order
5. Consumers 2nd order
6. Consumers 3rd order

WATER CHEMISTRY TESTS

Stream Equipment (Group):

1 gallon collection containe,
oxygentest kit
water sample collection apparatus
thermometer
Diatom filtration apparatus.

Laboratory Equipment (Group):

Hach water test kits
Hach colorimeter
stream water sample
waste container.

Procedure:

1. One or two students will work as a team.

2. Each team will be assigned a minimum of four tests to complete. As assignments are made, complete the individual assignment data table by writing your name after the test assigned to your team.

3. Complete the tests in the assigned sequence. Finish one test completely before starting another. The instructions and equipment needed for each test are stored individually in labeled boxes.

4. Report the test results to you instructor. If your value for the test varies widely from the established standard, you will be asked to repeat the measurement. If your measurement falls within the normal range, you will be told to continue on with step 5.

5. When each test is finished, return all equipment to the kit you used and then return the kit to the storage cabinet.

6. When all the tests have been done, you will be asked to help complete a general lab clean-up. Tables need to be dried, waste water dumped, and all data recorded. Do not leave the lab area until excused.

7. All data will be recorded in the master data table by the instructor. Students are not permitted to add data to the permanent record.

WATER CHEMISTRY TESTS

Use this page to write the data gathered by you and your team

Date ___________ Time____________

Test	Results	
1. Temperature	Air ______	
	Water Site #1_____	Site #2 _______
2. Air Pressure	______________________	mm Hg
3. Oxygen (D.O.)	______________________	mg/L
Saturation %	______________________	% Sat.
4. Carbon dioxide	______________________	mg/L
5. Nitrate	______________________	mg/L
6. Ammonium	______________________	mg/L
6. Phosphate	______________________	mg/L
7. pH	______________________	
8. Alkalinity	______________________	mg/L
9. Hardness	______________________	mg/L
10. Turbidity	______________________	JTU
11. True color	______________________	AU
12. B.O.D.	______________________	mg/L
13. Total Dissol. Solids	______________________	mg/L
14. Total Solids	______________________	mg/Ls
15. Solar Insolation	______________________	BTU
16. Diatoms	______________________	cells/ml
17. Coliform, Total	______________________	cells/ 100 ml
18. Coliform, Fecal	______________________	cells/ 100 ml
19. Stream Velocity	______________________	m/ sec
20. Stream Volume	______________________	L/ min.

Stream Water Chemistry Data Table

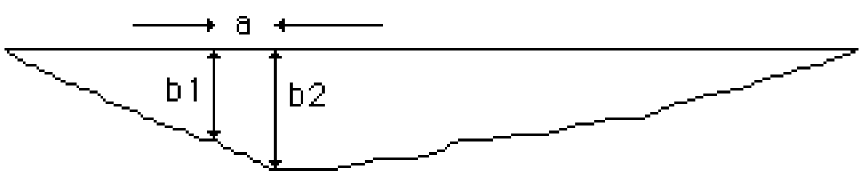
Time					Average
Date					
Air Temp.					
Water Temp					
The Change in Water Temp.					
Air Pressure					
Dissolved Oxygen (D.O.)					
% Sat. D.O.					
B.O.D.					
Carbon Dioxide					
Nitrate					
Ammonium					
Phosphate					
pH					
Alkallinity					
Hardness					
Turbidity					
True Color					
Total Solids					
Total Dissolved Solids					
Stream Velocity					
Stream Flow					

STREAM VOLUME AND VELOCITY

Stream Equipment:
- 100 m tape
- 50 m tape
- short ruler (30 cm)
- two meter sticks taped together
- stopwatch
- float (orange)

Laboratory Equipment:
- calculators
- poster board
- felt tip marker

Procedure:
1. A team of four students is needed for this activity.
2. Complete your stream measurements at the location selected by your instructor.
3. Two students should hold the line at water level across the stream.
4. The third student should measure the depth in cm of the water at each 30 cm interval along the line.
5. The fourth student should record the depth measurements in the cross-sectional data table.
6. Find the stream velocity by releasing a float into the water. Record the time it takes the float to move 4 m down stream. Repeat this procedure at four different places across the stream. Record the measurements in the Stream Velocity table and average.
7. After all measurements have been taken, return to the laboratory and calculate the cross-sectional area of the stream.
8. The method used will assume the total area is composed of a series of trapezoids of equal width as shown below. In this case, Area = 1/2a (b1+b2). Calculate the area of each trapezoid and record the results in the data table. Add the areas of the individual trapezoids to obtain the total area and record the value in the table. (NOTE: Your stream instructor may show you a shorthand way to calculate the cross-sectional area.)



9.

10. Calculate the VOLUME of a 1 m wide cross-section. Multiply the total area by 100 cm and record.
11. Convert cubic centimeters to liters. Note: 1000 cubic cm = 1 Liter
12. Convert the stream velocity from m/sec to m/min. Multiply your recorded velocity by 60 to make this conversion.
13. Find volume flow by multiplying the average velocity (m/min) by the number of liters in a cross-sectional volume one-meter wide.
14. Construct a profile of the creek drawn to scale by plotting the depth measurements on the graph paper provided. Use the same scale for **both** the distance across the stream and the depth.
15. Report the stream velocity and the volume flow data.

PLACE STREAM PROFILE PAGE HERE

DATA TABLE FOR CROSS SECTIONAL AREA

Distance (cm)	Depth (cm)	Area (cm3)	Distance (cm)	Depth (cm)	Area (cm3)
0			930		
30			960		
60			990		
90			1020		
120			1050		
150			1080		
180			1110		
210			1140		
240			1170		
270			1200		
300			1230		
330			1260		
360			1290		
390			1320		
420			1350		
450			1380		
480			1410		
510			1440		
540			1470		
570			1500		
600			1530		
630			1560		
660			1590		
690			1620		
720			1650		
750			1680		
780			1710		
810			1740		
840			1770		
870			1800		
900			1830		

DATA TABLE FOR CROSS SECTIONAL AREA

Distance (cm)	Depth (cm)	Area (cm3)	Distance (cm)	Depth (cm)	Area (cm3)
1860			2790		
1890			2820		
1920			2850		
1950			2880		
1980			2910		
2010			2940		
2040			2970		
2070			3000		
2100			3030		
2130			3060		
2160			3090		
2190			3120		
2220			3150		
2250			3180		
2280			3210		
2310			3240		
2340			3270		
2370			3300		
2400			3330		
2430			3360		
2460			3390		
2490			3420		
2520			3450		
2550			3480		
2580			3510		
2610			3540		
2640			3570		
2670			3600		
2700			3630		
2730			3660		
2760			3690		

STREAM VOLUME TABLE	
Total Area of the Cross Section	Sq. cm
Total Volume of a one-meter wide cross section	cu. cm (ml)
Total Number of Liters in the Cross-sectional Volume	Liters

VELOCITY TABLE			
Trial	Time (Sec)	Distance (m)	Velocity (m / sec)
1			
2			
3			
4			

Average velocity = _________________ m./sec.

Average velocity = _________________ m./min.

Volume Flow =
(average velocity m./min.) X (# liters in cross-sectional volume 1 meter wide)

= ________________ liters/min.

Average Volume and Velocity for All Groups									
Group	**Group A**			**Group B**			**Group C**		
	Velocity	**Flow**	**Place**	**Velocity**	**Flow**	**Place**	**Velocity**	**Flow**	**Place**
Team 1									
Team 2									
Team 3									
Average									

Session Average: **Velocity: ________________________ m/sec**

Flow: _________________________ Liters/min

RIFFLE SURVEY

Purpose: The purpose of this activity is to capture, count and identify invertebrates living in the riffles of the stream.

Stream Equipment:

- Surber nets
- white enameled trays
- turkey basters
- plastic droppers
- spoons
- baby food jars
- medicine droppers
- 5 gallon pails.

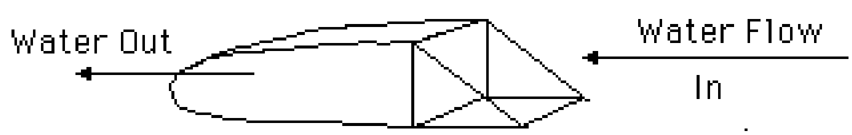
Laboratory Equipment:

- binocular microscopes
- petri dishes
- plastic droppers
- turkey basters
- spoons
- invertebrate key
- pond life reference, A Guide to the Study of Fresh Water Ecology.

Procedure:

1. Label 4 baby food jars with your name and group letter. Take these and the other equipment with you to the stream.

2. Invertebrates will be caught in the Surber Sampler shown below.

3. 

4. The base of the frame is one foot square and is carefully worked down into the stream bottom where it is held in place with your feet and legs. The second frame holds the net for trapped organisms carried downstream from the sample area.

5. After the Surber Sampler is in place, pick up the large rocks inside the sample area and wash organisms from them into the collecting net. After the rocks have been cleaned and discarded, churn the bottom pebbles and sand with your hands several times to dislodge any additional residents.

6. Raise the Surber Sampler from the stream and invert the net into a white tray containing water. Rinse the net carefully in the water to remove all of its contents.

7. Captured animals can be easily seen as they move against the white background of the tray. Suck individual animals up into a turkey baster or medicine dropper and then transfer them into baby food jars. Keep animals that look alike in the

same jar if possible.

8. Transfer larger animals (fish, Crayfish, etc.) caught in the net into the 5 gallon pails.

9. Repeat the collecting process several times. Take new samples from undisturbed areas of the riffles. Do not walk in areas intended for collection work.

10. Return all equipment to the porch of the lodge. Store the baby food jars containing organisms in the refrigerator until the evening lab.

11. dentify and count the number of stream organisms captured. Empty the contents of your baby food jars into petri dishes. Use the picture key to identify one of the animals present. Then remove and count all of the other animals like it from each petri dish. Record the name of the animal and the number captured on your data sheet. Repeat this process until all of the animals captured at the stream have been identified and counted.

12. Return the microscopes to their cases when your work is finished. Dry the petri dishes and generally organize the materials on the lab table.

13. Report your data to the evening lab instructor who will add it to the cumulative Biotic Data Table for all groups. You will need the cumulative data for your final report.

14. Classify the organisms identified as either shredders, filtering collectors, gathering collectors, scrapers or predators. Shredders feed on coarse particulate organic matter such as grass, leaves, algae and rooted plants. This material could be either living or dead. The dead material is colonized by bacteria fungi and protozoans which are also consumed by the shredders as they feed. For this reason shredders are considered to be omnivores. Representative shredders include stonefl nymphs, caddisfly larvae, adult beetles and cranefly larvae. Collectors feed on decomposing fine particulate organic matter as well as on attached bacteria. Filtering collectors strain the particles from the water with nets and fan shaped antennae. Net building caddisflies belong to this group. Gathering collectors feed on deposited organic matter on the stream bottom. These include the mayfly nymphs, caddisfly larvae, adult beetles and fly larvae, like the midge. Scrapers graze on attached algae growing on rocks or on attached vegetation. Examples include mayfly nymphs, caddisfly larvae, fly larvae and snails. Predators feed on other aquatic organisms and include large stonefly nymphs, dragon fly nymphs, damselfly nymphs, water striders, hellgramites, and some beetle larvae and adults.

BIOTIC ENVIRONMENT DATA TABLE

Stream Organism	Number Counted				
	GROUP A	GROUP B	GROUP C	TOTAL	Trophic Level
Dragon Fly Nymph					2
Dobson Fly Hellgrammite					2
Damsel Fly Nymph					1
Crane Fly Larvae					1
Caddis Fly Larvae					1
Mayfly Nymph					1
Midge Fly Larvae					1
Stone Fly Nymph					1
Water Penny					1
Beetel Larvae					2
Water Mite					Parasites
Misc. Adult Beetles					2
Whirligig Beetle					2
Water Strider					2
Water Scorpion					2
Black Fly Larvae					1

BIOTIC ENVIRONMENT DATA TABLE

Stream Organism	Number Counted				
	GROUP A	GROUP B	GROUP C	TOTAL	Trophic Level
Stilt Spider					2
Fisher Spider					2
Copepod					1
Crayfish					1
Snails					1
Clams					1
Fluke					Parasite
Planaria					1
Leeches					Parasite
Horsehair Worm					1
Freshwater Annelid					1

BIOTIC ENVIRONMENT DATA TABLE

Stream Organism	Number Counted				
	GROUP A	GROUP B	GROUP C	TOTAL	Trophic Level
Soft-shelled Turtle					3
Snapping Turtle					3
Painted Turtle					3
Strider Turtle					3
Frog					2
Common Water Snakes					3
Snakes					3
Snakes					3
Tadpoles					1
Coot					3
Blue Heron					3
Green Heron					2
Wood Duck					3
Raccoon					1
Bank Beaver					1
Otter					3

CRAYFISH POPULATION STUDY

Purpose: The purpose of this work is to obtain a reliable count of the number of crayfish inhabiting a given area of the stream shoreline. Because it is impractical to capture and count every individual of the species in a large area, a technique has been devised by Peterson for estimating the true population size from capture-release-recapture population samples. Why is estimating the size of the crayfish population important? What will it tell?

Stream Equipment:

- Many large plastic pails
- stream dip nets
- measuring tapes

1. In the quiet section of the stream select an area along the shoreline. It is desirable to include some immergent shoreline vegetation in the area. Do not walk within the area when it is being measured. When a crayfish is found place the net behind the animal and the other free hand in front of the animal's head. This will cause the animal to flip backwards into the net.

2. Place all captured crayfish in the large plastic pails.

3. Try to capture 50 or more crayfish for the first sample. Record the actual number captured in the population data table.

4. Dry the carapace of the crayfish with a paper towel. Place a white identification mark on the dorsal surface of the carapace using the finger nail polish provided. This "Tattoo" will identify the crayfish if it is recaptured later.

5. Release the marked crayfish within the boundary of the collection area. Try to distribute them evenly. Record the number of crayfish marked and released in the data table.

6. One day later return to the collection area and once again capture crayfish. Catch both marked and unmarked animals as you find them. Try to capture as many as you caught on the first day.

7. Count all of the crayfish captured on the second day. Record this value in the data table.

8. Count the number of marked crayfish caught on the second day. Record this value in the data table. Release the crayfish.

9. Complete the Peterson Index Calculations on the next page.

CRAYFISH POPULATION STUDY

Date ____________________ Group_________________

	Number of Crayfish		
	Group A	**Group B**	**Group C**
DAY 1: Marked and Released			
DAY 2: Captured			
DAY 2: Captured and Marked			
Size of Area (m x m)			

PETERSON INDEX CALCULATION:

Peterson Index of Population Size:

$$\text{Total Population} = \frac{(\#\ \text{Marked Day 1})\ \text{X}\ (\#\ \text{Captured Day 2})}{(\text{Recaptured and Marked Day 2})}$$

Show the Calculation for Your Group:

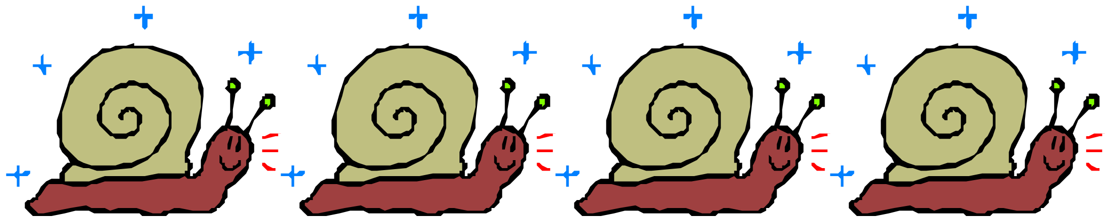
Population Density = (Total Population) / (Area)

Show the Calculation for Your Group:

(Include Units on all numbers!)

FINAL CRAYFISH DENSITY ESTIMATES FOR THIS SESSSION	
GROUP A Crayfish Density	
GROUP B Crayfish Density	
GROUP C Crayfish Density	
Session Crayfish Density (Include units!)	

SNAIL POPULATION COUNT



Stream Equipment:

- Pail
- 4 metal quadrat frames
- 4 enameled tray.

Procedure:

1. Carefully place the metal frame flat against the stream substrate.

2. Rocks from within the frame should be removed and all snails adhering to the rocks counted. Discard the rocks.

3. Remove the upper layer of pebbles and gravel from the quadrat area. Place this material in a tray. Count the snails present in or on this substrate material.

4. Record the total number of snails found in the Biotic Environment data table and in the data table below.

5. Observe whether the snail shells curve to the left (left-handed) or to the right (Right-handed).

6. Repeat this procedure for 5 samples taken in the immediate area.

Snail Population Counts for All Groups			
	Group A	**Group B**	**Group C**
Location of Sample Site			
Total Number of Snails Counted (Note # of Left and Right Handed Snails)	**Left Right**	**Left Right**	**Left Right**
Size of the Area Sampled			
Density of Snails (Snails/sq. ft.) (Use the Total # of Snails Counted)			
Session Average Density			

STREAM SEINE

Stream Equipment:

- Plastic pails
- seineing nets
- large dip nets
- small
- aquarium nets.
- Book: The Fishes of Missouri.

Procedure: Free swimming stream animals are most easily captured in large nets or seines. One or two seines, depending on the width, are positioned across the stream. Other seines are taken into the water upstream and brought down with the current, driving fish into the stationary nets below. Good group coordination is necessary for this activity to be successful. Your instructor will demonstrate the proper setting and hauling of the seines.

1. Fish caught in the seines should be transferred with dip nets into large containers and sorted.

2. Assign a number to each kind of fish captured.

3. Place 1 of each kind of fish into an individual container. Write the identification number of the fish on the container for future reference.

4. Count and measure the length of each kind of fish you capture. Record these values in the data table opposite the identification number of the fish.

5. Release the fish as they are counted and measured.

6. If there is time, complete two or three seine hauls. When a second haul is made, be careful to identify similar second catch species with the same numbers used earlier. Use the individually housed fish from the first catch to identify later catches. Record all additional data in the table. Note! If a new type of fish is caught, identify it by another number and save a representative specimen as before.

7. During the evening laboratory, classify the fish previously identified only by number. When a positive identification is made, enter the total number of that kind of fish captured opposite its name in the Biotic Data Table.

BIOTIC ENVIRONMENT DATA TABLE

Stream Organism	Number Counted				
	GROUP A	GROUP B	GROUP C	TOTAL	Trophic Level
Bass					2
Sculpin					2
Sunfish					2
Goggle Eye					2
Darter					2
Lamprey					Parasite
Bleeding Shiner					2
Ozark Minnow					1
Horny Head Chub					1
Catfish					Scavenger
Gar					3
Minnows					1
Suckers					2
Studfish (top Minnow)					2
Paddlefish					3
Drum					

RACCOON TRAP LINE

Equipment:
- 4 live capture raccoon traps
- cat food and / or raw vegetables and / or table scraps

Procedure:

1. Set four traps on the camp side of the creek at the locations designated by your instrctor.:
2. Place the traps near the water's edge where there is some vegetation growing. Observe the sand bars near the sites carefully for tracks. If tracks are present set a trap at that point.
3. Bait the trap with cat food and raw vegetables.
4. Traps should be set at least 100 feet apart along the stream bank. Carefully record the placement of the trap so that it will be easy to find the following morning.
5. Return the traps to the Lodge after breakfast the next morning. Report any catch or closed traps to your instructor.

Data Table for Racoon Trap Line

Trap #	Trap #1	Trap #2	Trap #3	Trap #4
Location				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				

Summary: animals captured, condition, problems experienced

DIATOM POPULATION COUNT

Purpose: First order consumers of the stream feed on aquatic vegetation or forest detritus. Detritus is carried from upstream or is blown, or falls into the water. Diatoms are the main kind of aquatic plant life in some streams. Their photosynthetic activity supports the feeding of many of the animals found in the stream. The number of diatoms present is a good indication of the productivity of a stream ecosystem in which grazing is the main base of the food chain and they are counted for this purpose. In this activity we will estimate the number of diatoms per ml. of creek water. Keep in mind at in streams almost all algae are attached to the bottom, not suspended in the water. The algae in the water mainly broke off the bottom. When you filter water, you are mainly sampling transported detritus. Generally, the suspended material in the water at any one point in time is a very tiny percent of the entire food base of a stream.

Stream Equipment:

- Diatom filtration kit.

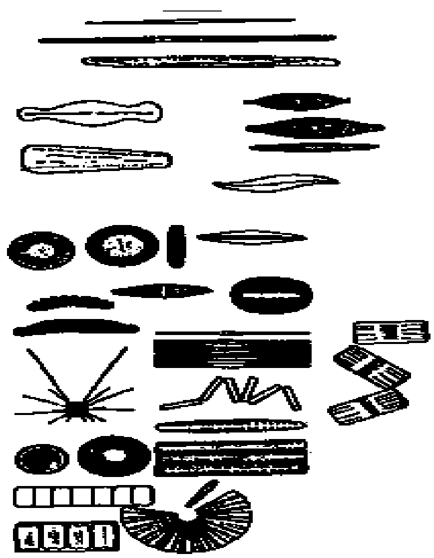
Laboratory Equipment:

- Microscope
- microscope slides
- immersion oil.

Procedure:

1. Work as a team. Collect and filter a water sample from a riffle by following the instructions that are included in the diatom filtration kit.
2. Filter 100 ml. and 200 ml. samples of creek water.
3. Air dry the filters in an open petri dish. Place the filter into the dish so that the diatoms collected on the filters surface are exposed to the air.
4. Label the dish clearly with your team identification and the size of the sample.
5. During the evening laboratory and after the filter is thoroughly dry cut the filter into 8 pieces of approximately the same size. Place each piece on a clean glass microscope slide.
6. Place a few drops if immersion oil on top of the filter paper. Notice that this process causes the filter to become transparent.
7. Place the slide on the stage of a microscope and focus with the low power objective in place. Scan the field for diatom cells. Change the magnification to high power. Compare the cells on the slide with those shown in the diagram on the next page.
8. Count the number of diatom cells present in the entire high power field. Record this value in the data table opposite the microscope field column.
9. Move the slide and focus on another field. Count and record the number of cells observed opposite microscope field 2.
10. Repeat this process 15 times using different areas of the filter. It is important to physically move the slide each time a count is made in order to get a random sample of the entire filter. Try not to count cells in the same area of the filter.
11. Use the data analysis procedure shown on the next page to calculate an estimate of the creek diatom population.

Representative Diatoms



Field	Diatoms Counter		Field	Diatoms Counted		Field	Diatoms Counted	
Number	100 ml	200 ml	Number	100 ml	200 ml	Number	100 ml	200 ml
1			6			1		
2			7			12		
3			8			13		
4			9			14		
5			10			15		

Total Number Counted = _______________ (/100ml) ______________(/200ml)

Calculations:

Area of Filter = 1380 mm^2; Area of 1 field = .169823 mm^2;
Number of fields counter = 15

Given: 1380mm^2 / .169823 mm^2 X 15 = **541.7 constant**

1. Multiply the number of diatoms counted by the constant in order to obtain the number of diatoms in the volume of water filtered =

2. Divide the value obtained in step 1 by the volume of water filtered. This new value is the estimated number of diatoms in 1ml of Sinking Creek water. **Number of diatoms/ml =**

DIATOM COUNTS (Cells/ml) FOR THIS SESSION

Sample Size	100 ml	200 ml
GROUP A		
GROUP B		
GROUP C		
Average		

Session Average ________

BACTERIA, TOTAL AND FECAL COLIFORM

Purpose: Coliform bacteria live in the gut of animals and are excreted in the feces of these animals. If this waste is not properly disposed of, bacteria contained in it enters and pollutes the neighboring streams, rivers and lakes. Health authorities use the coliform test as one index of water pollution. This is based on the knowledge that bacteria causing serious diseases, such as typhoid fever and dysentery, are also excreted in the feces. So, the presence of coliforms in the water is a warning that dangerous bacteria may also be present. Keep in mind that these sewage organisms are mainly harmful to humans and not to aquatic life.

Stream Equipment: Sterile water sample jar.
Laboratory Equipment: Sterile collection bag, 15 Dilution tubes with Endo medium, 6 sterile pipettes, bacteriological incubator, UV light source 3 jars sterile dilution water.

Procedure:

1. **DAY 1:** Fill the sterile collection bag with creek water.
2. Using sterile techniques, pipettes 11 ml of creek water to one sterile dilution water jar (marked 10). Discard pipette and mix. Pipette 11 ml from the 10 jar into the second sterile dilution water jar (marked 100). Discard pipette and mix. Pipette 11 ml from the 100 jar into the third sterile dilution jar (marked 1000). discard pipette and mix.
3. Mark 5 of the 15 coliform tubes with a "10"; mark another 5 with a "100"; mark the final third with "1000". Into each of the first 5 coliform tubes, place 10 mls of the diluted creek water from the jar marked with a "10". Into each of the second 5 coliform tubes, place 10 mls of the diluted creek water from the jar marked "100." Into the last 5 coliform tubes, place 10 mls of the diluted creek water from the jar marked "1000."
4. Place all tubes into the blue incubator at about 35 oC for 24 hr. and 48 hr.
5. **Day 2-3:** When positive presumptive results are obtained immediately complete the confirmed and fecal coliform tests. Use the special instructions provided in the kit.
6. Record all observations as they are obtained in the data table. When all information is on hand determine the MPN index values for, total coliform and fecal coliform.

TUBE	Dilution Factor	Total Coliform Bacteria		Fecal Coliform Bacteria	
		24 hr.	48 hr.	24 hr.	48 hr.
A 1	10				
2	10				
3	10				
4	10				
5	10				
B1	100				
2	100				
3	100				
4	100				
5	100				
C1	1000				
2	1000				
3	1000				
4	1000				
5	1000				

Confirm code________ Confirm MPN_________ Coliform #____________

Fecal code _________ Fecal MPN________ Fecal Coliforms____________

TABLE: MPN Index							
Multiply the MPN indx by the lowest dilution factor from the series used when dilution other than 1, 10 and 100 are used.							
Number of Tubes Giving Positive Reaction out of 5			MPN Index per 100 ml	Number of Tubes Giving Positive Reaction out of 5			MPN Index per 100 ml
Dilution Factor = 1	Dilution Factor = 10	Dilution Factor = 100		Dilution Factor = 1	Dilution Factor = 10	Dilution Factor = 100	
0	0	0	<2	4	2	1	26
0	0	1	2	4	3	0	27
0	1	0	2	4	3	1	33
0	2	0	4	4	4	0	34
1	0	0	2	5	0	0	23
1	0	1	4	5	0	1	31
1	1	0	4	5	0	2	43
1	1	1	6	5	1	0	33
1	2	0	6	5	1	1	46
2	0	0	5	5	1	2	63
2	0	1	7	5	2	0	49
2	1	0	7	5	2	1	70
2	1	1	9	5	3	2	94
2	2	0	9	5	3	0	79
2	3	0	12	5	3	1	110
3	0	0	8	5	3	2	140
3	0	1	11	5	3	3	180
3	1	0	11	5	4	0	130
3	1	1	14	5	4	1	170
3	2	0	14	5	4	2	220
3	2	1	17	5	4	3	280
3	3	0	17	5	4	4	350
4	0	0	13	5	5	0	240
4	0	1	17	5	5	1	350
4	1	0	17	5	5	2	540
4	1	1	21	5	5	3	920
4	2	0	22	5	5	4	1600
4	1	2	26	5	5	5	>2400

BIOCHEMICAL OXYGEN DEMAND (BOD)

Purpose: The measurement of biochemical oxygen demand produces a value that is an estimate of the organic material found in the water. Organic matter such as detritus is feed upon by bacteria and oxidized during the process of respiration. Other organisms in the stream food chain prey upon the bacteria for their energy supply. This process also requires oxygen. Our BOD test will measure the amount of oxygen used for respiration during a 5 day time interval. Streams containing a lot of organic matter such as sewage will show high BOD values and low dissolved oxygen levels because of respiration by an elevated population of bacteria and other organisms in the stream.

Field Equipment:

- Dissolved oxygen test kit
- BOD dark bottle
- water sample collection equipment.

Laboratory Equipment:

- incubator.

Procedure:

1. Measure the temperature of the water in the stream by holding the thermometer 1 foot below the surface until it gives a stable reading. Record the temperature in the table below.

2. Collect a water sample and determine the D.O. of the sample by following the instructions in the Oxygen test Kit. Record the D.O. value in the table below.

3. Collect a second water sample. Wrap this sample bottle with aluminum foil.. Place the glass stopper in the bottle while the lip of the bottle is still under water. This will avoid trapping an air bubble in the jar.

4. Place the foil covered sample bottle in the 68 degree F. incubator for 5 days.

5. After 5 days test this water sample for dissolved oxygen. Record the D.O. value in the data table. The difference in the readings obtained on the first day and fifth day is the B.O.D.

	Sinkin' Creek	**Missouri River**
Stream Water Temperature	C	C
Dissolved Oxygen (Day 1)	mg/L	mg/L
Dissolved Oxygen (Day 2)	mg/L	mg/L
Biochem. Oxygen Demand	mg/L	mg/L

TOTAL SOLIDS

Purpose: The measure of total solids includes both the suspended material as well as the dissolved material in the water. The amount of total solids in the water is affected by the runoff during rains which brings both eroded soil and fertilizers from agricultural use into the stream. High levels of suspended material reduces water clarity while high levels of dissolved solids cause water regulatory problems for stream organisms. On the other hand, water that is very soft (very low in dissolved minerals) is poorly buffered (gets lower in pH when acid rain falls) and is hard on water regulatory problems and heavy metals are more toxic in soft water. So, very soft or very had water makes it more difficult for organisms to function. This test will be conducted at school on water brought back from the stream and completed before we leave for Drey Land.

Field Equipment:

- Water sample bottle.

Laboratory Equipment:

- Porcelain dish
- oven
- analytical balance.

Procedure:

1. Collect a 100ml sample of stream water from a riffle area.
2. Clean and dry a porcelain dish. Place the dish in an oven at 212 degrees F. for one hour.
3. Remove the dish from the oven with a tongs and allow it to cool. Weigh the dish after it has cooled but DO NOT handle it with your fingers. Use the tongs in order to avoid adding moisture from your hands to the dish. Record the weight of the dish.
4. Transfer 100ml of stream water to the dish. Rinse the container with DISTILLED water and add this to the dish.
5. Place the dish and solution in a 212 degree oven overnight in order to evaporate the water and to dry the residue and dish.
6. Remove the dish from the oven, allow the dish to cool and then reweigh it. Handle the dish with a tongs as before. Record the weight of the dish and residue.
7. Find the weight of the residue by subtraction of the original weight from the new weight.
8. Determine the ppm of total solids by the solution of the following formula.

$$\textbf{Total solids} = \frac{\text{Increase in weight X 1,000,000}}{\text{ml of sample (100)}} = \underline{\qquad\qquad} \text{ mg/L}$$

SINKIN' CREEK
DETERMINING THE WATER QUALITY OF THE STREAM

The water quality of Sinking Creek can be compared to that of other streams throughout the state or country by the use of an index devised by the National Sanitation Foundation. Their index uses 9 variables that most reflect the condition of the stream. After the WQI is determined the general condition of the water can be determined from the following table.

90 - 100	**Excellent**	**25 - 50**	**Bad**
70 - 90	**Good**	**0 - 25**	**Very Bad**
50 - 70	**Medium**		

Procedure:

1. Take the average test results from one of the WQI variables and find the appropriate weighting curve for that variable.
2. Interpolate the "Q" value from the Y axis of the table for the variable. Record the Q value in the data table below.
3. Repeat these steps for each of the remaining 8 variables.
4. Each variable is also weighted according to its overall contribution to water quality. These weightings are given in the weighting factor column. To obtain the total contribution of each variable multiply the "Q" factor by the weighting factor and record the results in the TOTAL column.
5. Add the values in the total column to obtain the WQI.

SINKIN' CREEK

Measurement	Test Results	Q-Value Factor	Weighting	Total
D.O. - % Sat.			0.17	
Fecal Coliform			0.16	
pH			0.11	
B.O.D.			0.11	
Temperature Change			0.10	
Phosphorus			0.10	
Nitrates			0.10	
Turbidity			0.08	
Total Solids			0.07	

Overall WQI ______________________________

General Rating ______________________________

MISSOURI RIVER
DETERMINING THE WATER QUALITY OF THE STREAM

Measurement	Test Results	Q-Value Factor	Weighting	Total
D.O. - % Sat.			0.17	
Fecal Coliform			0.16	
pH			0.11	
B.O.D.			0.11	
Temperature Change			0.10	
Phosphorus			0.10	
Nitrates			0.10	
Turbidity			0.08	
Total Solids			0.07	

Overall WQI ____

General Rating ____

“Where His Heart Is ... Leo Drey Uses His Resources to Buy and Save Nature’s Gems.”

from: Ahmed, Safir, St. Louis Post Dispatch, Sunday, Jan. 20, 1991, Everyday Section, Page 1C.

It is a 74-year-old face that has been creased with smiles, not frowns. It is the face of gentle, self-effacing and passionate Leo Albert Drey of University City, perhaps Missouri’s leading conservationist and environmentalist. He is the state’s largest private landowner, a timberman who is quite rich. And he has a bashful-schoolboy smile that lingers after he has left the room.He is lanky, old-fashioned, salt-fo-the-earth, an anachronism in this last decade of the 20th century, a millionaire who pumps his own gas, who has an office without a computer or a secretary, and who uses his riches to buy and protect nature’s little gems - springs, canyons and hollows.

He walks fast and speaks in a staccato, yet he manages an aw-shucks, Jimmy Stewart-style demeanor. Drey has, over the last 40 years: spawned an environmental movement in the state; demonstrated by management of his 154,000-acre Pioneer Forest that you can cut trees for timber without damaging the land; bought and turned over for public use 3,300 acres of the most pristine natural areas in the state; and supported, with his money and his work, hundred of local, state and national organizations.

When you take away the accomplishments, the wards, the affluence, what you get is a man who believes that there is more to be had from the earth than just food, minerals, wood, oil, and other resources. There is inspiration, for instance. “We need a balance between land that is protected and land that is developed,” he says. “We need commodities, but we need inspiration too.”

Greer Spring inspires him. When something inspires him, he puts his money where his heart is. Threatened by Anheuser-Busch Inc.’s offer to by the 6,900-acre tract in the Ozarks for a bottling plant, Drey plopped down $4.5 million to buy the land - which includes what he considered to be the most beautiful spot in the state.As a matter of public policy, he says, government ought to set aside places for those who wish to commune with Mother Nature. There ought to be places in the sun, however small, where one can go to relax and recreate, he says. And he is not talking of Six Flags or Coney Island. “Which is worth more - one nut Thoreau sitting by the pond or a million people recreationing in Coney Island,” Drey asks, sitting on the rocks at Greer Spring, raising his voice above the gushing waters. By his feet, a dead tree trunk lies undisturbed, covered with moss.

He has offered to sell all 6,900 acres to the federal government on the condition that there be no commercial use allowed. No timbering, no mining, no concession stands, no paved walkways. Congress has not acted on the offer, made three years ago, primarily because Bill Emerson, the Republican congressman whose district includes Greer Spring, wants to allow logging on the land.

While Drey has never shied away from a fight over environmental issues, he has lost some and won some. Perhaps his most serious loss came in November, when Missouri voters rejected the proposed Natural Streams Act, a measure aimed at protecting 52 of the state’s rivers. Drey had sunk countless hours and $400,000 of his money into that effort. Despite his battles and the many public officials and others who have opposed him on various issues, Drey has bred no enemies. Those who know him say he has not a mean bone in that tall frame. “It’s hard to dislike the guy, because everything he does is motivated by public concern,” says R. Roger Pryor, director of the coalition for the Environment, an organization that Drey helped create in 1969. “He’s cause-oriented. He never gets involved with personalities.”

And Lewis Green, a lawyer who has been floating with Drey on the Jack’s Fork and Current rivers for 30 years, says, “His dominant characteristic is a determination to leave the world a better place for future generations.”

If you think Green and Pryor, as friends, are rather effusive in their praise of Drey, listen to what John Powell says. Powell, a timberman who is also chairman of the Missouri Conservation Commission, has found himself at loggerheads with Drey over several issues, including the practice of clear-cutting, which Drey sees as environmentally unsound and Powell does not. Powell, who has called environmental activists “intellectual idiots” and “fanatical,”, says of Drey, “I like to thank him personally. I consider him as a friend. I think he is a sharp, astute individual. I think he is a good steward of the land.

The son of a prosperous glass manufacturer (“Drey’s

Perfect Mason Jar"), Drey was born Jan 19, 1917, in University City and graduated from John Burroughs School. Partly at his mother's insistence, he went to Antioch College in Yellow Springs, Ohio, and graduated in 1939 with a business degree. His fondness of Antioch, a service-oriented school, led him to take on the post of chairing the school's board of governors in 1974. He still serves on the board, and some of his largess has been directed at the college. He would later tell friends that as a college student, he essentially faced three choices - doctor, lawyer or businessman - and chose business because he was "too dumb to be a doctor and too smart to be a lawyer."

He returned to St. Louis and worked for the Wohl Shoe Co., rising to assistant treasurer after doing a five-year stint in the Army during World War II. By 1950, at the age of 33, he realized the life of a bean counter was not for him. "All I was doing was counting old man Wohl's money and he had so darn much of it, I got tired of counting it," he says.

Changing careers in midlife, he decided he always liked the outdoors and enjoyed canoeing Ozarks streams. Beginning in 1951, he used his inheritance, along with the shoe company stock he had acquired, and started to buy up land in the Ozarks, most of it for less than $5 an acre. His big purchase came on June 1, 1954, when he bought 87,414 acres from National Distillers Products Corp. for $360,650, a bargain at $4.12 an acre. With that and his other acquisitions, he established Pioneer Forest. While his business has been selling timber, Drey acknowledges earning an income from lead mining. Drey said that while he wishes there were no lead mines on his land, he was bound by agreements of sale to give away mineral rights.

True to the name of his forest, Drey began pioneering forest management techniques. Ever since mid-1950s, Drey and his foresters have been managing the land using their "individual tree selection" method, in which trees are individually selected for cutting when they reach maturity, rather than "clear-cut." Clear-cutting involves cutting all trees in a designated area. While the practice yields a higher amount of wood per acre, Drey believes that it contributes to soil erosion and reduces the habitat for certain wildlife. Drey says his method of forest management means only that he makes less of a profit because he gets less wood per acre. Therein lies the answer to the seeming contradiction of a timberman being a conservationist and an environmentalist: Drey says Pioneer Forest clearly demonstrates that you can manage a forest in an environmentally sound manner and still make a buck. But not a fast buck. He points out that it takes 80 years before a tree reaches "economic maturity." "In our operation, we don't wring the last penny we could out of it," he says. "But in the long run, I'm not sure we pay any economic price for it." This is not a capitalist suffering from a fiscal-quarter mentality.

While he was managing this forest land in the Ozarks, Drey also was working to change the minds of people in St. Louis and St. Louis County about the need for what he called "breathing space." He formed the Open Space Council in 1965, an organization that continues to this day. Shortly after the council was formed, it engaged in a major effort to get St. Louis County voters to approve a $25 million bond issue to finance establishing 6,000 acres of county parks. The measure failed, as Drey remembers well, "by 376 votes out of 76,854 votes cast." In 1969, he helped establish the Coalition for the Environment and served as its first president. Over the years, he has also worked with and served on various boards and councils, including the Sierra Club and the Nature Conservancy, and has chaired the environment committee of the East-West Gateway Coordinating Council.

On Nov. 25, 1955, the year after he acquired the National Distiller's property, Drey married Kay Kranzberg in a simple ceremony at the home of his parents in Clayton. Those who know Kay and Leo Drey way that the couple have been living a life dedicated to public service ever since that day. Their home of 35 years on West Point Ave. in U. City is eclectically furnished without being ostentatious. They have raised three children about whom they talk with some pride. The children have grown up and moved away, although they remain close to their parents.

In the first 20 years of their marriage, Kay Drey worked diligently on issues of civil rights and fair housing. Then, in 1974, when she was alerted to problems of nuclear power plants and radioactive waste by a friend during a regular morning walk, she changed her course. As a result of her inquiries into the issue, Kay turned into a full-time anti-nuclear activist. Today, the basement of the Dreys' home is a veritable library of materials on things nuclear. Pryor, of the Coalition for the Environment, calls Kay Drey a "one-person nuclear information service." There are activists, public officials and reporters who will acknowledge having used that service. While Kay and Leo

Drey fight their separate battles and sometimes join forces, they also play a major role in providing support to various public interest organizations.

On an icy January morning, Leo Drey sat in his one-room office downtown - the one with an ancient safe, mahogany cabinet, creaky chairs and no secretary. Nothing electric but the light. A rather low-watt light at that. Asked about a stack of a hundred envelopes sitting by the telephone, he said they contained checks he was mailing to local, state and national organizations and to some political campaigns. He estimates that each year, he sends contributions to about 300 groups and individuals, ranging from $25 to "four figures." Asked by he spends his money on supporting groups, Drey says, "Well, I don't think President George Bush's thousand points of light are going to meet the needs by a jugful."

"I've tried to provide for may family and I think I've done that, and now I'm free to take whatever resources I have and use them as I think they ought to be used." he adds.

Convinced that Missouri needs laws to protect its streams, Drey put his weight behind the campaign for the Natural Stream Act last year, working on it and financing most of the campaign with $400,000 of his own money. When the ballot measure failed in November, Drey was extremely disappointed. "Missouri is a 'Show Me' state. We never show anyone else. We tend to be at the bottom in our support for education and all kinds of social services. The same thing is true in conservation. Here we have 30 states with a rivers program and we tried to give Missouri one and we didn't succeed." Drey adds that he believes the campaign failed partly because the opposition -- including the Missouri Department of Conservation and some rural organizations -- scared a lot of people into thinking that it would infringe on their property rights. Among those spreading the fear, he said, was State Sen. Danny Staples, a Democrat from Eminence, Mo.

During lunch recently at a restaurant in Eminence, Drey and a reporter were talking of the ballot measure when Staples walked in. Seeing Drey, he walked over and made small talk. Drey smiled cheerfully at the politician. "I thought you came over to apologize to me about all the things you said during the campaign," Drey said.

Staples said, "I like you Leo. I love you, I really do." Drey smiled again and turned his attention back to his food. What irritated him the most about the campaign, he says, was what he believed to be an about-face by the Conservation Department. Officials of the Department had told him initially that they would remain neutral on the act, but later actively campaigned against it.

"I think what they did was unforgivable and I don't think I will ever forgive them," Drey says.

Says Kay Drey, "He knew there would be an opposition, but he never thought it would get so ugly and nasty."

While Leo Drey may not embark on a campaign again, he continues to turn over some of the land he buys to government agencies so it can be protected from development and used for public recreation and relaxation. Over the years, he has donated several chunks of beautiful land. To the Missouri Department of Natural Resources, he has given the 160-acre Grand Gulf State Park in Oregon County and the 132-acre Dillard Mill Historic Site in Crawford County. To the conservation Department, he has turned over Dripping Springs Natural Area and the Piney River Narrows Area, both in Texas county; Clifty Creek Natural History Area in Maries County; Hickory Canyons Natural Area in St. Genevieve County; Rocky Hollow Wildlife Area in Monroe County and the Ball Mill Resurgence Area in Perry County. G. Tracy Mehan III, director of the Natural Resources Department, ways of Drey, "I think he is an altruist at heart and deeply concerned about the state's natural resources."

And John Karel, director of Tower Grove Park and a former director of state parks, says Drey is "a thinker and a doer. He's a leader who is not comfortable in the lead role."

Karel adds, "If he has any enemies, they are obviously people who don't know him."

What everyone who has known Drey seems to agree on is just what makes the man tick. They say he relentlessly promoted a rather simple notion, best stated in his own words in a letter that he wrote to the St. Louis county council in 1970, as the first president of the Coalition for the Environment:

"The Coalition embraces the fundamental humanistic concept that we are stewards of the land -- that we hold it in trust for ourselves and future generations," Drey wrote. "In the light of that truth we believe that progress can no longer be defined simply as economic growth."