



Restoring Native Plants

*Kanab High School with Grand Staircase Escalante National Monument, UT
Teacher Guide*



Lesson Plan	1
Resources	5
Links	5
KHS Native Plant Project Summary	6
Grand Staircase Escalante Students Explorations	7-8
Route Finding	7
How to Use a Topographic Map	8
News & Press	9-11
Directions for Plant Frequency Sampling (BLM)	12-18
Direction for Making a Frequency Frame(BLM)	19-20
Blank and Sample Plant Frequency Charts	21-24
Instructions for Setting up The Garmin eTREX10.....	25-31
Instructions for Finding Waypoints with The Garmin eTREX10	32-35
Blank and Sample Project Data Forms.....	36-48
Next Generation Science Standards	49-50



Restoring Native Plants

Kanab High School with Grand Staircase Escalante National Monument, UT

Project Synopsis

Students in Barbara Warner's high school Ecology Class at Kanab High (Kanab, Utah) worked at Grand Staircase Escalante National Monument, (1,880,461 acre park in Utah). Students removed invasive plants by weeding, noted the location and frequency of native winterfat plants using GPS/GIS devices, collected seeds from those plants, grew them in their school greenhouse, transplanted seedlings in places where non-native plants had been removed, and monitored their viability for several years. The purpose of the project was to remove and replace introduced plant species that crowd out a particular native plant (winterfat) which is essential for wildlife survival in this ecosystem.

Adapting the Project for Replication

The original project took place in southwest Utah and centered on plant and animal species of that area. To replicate the project elsewhere, the protocols and equipment could be used without modification, but the particular invasive, non-native species to be removed, as well as the native species to be replanted, should be determined according to local conditions.

Native Plant Restoration LITE

A quick and easy version of the project could be accomplished without a greenhouse, GPS devices, nor any other special equipment. Instead of making a frequency frame from an angle iron and rods, substitute a hula hoop, an empty picture frame, or a length of string equal to the perimeter of the desired-size square.* Instead of a greenhouse, start seeds in the classroom in cups or paper funnels (for long root growth), using natural light. In lieu of GPS devices, stake a starting point and use a compass and tape measure or pacing to set up a transect (baseline) with offsets to the right and left at certain intervals. For an even simpler project, make seed balls by mixing one part soaked native seeds, one part (red powdered) clay and two parts moist soil or compost; roll into balls; drop in areas that need revegetation; flag locations; and monitor viability (or practice "guerilla gardening" by slingshotting seed balls randomly).

Correlation to NGSS

NGSS2-ESS 2-1

NGSS MS-LS2-1,4 Matter and Energy

NGSS HS- LS2-2,6,7 Interdependent Relationships

Supplies and Equipment

(Per class)

- Greenhouse or indoor location for starting seedlings
- Soil mixes (for growth comparison)
- Seeds (saved from native plants)

(Per team of 2-4 students)

- Weeding hand tool(s)
- Planting trowel(s)
- Orange or yellow spray paint
- Hand held GPS device
- Topographic maps of study area
- Metric Tape Measure (20 – 70m)
- Transect stake (18" rebar)
- Flagging tape
- Hammer
- Compass
- GPS instructions (geocache mode)
- Frequency Method instructions
- Native vegetation report forms
 - o Study Location/Data Form
 - o Site Frequency Form
 - o Nested Frequency Form
- Frequency Frame
 - o Made with angle iron, per included directions
- Examples of student work
- Smartphone or tablet computer + free apps for plant i.d.: optional
 - o What's Invasive
 - o LeafSnap
- Web sites for posting project-specific field guides
 - o UGA's Discover Life
 - o Project Noah particular invasive, non-native species to be removed, as well as the native species to be replanted, should be determined according to local conditions.



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Procedures

Project Planning

1. Students research and conduct field investigations to choose one or more non-native, invasive plant species to remove and a specific native plant to replace it.
2. Obtain permission to work on (public or private) land. Arrange for travel logistics and parental permission, if field work is off-campus. Note that the time of year for seed collection will vary depending on the target species.

Project Preparation for Students

3. Gain proficiency in identifying non-native plant(s) to be removed. Local land managers, field scientists, and master gardeners are sources of information on local species, but free smartphone apps such as Alien Invader can help identify non-natives; LeafSnap can instantly identify some plants from uploaded photos; and online field guides can help identify plants with taxonomic keys.
4. Practice using GPS devices in geocache mode with UTM settings.
(See included [directions](#) for use of a typical GPS device).
5. Compare location indicated on GPS device to same location on a topo map and actual location on the ground, for deeper understanding of how they relate to each other. (Complete GSENM Student Explorations Unit 2: [“Route Finding in the Land of Hoodoos...”](#) and [“How to Read a Topo Map”](#)).
6. Practice using a compass to lay out a transect (a baseline that extends in any direction from a stake) and traveling perpendicular to it, in either direction.
7. Measure each student’s pace length and practice estimating distances by pace, if long measuring tapes are not available for each team.
8. Make a preliminary visit to the project site. Determine dimensions of the frequency frame based on whatever size is necessary to be able to find the targeted vegetation with 20% - 80% frequency.
9. Build or fashion a frequency frame, based on the size determined by preliminary site visit. (Typically, sizes range from 20 sq cm to 70 sq cm).

Conducting the Project

10. Students will travel to the project site and map the location of the targeted native plant species in frequency

The Value of Native Plant Restoration Projects

Non-native plant species, which may have been intentionally introduced or have traveled away from their places of origin inadvertently, are considered invasive when they aggressively out-compete and replace local native plants. This typically happens because of a lack of predators in the new setting. Since plants provide food and shelter for animals, displacing native plants deprives native wildlife of their habitat, as well. Native plant restoration is the first step in habitat restoration.

Project Partners

Captain Planet Foundation
Kanab High School
Roger Cole
Wade Parsons
Grand Staircase – Escalante National Monument (GSENM)
Grand Staircase – Escalante Partners
Bureau of Public Lands

This American Land

This American Land is an original conservation newsmagazine series on public television stations nationwide. Opening windows to our country’s amazing natural heritage, the show reports engaging stories on America’s landscapes, water, and wildlife, taking viewers to the front line of conservation, science and outdoor adventure with stories that inform and entertain.

This American Land is produced by Environmental New Trust (ENT), a non-profit news venture which has produced and distributed hundreds of environmental news stories for an international broadcast and Internet audience since 2004, ENT was founded by award winning television correspondent Gary Strieker, who reported for 20 years with CNN as a bureau chief and international environment correspondent. Gary is the executive producer of *This American Land*.



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



frames along a transect (baseline) and quadrats to right and left, [recording results](#).
(See [“Frequency Methods”](#)).

11. During the same site visit, students will remove non-native plants from selected planting sites by weeding (manually removing by the roots).
12. Also at the same site visit, students will find and collect seeds from the targeted native plant species, taking care not to damage the parent plants.
13. Back in the classroom, students follow [seed saving](#) protocols to germinate seeds and grow seedlings near a window or in a greenhouse. (Students will research the targeted native species to determine whether seeds require soaking, scarification, or certain temperatures for best results). Collect data on % of seeds germinated and compare seed viability in different soil mixes.
14. Transplant seedlings at the selected planting sites, flag the locations, and monitor plant viability over time.

*Note in the case of string used for frequency frames: Perimeters of the same length can enclose areas of different sizes. For instance, a 16’ long string could be arranged in a rectangle (say: 7 ft long x 1 ft wide for an area of 7 sf) or in a square (4’ long x 4’ wide for an area of 16 sf). Be clear about directions, for consistency in measurements among student teams.

Debriefing

Organisms are not randomly sprinkled around the earth but have adapted over generations, in conjunction with other plants and animals, to be suited to a particular place and its soils, climate, precipitation, terrain and drainage. Human impacts, including clearing and development of land, building roads that fragment habitats, removing or introducing species of plants or animals, degrading water quality, etc., change the potential of the land to support native plants and animals.

Non-native plants and animals present because they have been introduced by humans, or because the abiotic elements of the ecosystem have been altered by humans, may out-compete native species for limited resources (space, water, food, sunlight) due to lack of predators or other limiting factors they would typically face in their native environment.

Extensions

Opportunities for Student Research

Students may want to research topics related to the project, such as which plant species are native to the area; how non-native, invasive species change ecosystems; how human impact (such as hunting, grazing, development, clearing, fragmenting habitat, water usage, pollution, land management that favors certain species, etc.) changes the plant and animal species in the ecosystem; the relationship between changes in plant species and changes in animal species; how the abundance or shortage of resources affects plant and animal populations; and how a change in the population size of a keystone species can have a cascading effect felt throughout the ecosystem.





Opportunities for Student-Directed Inquiry Investigations

Students may design and conduct experiments or “fair tests” to determine which type of soil mix produces the most viable seedlings; which planting technique results in the highest transplant survival rate; which removal technique is most effective in discouraging non-native species from re-establishing; or other topics.

Additional Native Plant Restoration Projects to Consider

Stream Shading and Bank Stabilization

Land that has been cleared for farming or development often has no vegetation left along creeks and streams. As a consequence, there is a loss of riparian (river and riverside) habitat, affecting wildlife species on the land and in the water. Many fish species require overhanging shade so water temperatures do not get too hot, and animals that live along waterways require particular plants for food and shelter. Although erosion also happens naturally and does not require mitigation, human-made clearing of stream banks exacerbates erosion resulting in loss of habitat and siltation of waterways.

Streambank stabilization and restoration of native riparian habitat are valuable and important projects for students to undertake, because these projects restore native habitat. Native plant species can be grown from seed and transplanted, or grown from cuttings of species such as black willow, alder or cottonwood and planted during the dormant season.

Correlation to Next Gen Science Standards

NGSS MS-LS2-1h2 Matter and Energy

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations in an ecosystem.

NGSS HS LS2-6

Evaluate claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Technology Integration

GPS technology allows students to record precise locations of native plants, so they can observe the same areas over time to determine if the removal of non-native plants and replacement with native species is effective. A hand-held GPS-GIS device such as the one used by students in this project, is available for approximately \$100. A class can be well equipped for \$1500 (assuming one device per pair of students). Native plant restoration projects can also incorporate use of smartphone / tablet apps including online field guides to help students correctly identify species. Students can create their own project-specific online field guides using Project Noah or UGA's Discover Life.



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Links

Route Finding in the Land of Hoodoos (Grand Staircase Escalante National Monument)

http://www.gsenmschool.org/Landscape/Unit_02/

How to Read a Topo Map

http://www.gsenmschool.org/Landscape/Unit_02/

Frequency Methods (Bureau of Land Management)

<http://www.wy.blm.gov/jio-papo/papo/reclamation/FrequencyMethod.pdf>

Native Plant Project Site Data (use clean copy you created instead of this): [recording results](#)

Seed Saving directions

<http://www.ext.colostate.edu/pubs/garden/07602.html>

Project Noah - for creating a student data collection project

<http://www.projectnoah.org/>

UGA's Discover Life Identification Guides

<http://www.discoverlife.org/nh/tx/>

UGA's Discover Life: How to Make Your Own Field Guide

<http://www.discoverlife.org/mp/20q>

Leaf Snap app for identifying plants from uploaded photos

<http://leafsnap.com/>

What's Invasive? app for identifying and collecting data on invasive species of plants and animals

<http://whatsinvasive.com/>

This American Land

<http://www.thisamericanland.org/>

This American Land Season One episodes

http://www.thisamericanland.org/Episodes/season-two_copy

This American Land Season Two episodes

<http://www.thisamericanland.org/Episodes/season-two>



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.

KHS Native Plant Project Summary

Stage 1 – Identify specific objectives.

- Objective 1: Identify areas where winterfat needs to be reestablished.
- Objective 2: Collect seeds from winterfat plants in identified areas with care NOT to destroy seed sources.
- Objective 3: Propagate winterfat seeds in the KHS greenhouse
- Objective 4: Transplant seedlings to area identified for revegetation
- Objective 5: Assess success of revegetation by monitoring

Stage 2 – Identify people and funding resources

- GSENM/BLM - Botanists & Rangeland Management Specialists
 - o Botanist – Dustin _____, Raymond Brinkerhoff
 - o Rangeland Management Specialists – Alan Bate, Carson Gubler & John Reese
- GSEPartners – Education Specialist - Wade Parsons
- EPA – Grant
- Utah State BLM – Funding
- Captain Planet – Funding

Stage 3 – List frequency, location & methods

2009 – 10 – Initiate project & begin monitoring

- Identify location for revegetation - Telegraph Flats (October 2009)
- Identify seed source & collect seeds – Undisturbed winterfat areas across highway 89 (south) of Telegraph Flat site (November 2009)
- Propagate seeds in KHS greenhouse (November 2009 – May 2010)
- Fence site and begin transplanting seedlings
- March 23, 2010 – 10 transplanted
- Weed site and transplant more seedlings
- April 15, 2010 – 65 transplanted
- May 12, 2010 - 85 transplanted
- Monitor transplant survival & provide supplemental water (May – August 2010)

2010 – 11 – Continue propagation & monitor transplants

- Monitor transplant survival & weed site (October 6, 2010)
- Collect seeds – Same seed source, south of Telegraph Flat site (November 22, 2010)
- Propagate seeds in KHS greenhouse (December 2010 – March 2011) – crop failure
- May – August – Supplemental watering 1X/month

2011 – 12 – Continue propagation & monitor transplants

- Monitor transplant survival & weed site (September 9, 2011)
- Collect seeds & GPS surviving transplant locations (November 9, 2011)
- Propagate seeds in KHS greenhouse (December 2011 – May 2012)
- No transplanting – No supplemental watering in summer 2012

2012 - 13 - Continue propagation & monitor transplants

- Monitor transplant survival & weed site (October 11, 2012)
- Collect seeds near Telegraph Flat (November 15, 2012)
- Propagate seeds in KHS greenhouse (December 2012 – May 2013)
- Transplant seedlings to Telegraph Flat (may 2013)
- June – August – Supplemental watering (?)

Stage 4 – Initiate monitoring & evaluate a sub-set of data

- 2009 – 10

1. Winterfat Propagation – KHS Greenhouse

- Seed Viability = 20%
- Analysis of 11 Potting Soil Mixes - Zions Mix Potting Soil = 65%

2. Seedling Transplants – Telegraph Flat

- 150 seedlings (March, April, May, 2010)

3. Seedling Survival at Telegraph Flat

- 67 plants (August 2010) = 45% survival
- 2010-11

1. Winterfat Propagation – Seed Viability = 5%

2. Seedling Transplants – None – crop failure

3. Seedling Survival at Telegraph Flat

- 60 plants (August 2011) = 90% survival from August 2010
- 2011-12

1. Winterfat Propagation – Seed Viability = 15%

2. Seedling Transplants – None – no supplemental watering available

3. Seedling Survival at Telegraph Flat

- 56 plants (April 2012) = 93% survival from August 2011

KHS Winterfat Revegetation Project

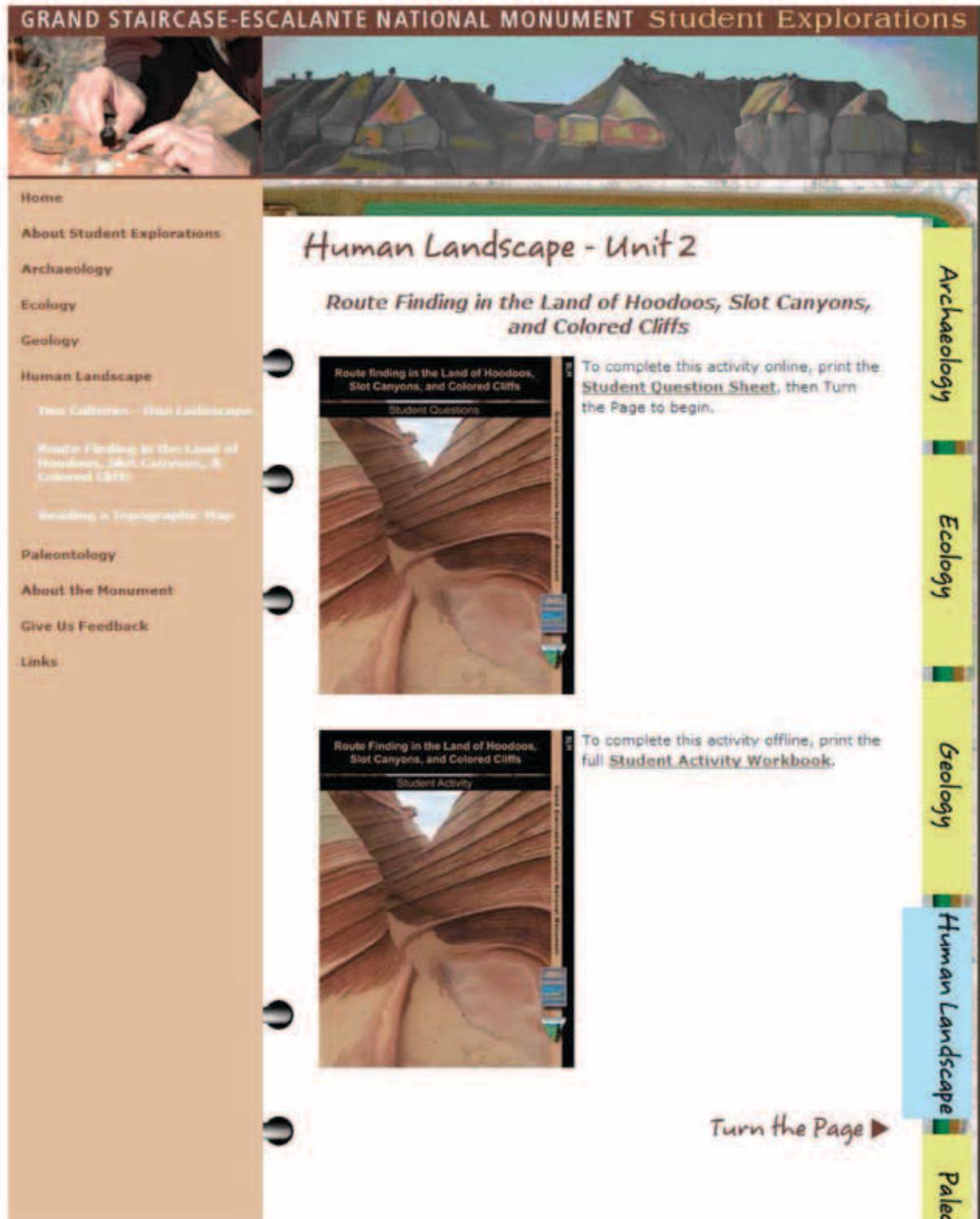
- 36 plants (November 2012) = 64% survival from April 2011



The Kane Schools Foundation for Students and the Grand Staircase-Escalante Partners recently purchased new GPS mapping units for the Natural Resources class at Kanab High School. Students will use the GPS units to monitor native plants on the Grand Staircase-Escalante National Monument.

Route Finding

WEB PAGE CAN BE FOUND HERE: http://www.gsenmschool.org/Landscape/Unit_02/



GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT Student Explorations

Home
About Student Explorations
Archaeology
Ecology
Geology
Human Landscape
 Two Cultures - One Landscape
 Route Finding in the Land of Hoodoos, Slot Canyons, & Colored Cliffs
 Reading a Topographic Map
Paleontology
About the Monument
Give Us Feedback
Links

Human Landscape - Unit 2

Route Finding in the Land of Hoodoos, Slot Canyons, and Colored Cliffs

To complete this activity online, print the [Student Question Sheet](#), then Turn the Page to begin.

Student Questions

To complete this activity offline, print the full [Student Activity Workbook](#).

Student Activity

Archaeology
Ecology
Geology
Human Landscape
Paleo

Turn the Page ▶



How To Use A Topographic Map

WEB PAGE CAN BE FOUND HERE: http://www.gsenmschool.org/Landscape/Unit_03/

GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT Student Explorations

Home

About Student Explorations

- Archaeology
- Ecology
- Geology
- Human Landscape
 - Two Cultures - One Landscape
 - Roads Flooding in the Land of Hoodoos, Slot Canyons, & Colored Cliffs
 - Reading a Topographic Map
- Paleontology
- About the Monument
- Give Us Feedback
- Links

Human Landscape - Unit 3 Page 1 of 8

Reading A Topographic Map

Reading a Topographic Map

Student Questions

To complete this activity online, print the **Student Question Sheet**, then Turn the Page to begin.

Reading a Topographic Map

Student Activity

To complete this activity offline, print the full **Student Activity Workbook**.

Turn the Page ▶

Archaeology
Ecology
Geology
Human Landscape
Paleo



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Kane Schools Foundation for Students and GSE Partners purchase GPS units for students at KHS

It is gratifying when different groups come together for a successful outcome. Recently, the fundraising endeavors of the Grand Staircase Escalante Partners (GSEP), with the support of the Kane Schools Foundation for Students (KSFS), resulted in the purchase of 25 GPS units for use in the Natural Resource Science class at Kanab High School.

For the past five years, staff at the Grand Staircase-Escalante National Monument, through Grand Staircase Escalante Partners, has worked with Kanab High School on a Native Plant Restoration Project (NPRP). Mary Dewitz, BLM interpretive specialist, described the original goal for the NPRP as, "we planned on giving the students an appetizer of what a career in agriculture or land management might be like."

Through the NPRP, students, working with ecologists and teachers, took on responsibility for a multitude of exacting and complicated tasks. GSEP Director Roger Cole explained that students in this "citizen science" initiative carried out research on native plant species within habitat zones on the Monument. After the research phase, the students removed and replaced invasive plants, and used GPS technology to keep records of exactly where certain native plants are located. After identifying which species were being driven out of the habitat zones, they collected seeds, grew seedlings in the high school greenhouse, transplanted seedlings to the field, and moni-

tored growth within control and experimental plots.

This learning activity was made possible through the generous financial support from the Captain Planet Foundation (www.captainplanetfoundation.org), which provided funds for GPS units, field guides, native seeds, and laboratory equipment. The outdoor recreation equipment corporation REI assisted the NPRP by reducing the cost of the GPS units.

Marty Ott, chairperson of Kane School Foundation for Students, said, "The Kane School Foundation for Students and the Grand Staircase Escalante Partners are both in the business of education. When we have opportunities to work together on projects such as this, the benefits to local students are greatly enhanced."

The value of the Native Plant Restoration Project to environmental good health, as well as environmental education, is inestimable. Roger Cole explained that, "the 'Sequester' and reduction in funding for agencies like the BLM may reduce participation by federal agencies in the NPRP. However, when Partners receives non-federal support from funders like the Captain Planet Foundation, the NPRP will continue to benefit students and educators."

For over five years, the Bureau of Land Management has supported, and provided funding for the NPRP, and without the financial backing from the BLM, and expertise from the BLM staff, the program would not exist.



The Kane Schools Foundation for Students and the Grand Staircase Escalante Partners recently purchased new GPS mapping units for the Natural Resources class at Kanab High School. Students will use the GPS units to monitor native plants on the Grand Staircase-Escalante National Monument.



Fredonia Elementary students who finished Accelerated Math with 100% of the set goal.

Fredonia Elementary School Accelerated Math

Fredonia Elementary Students who finished Accelerated Math with 100% of the set goal were:

- Second grade: Brooklyn Sherwood and Mikelle Waters
- Third grade: Hailey Castor, Wyatt Grover, Oscar Martinez, Elizabeth Morris and Sienna Robinson
- Fourth grade: Emily Cutchen, Jalexis Lukus, Cameron Nez and Joe Tracy
- Fifth grade: Dakota Bradley, Maloia Purvis, Tyler Rogers and Nicole Zaccaria
- Sixth grade: Taft Ballard, Penny Chell, Trevor Evans and Teshla Tidwell

We would like to thank the PTO for purchasing the T-shirts awarded to these students and T-Time for printing them for us.

"Inspire a Generation" was our theme for the Accelerated Math 2012-2013 school year. Not only were the students an inspiration to us (the teachers), but to each other. Many students math scores were up 1, 2 and even higher grade levels, exceeding their own grade. Star Math scores were awesome.

Accelerate into Math meaning - learning about math in many levels, areas, and how it works. There was a lot of learning, fun, and hands-on with math this year.

Principal Joe B. Wright had challenges throughout the year posted in the classrooms and hallways - that too - kept us thinking and doing math. Thank you to all the students of Fredonia Elementary for working so hard!

StarLoans
& FINANCE LTD

Need some CASH?

\$100 - \$3,000

We want to make you a loan!

Unexpected expense? Holiday parties?
Build your credit?

87 W. Center • Kanab
(435) 644-3890

Rodeo With A Purpose

Ages 12-19
if graduating in 2013.

Sponsored by Trinity Church

Rodeo Bible Camp
June 3-6, 2013 - Panguitch, Utah

For more info, contact
Tammy Staton 435-644-2122
or e-mail tamwo60@gmail.com

Featuring Pro Instructors
Kanin Asay - Bull Rider
Dusty Tuckness - Bull Fighter

LIBERTY CONTROLS
Providing Temperature Solutions

Edson Hammon AIR CONDITIONING & HEATING
435-644-5553
Licensed & Insured

Kanab and Surrounding Area





Congratulations to FES Accelerated Readers!

Fredonia Elementary School Principal Joe B. Wright and the elementary school teachers would like to congratulate all the students who earned their Accelerated Reading T-shirts for the 2012-13 school year. Awards were given to students who met 100% of their reading goals. A special thank you to Honey's Marketplace who helped sponsor the T-shirts. Fifty-two students in grades K-6 reached 100% of their goal. Many of the students exceeded their goal and some even reached 200% of their set goal. "We are very proud of our students for their accomplishment," said Wright, "Reading is the foundation of learning and we encourage students to continue reading throughout the summer months."

Old 200 rides again! Natural Resource Management Class

By Chick Nielsen

Dixie Brunner has already given an excellent account of a visit by "This American Land." Let Old 200 give her version of just one tiny portion.

The things Old 200 gets a chance to see or to be a part of!

Originally, Wade Parsons of the Escalante-Grand Staircase Partnership got in touch with an organization called "Captain

Planet" to see if they would underwrite some GPS units for Barbara Warner's Natural Resource Management Class.

Captain Planet generously wrote a grant for 25 GPS units. But ... it took things a step further down the line. They approached PBS and got an okay for Marsha Walton and David Waters from "This American Land" to come to a Warner and

Parsons "winter fat" planting activity, to film a seven or eight minute segment to air this fall on a science documentary.

"This American Land" does documentaries on all sorts of science activities, including National Parks or any topic that includes natural resources. Ted Turner is the financial underwriter for this project.

Now, about "winter fat." It is

also called "lamb's tail" or "white sage." It is a high protein, hardy plant, hard to kill, and winters draught and cold beautifully.

The management class planted new "winter fat" and checked on previous plants growing in a fenced area. They checked and repaired the fence, which keeps out cattle, deer and rodents, since the fence is supposed to be animal proof. The class planted 141 new "winter fat" sprouts.

It is an experimental project and could well become, someday, a wide spread practice if it proves to be practical. It could be the answer to "winter feed" when

harsh weather has killed most nutritious foliage.

Again, this is merely an experimental planting to see if it could be used to feed the livestock it now fences out. Also, it lets students experience "hands on" with a real-life experience.

This is world-class public relations, and a feather in the cap of Wade Parsons, Barbara Warner and the Kanab High School science class.

See you on TV, all you Kanab Paul Bunyans. Did Paul Bunyan cut down sagebrush?

A coup, Barbara and Wade, a coup!

It's back again...and you're invited!

Faith & Freedom Kid's Camp

July 8-12, 2013
Monday thru Friday
9:00 to 11:00 am
Kanab's Jacob Hamblin Park

- Totally free - no charge
- Gospel Lessons, Games, Crafts
- Community event for all kids from all surrounding areas
- Come any or all the days of camp
- Safe, well-supervised activity
- Free t-shirt for each child
- Call for info 435-644-2889

Parents always welcome to stay - to observe or participate



Wade Parsons, Barbara Warner and Raymond Brinkerhoff work a science project with "This American Land" representatives. The big time has come to little of Kanab. National coverage on PBS! As good as it gets. Photo by Chick Nielsen.



A cameraman from PBS films students at Kanab High School for a show called "This American Land." Photo by Laurel Beesley.

PBS program "This American Land" films in Kanab

By Dixie Brunner

The PBS program, "This American Land" filmed Kanab High School's Natural Resource Management class this past week. The film crew focused on students learning different aspects of land management and restoration. The PBS crew recorded students in the classroom, at the school greenhouse, and on experimental plots on the Grand Staircase Escalante National Monument.

Grand Staircase Escalante Partners, the Monument's Friends Group, started the Native Plant Restoration Project with an EPA environmental education grant in 2010. Since its inception, more than 100 high school students have participated in the program.

The project consists of classroom instruction and greenhouse work (conducting soil analysis, determining the best soil mix for growing winterfat, determining watering levels, using GIS/GPS technology for developing maps of the control and experimental plots, etc.), and field work on GSENM, which consisted of identifying/establishing a control plot (CP); using the CP as a seed source; establishing an experimental plot where the seedlings grown in the greenhouse are planted; monitoring the survival rate and

seed reproduction, etc.

The Kanab High School's involvement includes the Natural Resource Management Class, instructed by Barbara Warner; the media productions class that developed a DVD about the project; and a math class that did a statistical analysis of the plots' perimeters. GSENM staff taught plant identification and monitoring techniques.

"We got together (concerning Natural Resource Science) to figure out how we could incorporate the science available through the Monument and Partners," said Warner. "We came up with the Native Plant Restoration Project."

Thirty one students are in Warner's classes this year. She credits teacher Josh Baird for being a large part of the project, saying he's been invaluable in sending some students (Valley and Kanab) out to make plantings. Warner also praises GSENM's Carolyn Shelton for inspiration in stressing learning on the land projects.

The target? "Winter Fat" or white sage, which supposedly fattens sheep, deer and cows. The students collect the seeds out on the Monument, grow them in the greenhouse and later transplant them in March

See PBS, Page 3

PBS

Continued from Page 1

or April onto the test plot in a fenced enclosure on Telegraph Flat. (Thanks to permittee Worth Brown, who works with the school and Monument.) "We have seeds in the second year," said Warner. "The cool thing about the winter fats is they are a hearty breed."

"Because the project was with the high school and concerning natural resource management, it gave many folks here ownership," added GSENM's Mary DeWitz. "We wanted to provide an opportunity for students to have a hands-on project."

DeWitz praised the Grand Staircase Escalante National Monument Partners for its educational focus. "Partners is what keeps the program alive. They can do a lot of the fundraising and volunteer efforts...they are really the glue."

Wade Parsons, Education Coordinator for GSENM Partners, stressed that this project is just one of many for the support group. "The Partners are a

conduit to facilitate projects like this," said Parsons.

Marsha Walton, "This American Land" series producer, said that she works with the Environment News Trust and Gary Stricker. "He is one of the best conservation reporters on the earth." The show features short conservation stories. The piece in Kane County will be part of its third season, airing in early fall.

The show is a part of Ted Turner's Captain Planet (CNN), conservation shows which give advice and small grants to creative environmental education projects. The four focused on this segment were: Kane Schools/Monument/Friends project; Albany, Oregon school's bio-swale run off filters; Tahoe City, California where students have raised a species of trout; and the San Juan Islands, where they have studied a certain type of native mushrooms that have ability to filter toxins.

"We hope to get people to just talk about and understand where they live," said Walton, of the shows. "On our show, we do conservation, not politics!"



B. Frequency Methods - Pace Frequency, Quadrat Frequency, and Nested Frequency Methods

1. *General Description* All three methods consist of observing quadrats along transects, with quadrats systematically located at specified intervals along each transect. The only differences in these techniques are the size and configuration of the quadrat frames and the layout of the transect. The following vegetation attributes are monitored with this method:

- Frequency
- Basal cover and general cover categories (including litter)
- Reproduction of key species (if seedling data are collected)

It is important to establish a photo plot (see Section V.A) and take both close-up and general view photographs. This allows the portrayal of resource values and conditions and furnishes visual evidence of vegetation and soil changes over time.

2. *Areas of Use* This method is applicable to a wide variety of vegetation types and is suited for use with grasses, forbs, and shrubs.

3. *Advantages and Limitations*

- a Frequency sampling is highly objective, repeatable, rapid, and simple to perform, and it involves a minimum number of decisions. Decisions are limited to identifying species and determining whether or not species are rooted within the quadrats (presence or absence).
- b Frequency data can be collected in different-sized quadrats with the use of the nested frame. When a plant of a particular species occurs within a plot, it also occurs in all of the successively larger plots. Frequency of occurrence for various size plots can be analyzed even though frequency is recorded for only one size plot. This eliminates problems with comparing frequency data from different plot sizes. Use of the nested plot configuration improves the chance of selecting a proper size plot for frequency sampling.
- c Cover data can also be collected at the same time frequency data is gathered. However, cover data collected in this manner will greatly overestimate cover; unless the times are honed to a fine point, observer bias will come into play. Another limitation is that the use of one size quadrat will likely result in values falling outside the optimum frequency range (greater than 20 percent to less than 80 percent) for some of the species of interest.

4. *Equipment* The following equipment is needed (see also the equipment list in Section V.A, page 31, for the establishment of the photo plot):

- Study Location and Documentation Data form (see Appendix A)
- Frequency form (see Illustration 4)
- Nested Frequency form (see Illustration 5)
- Permanent yellow or orange spray paint
- Frequency frames (see Illustrations 6 and 7)



METHODS—Frequency

- One transect location stake: 3/4 - or 1-inch angle iron not less than 16 inches long
 - Hammer
 - Tally counter (optional)
 - Compass
 - Steel post and driver
 - Tape: 50-, 100-, or 200-foot delineated in tenths and hundreds or a metric tape of the desired length.
5. **Training** A minimum amount of training is needed for this method. Examiners must be able to identify the plant species and be able to tell whether or not a species occurs, according to study specifications, within a quadrat. Examiners must be familiar with the cover categories and how to collect cover data using the tines on the quadrat frame.
6. **Establishing Studies** Careful establishment of studies is a critical element in obtaining meaningful data (see Section III).
- a **Site Selection** The most important factor in obtaining usable data is selecting representative areas (critical or key areas) in which to run the study (see Sections II.D). Study sites should be located within a single plant community within a single ecological site. Transects and sampling points need to be randomly located within the critical or key areas (see Section III).
- b **Pilot Studies** Collect data on several pilot studies to determine the number of samples (transects or observation points) and the number and size of quadrats needed to collect a statistically valid sample (see Section III.B.8).
- c **Selecting Quadrat Size** The selection of quadrat size is important and depends on the characteristics of the vegetation to be sampled (see Section III.B.6).
- (1) As a rule of thumb, it is expected that all frequency percentages for important species should fall between 10 and 90 percent or, if possible, between 20 and 80 percent. This will provide the greatest possible chance for detecting an important trend for a species when the study is read again. Use a frame size that will produce frequencies falling in this range for the greatest number of species possible.
 - (2) To build a sample frame, see Illustration 6, which shows an example of a frequency frame.
 - (3) Use the same size quadrat throughout a study and for rereading the study. If frequencies for a specific species approach the extremes of either 0 or 100 percent, it may be necessary to use a different sized quadrat for that species. The nested plot concept would be suitable in this instance.
- d **Nested Plot Technique** The use of one size plot is usually not adequate to collect frequency data on all the important species within a community. For each species occurring on a site, there is a limited range of plot sizes capable of producing frequency percentages between 20 and 80 percent. A plot size appropriate for one species may not be appropriate for another. The nested plot



METHODS—Frequency

concept is a simple approach to collecting data on two or more different sized plots at one time. Several different sized plots are placed inside each other in a smallest to largest sequence (see Illustration 7).

- e **Number of Studies** Establish at least one frequency study on each study site; establish more if needed (see Sections II.D and III.B).
- f **Study Layout** Frequency data can be collected using either the baseline, macroplot, or linear study designs described in Section III.A.2 beginning on page 8. The baseline technique is the one most often used.

Align a tape (100-, or 200-foot, or metric equivalent) in a straight line by stretching it between the baseline beginning stake and the baseline end point stake (see Figure 4 on page 13.) A pin may also be driven into the ground at the midpoint of the transect. Do not allow vegetation to deflect the alignment of the tape. A spring and pulley may be useful to help maintain a straight line.

With the baseline technique, any number of transects can be run perpendicularly to the baseline, depending on the intensity of the sample needed (see Figure 1 on page 9). Each transect originates at a randomly selected mark along the baseline. The randomization is restricted so that half of the transects are randomized on each side of the halfway mark. (Directions for randomly selecting the location of transects to be run off of a baseline using random number tables are given in Appendix D.)

The starting point for each transect off the base line and the distance between each quadrat should not be any closer than the width of the quadrat being used to avoid the possibility that any two quadrats might overlap.

- g **Reference Post or Point** Permanently mark the location of each study with a reference post and study location stake (see beginning of Section III).
 - h **Study Identification** Number studies for proper identification to ensure that the data collected can be positively associated with specific studies on the ground (see Appendix B).
 - i **Study Documentation** Document pertinent information concerning the study on the Study Location and Documentation Data form (see beginning of Section III and Appendix A).
- **Taking Photographs** The directions for establishing photo plots and for taking close-up and general view photographs are given in Section V.A.
 - **Sampling Process** In addition to collecting the specific study data, general observations should be made of the study sites (see Section II.F).
- a **Running the Transect** Study data are collected along several transects. The location of each transect (distance along the baseline) and the direction (to left or right from the baseline) are randomly determined for each study site. A quadrat is read at the specified interval until all quadrats have been read. The interval between quadrats can be either paced or measured. To widen the area



METHODS—Frequency

transected, add additional paces or distance (20 paces, 50 feet) between quadrats. Additional transects can be added to obtain an adequate sample.

- (1) Start each transect by placing the rear corner of the quadrat frame at the starting point along the baseline tape.
- (2) Place the quadrat frame at the designated interval along a transect perpendicular to the baseline until the specified number of quadrats have been read. The interval between quadrats can be measured or estimated by pacing.
- (3) When a transect is completed, move to the next starting point on the baseline tape and run the next transect.

b Collecting Cover Data Record, by dot count tally, the cover category at each of the four corners and at the tip of any tines on the frame. Enter this data in the Cover Summary section of the Frequency and Nested Frequency forms (see Illustrations 4 and 5). The cover categories are bare ground (gravel less than 1/12 inch in diameter is tallied as bare ground), litter, and gravel (1/12 inch and larger). Additional cover categories can be added as needed. Vegetation is recorded as basal hits or canopy layers in the bottom portion of the form. Up to three canopy layers can be recorded. For additional information on collecting vegetation cover data, see Section V.F.8.b on page 72. Cover data can also be recorded on the Cover Data form, Illustration 13, page 75.

Read the same points on the frame and the same number of points at each placement of the frame throughout a study and when rereading that study.

- c Collecting Frequency Data** Collect frequency data for all plant species. Record the data by species within each quadrat using the Frequency form (Illustration 4). Only one record is made for each species per quadrat, regardless of the number of individual plants of a species that occurs within the quadrat.
- (1) Herbaceous plants (grasses and forbs) must be rooted in the quadrat to be counted.
 - (2) On many occasions, rooted frequency on trees and shrubs (including half shrubs) does not provide an adequate sample (occurring within 20% of the plots). To increase the sample size on trees and shrubs, the canopy overhanging the quadrat can be counted.
 - (3) Annual plants are counted whether green or dried.
 - (4) Specimens of the plants that are unknown should be collected and marked for later identification.
 - (5) Frequency occurrence of seedlings by plant species should be tallied separately from mature plants.





METHODS—Frequency

- d Nested Plot Method** Collect frequency data for all plant species. For uniformity in recording data, the four nested plots in a quadrat are numbered from 1 through 4, with the largest plot size corresponding with the higher number. Each time the quadrat frame is placed on the ground, determine the smallest size plot each species occurs in and record the plot number for that quadrat on the Nested Frequency form (Illustration 5).
9. **Calculations** Make the calculations and record the results in the appropriate columns on the Frequency form (see Illustration 4).
- a Cover** Calculate the percent cover for each cover category by dividing the number of hits for each category by the total number of hits for all categories, including hits on vegetation, and multiplying the value by 100. The total of the percent cover for all cover categories equals 100 percent. Additional information on calculating ground cover, canopy cover, and basal cover can be found in Section F.9 on page 73.
- b Frequency: Single Plot** On the Frequency form, Illustration 4, total the frequency hits by species. Calculate the percent frequency for each plant species by dividing the total number of hits for that species by the total number of quadrats sampled along the transect and multiplying the value by 100. Record the percent frequency on the form.
- c Frequency: Nested Plot** Percent frequency by species can be calculated for each transect and/or for the total of all transects.
- (1) **Compiling data** Determine the number of occurrences for each species for each plot size.
- (a) Count the number of occurrences of a species in plot 1 and record the value in the Hits portion of column 1 in the Frequency Summary portion of the Nested Frequency form (see Illustration 5).
- (b) Count the number of occurrences of the same species in plot 2 and add this number to the number recorded for plot 1. Record this total in the Hits portion of column 2.
- (c) Count the number of occurrences of the same species in plot 3 and add this number to the number recorded for plot 2. Record this total in the Hits portion of column 3.
- (d) Count the number of occurrences of the same species in plot 4 and add this number to the number recorded for plot 3. Record this total in the Hits portion of column 4.
- (2) **Frequency for each transect** Calculate the percent frequency of a plant species by plot size for a transect by dividing the number of occurrences by the number of quadrats sampled and multiplying the value by 100. Record in the "% Freq" section of the Frequency Summary portion.





METHODS—Frequency

(3) **Total frequency for all transects** Calculate the percent frequency of a plant species by plot size for the total of all transects by adding the occurrences of a species by plot size on all transects, dividing the total by the total number of quadrats sampled for the study, and multiplying the value by 100. Record the percent frequency in the appropriate plot size on a separate form.

10. **Data Analysis** To determine if the change between sampling periods is significant, a Chi Square contingency table analysis should be used. Frequency must be analyzed separately for each species. Chi Square (See Technical Reference, *Measuring & Monitoring Plant Populations*) can also be used to detect changes in cover classes between sampling periods.

11. References

- Bonham, C.D. 1989. *Measurements for Terrestrial Vegetation*, John Wiley and Sons, 338 p.
- Despain, D.W., P.R. Ogden, and E.L. Smith. 1991. Plant frequency sampling for monitoring rangelands. Some methods for monitoring rangelands and other natural area vegetation. Extension Report 9043. University of Arizona, Tucson, AZ.
- Eckert, Richard E., Jr. and John S. Spencer. 1986. Vegetation response on allotments grazed under rest rotation management. *Soc. for Range Manage.* 39 (2): 166-173.
- Francis, Richard E., Richard S. Driscoll, and Jack N. Reppert. 1972. Loop-frequency as related to plant cover, herbage production, and plant density. U.S. Dept. of Agr., For. Ser., Rocky Mtn. For. and Range Exp. Sta., Ft. Collins, CO. Research Paper MA-94. 15 p.
- Hironaka, M. 1985. Frequency approaches to monitor rangeland vegetation. Symp. on use of frequency and for rangeland monitoring. William C. Krueger, Chairman. Proc., 38th Annual Meeting, Soc. for Range Manag. Feb. 1985. Salt Lake City, UT. *Soc. for Range Manage.* 84-86.
- Hyder, D.N., C.E. Conrad, P.T. Tueller, L.D. Calvin, C.E. Poulton, and F.A. Sneva. 1963. Frequency sampling of sagebrush-bunchgrass vegetation. *Ecology* 44:740-746.
- Hyder, D.N., R.E. Bement, E.E. Remmenga, and C. Terwilliger, Jr. 1965. Frequency sampling of blue grama range. *J. Range Manage.* 18:94-98.
- Hyder, D.N., R.E. Bement, and C. Terwilliger. 1966. Vegetation-soils and vegetation-grazing relations from frequency data. *J. Range Manage.* 19:11-17.
- Nevada Range Studies Task Group. 1984. *Nevada Rangeland Monitoring Handbook*. Bureau of Land Management Nevada State Office, Reno, NV. 50 p.





METHODS—Frequency

- Tueller, Paul T., Garwin Lorain, Karl Kipping, and Charles Wilkie. 1972. Methods for measuring vegetation changes on Nevada rangelands. Agr. Exp. Sta., Univ. of Nevada, Reno, NV. T16. 55 p.
- USDI, Bureau of Land Management. 1985. Rangeland monitoring - Trend studies TR4400-4.
- West, N.E. 1985. Shortcomings of plant frequency-based methods for range condition and trend. William C. Krueger, Chairman. Proc., 38th Annual Meeting Soc. for Range Manage. Feb. 1985. Salt Lake City. Soc. for Range Manage. 87-90.
- Whysong, G.L. and W.W. Brady, 1987. Frequency Sampling and Type II Errors. J. Range Manage. 40:172-174.



METHODS—Frequency

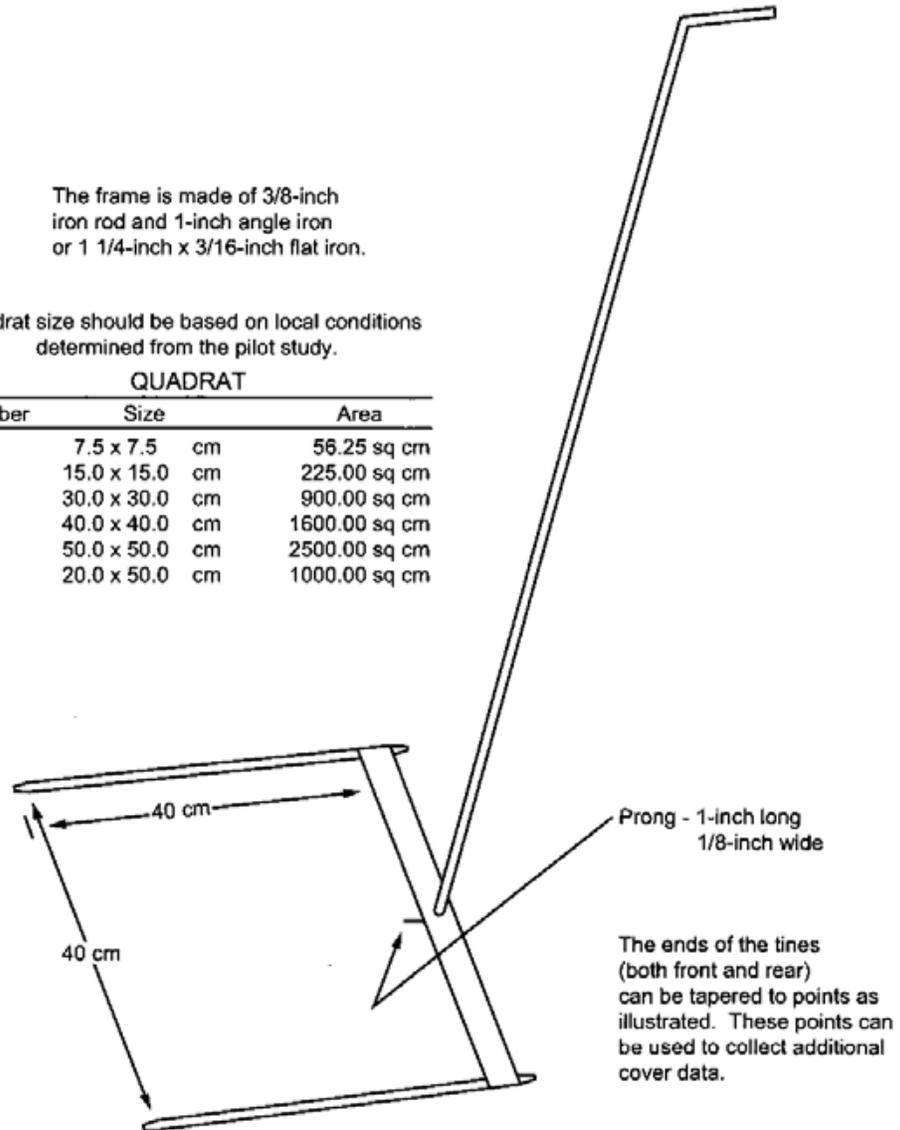
Rangeland Monitoring

Frequency Frame

The frame is made of 3/8-inch iron rod and 1-inch angle iron or 1 1/4-inch x 3/16-inch flat iron.

Quadrat size should be based on local conditions determined from the pilot study.

QUADRAT			
Number	Size		Area
1	7.5 x 7.5	cm	56.25 sq cm
2	15.0 x 15.0	cm	225.00 sq cm
3	30.0 x 30.0	cm	900.00 sq cm
4	40.0 x 40.0	cm	1600.00 sq cm
5	50.0 x 50.0	cm	2500.00 sq cm
6	20.0 x 50.0	cm	1000.00 sq cm



Rangeland Monitoring

Nested Plot Frame

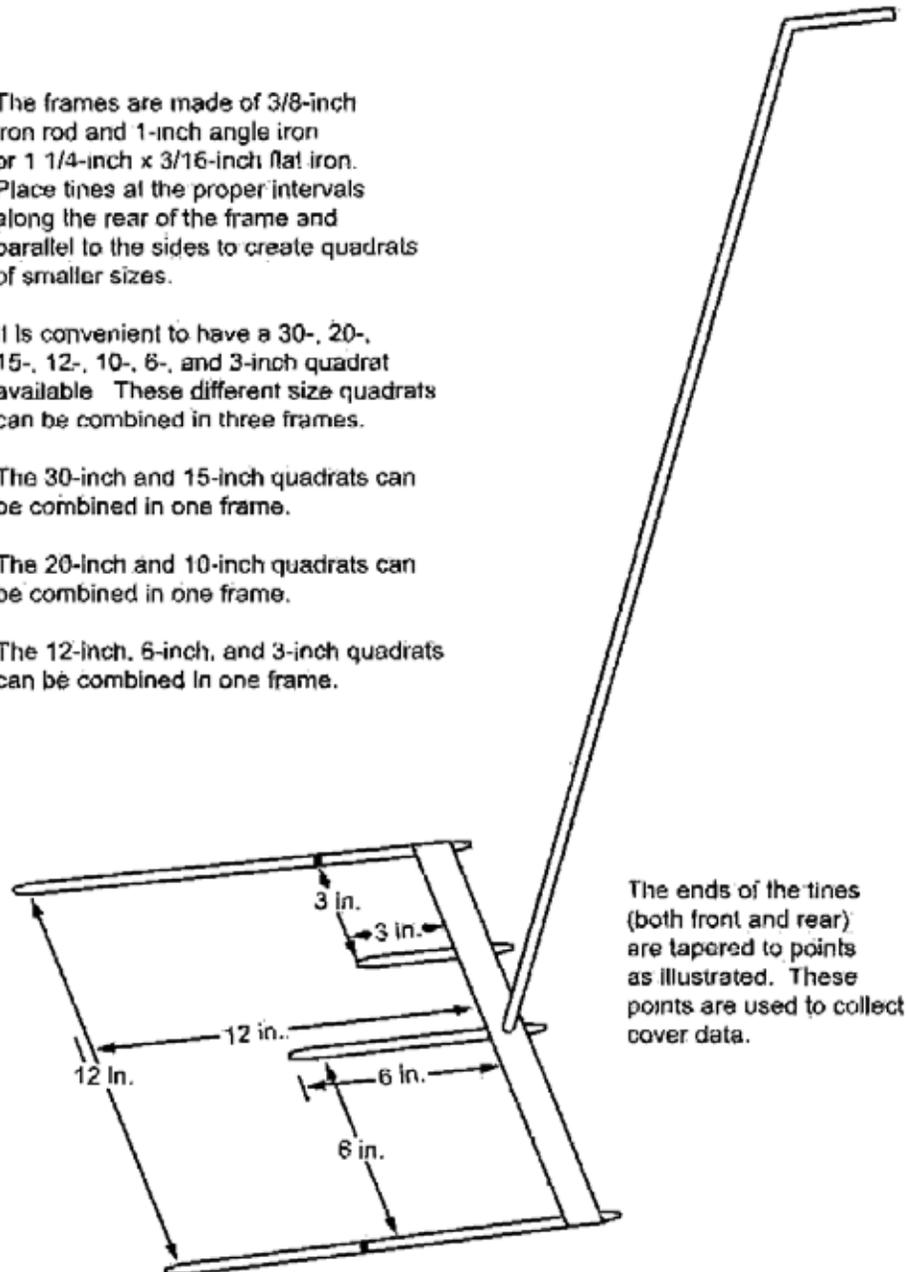
The frames are made of 3/8-inch iron rod and 1-inch angle iron or 1 1/4-inch x 3/16-inch flat iron. Place lines at the proper intervals along the rear of the frame and parallel to the sides to create quadrats of smaller sizes.

It is convenient to have a 30-, 20-, 15-, 12-, 10-, 6-, and 3-inch quadrat available. These different size quadrats can be combined in three frames.

The 30-inch and 15-inch quadrats can be combined in one frame.

The 20-inch and 10-inch quadrats can be combined in one frame.

The 12-inch, 6-inch, and 3-inch quadrats can be combined in one frame.





Frequency				Page ___ of ___
Study Number	Date	Examiner	Allotment Name & Number	Pasture
Transect Location		Number of Quadrats		
Plant Species	Quadrat Number			
	0	10	20	30
				40
				50
				60
				70
				80
				90
				100
				Total

Cover Summary				
Vegetation (Basal)	Vegetation (Canopy)	Litter	Bare Ground	Gravel/Stone
Hits	Hits	Hits	Hits	Hits
%Cover	%Cover	%Cover	%Cover	%Cover

Notes (use other side or another page)



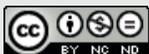
This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Frequency				Page <u>1</u> of <u>1</u>								
Study Number <u>DTN-04W-13-05</u>	Date <u>10/27/95</u>	Examiner <u>Buddy Clump</u>	Allotment Name & Number <u>Blue Dome - 03131</u>	Pasture								
Transect Location <u>1 mile East of Weatherby Cottage</u>		Number of Quadrats <u>100</u>	Quadrat Size <u>40 x 40 cm</u>									
Plant Species	0	10	20	30	40	50	60	70	80	90	100	Total
<u>BOGR2</u>												<u>65</u>
<u>BOHI2</u>												<u>36</u>
<u>PAOB</u>												<u>6</u>
<u>BOCU</u>												<u>35</u>
<u>BRRU2</u>												<u>10</u>
<u>SIHY</u>												<u>31</u>
<u>KOCR</u>												<u>24</u>
<u>VIGUI</u>												<u>33</u>
<u>HYRI</u>												<u>16</u>
<u>AMPS</u>												<u>12</u>
<u>OPUNT</u>												<u>3</u>
<u>CEGR</u>												<u>4</u>
<u>ERIOG</u>												<u>2</u>
<u>PSORA</u>												<u>3</u>
<u>JUNIP</u>												<u>1</u>

Cover Summary			
Vegetation (Basal)	Vegetation (Canopy)	Litter	Bare Ground
<u>20</u> His <u>5</u> %Cover	<u>46</u> His <u>12</u> %Cover	<u>164</u> His <u>41</u> %Cover	<u>136</u> His <u>34</u> %Cover
			Gravel/Stone
			<u>34</u> His <u>8</u> %Cover

Notes (use other side or another page)



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Page ___ of ___

Study Number	Date	Examiner	Allotment Name & Number		Pasture																																				
Transsect Location		Number of Quadrats																																							
Plant Species	Quadrats										Frequency Summary by Plot Size				Cover Summary																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		15	16	17	18	19	20	1	2	3	4	Vegetation (Basal)	Hits	%Cover	Vegetation (Canopy)	Hits	%Cover	Litter	Hits	%Cover	Bare Ground	Hits	%Cover	Gravel/Stone	Hits	%Cover	Cryptogamic crust
Observations/Comments																																									

Notes (Use other side or another page) Canopy* Dont record ground cover under canopy hits of shrubs under 10ft in height



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.

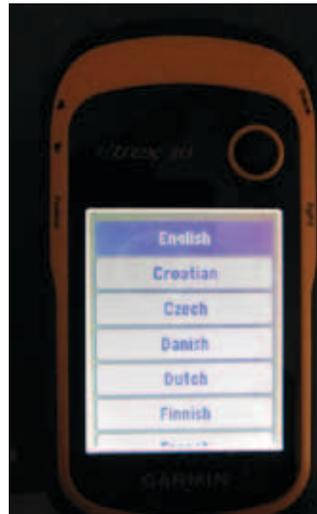
INSTRUCTIONS FOR USING THE GARMIN eTREX10



Shown above are the buttons for use on the Garmin eTrex10. Pushing the “light” button and briefly holding it will power up the GPS unit. After the GPS has initiated, a very quick push of the “light” button will pull up the status window shown above. This will display the Date and Time, the Backlight level, how much power remains in the batteries, and the strength of the GPS signal received. Pushing twice on the menu button at any time will take you to the main menu.

INSTRUCTIONS FOR INITIAL SET-UP OF THE GARMIN eTREX10

STEP 1



After Factory Reset

Reset English as the preferred option and push the joystick so it clicks and accepts the selection

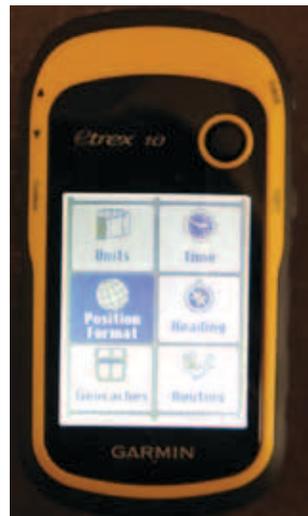
STEP 2



From the main menu use the joystick to highlight the "Setup" option. Push the joystick to enter the setup menu

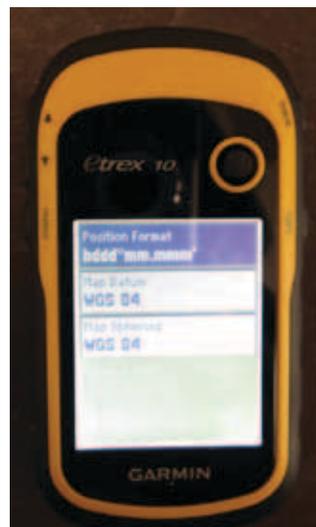
INSTRUCTIONS FOR INITIAL SET-UP OF THE GARMIN eTREX10

STEP 3



Use the joystick to navigate to the “Position Format” option and select that menu

STEP 4



The factory default option is to acquire data in a Lat-Lon format. Click the joystick on the “Position Format” option to change to a UTM format.

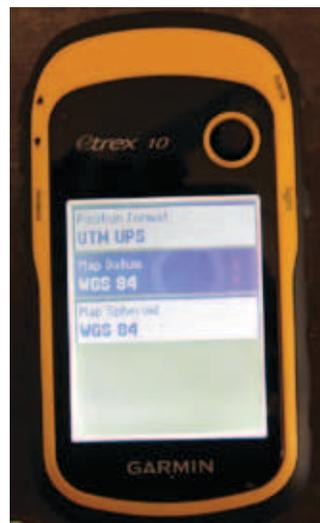
INSTRUCTIONS FOR INITIAL SET-UP OF THE GARMIN eTREX10

STEP 5



For Use the joystick to navigate through the numerous position format options until you can select the "UTM UPS" option. Note that these options are in an alphabetical sequence

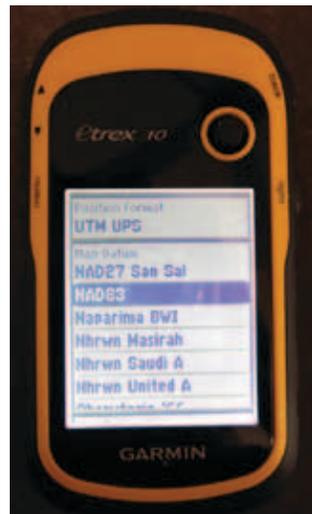
STEP 6



We now want to use the "Map Datum" options to change from WGS84 to NAD83.

INSTRUCTIONS FOR INITIAL SET-UP OF THE GARMIN eTREX10

STEP 7



After selecting the NAD83 options press once on the “Back” button to return to the setup menu. The UTM data will be acquired by the GPS to display position information with USGS mapping products using the UTM coordinate system.

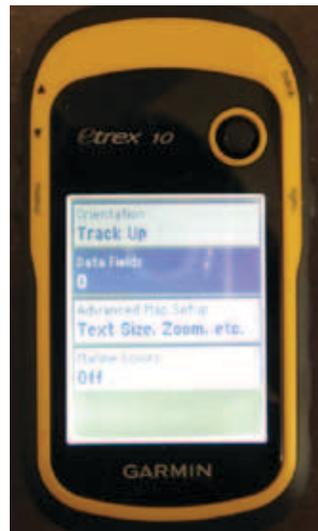
STEP 8



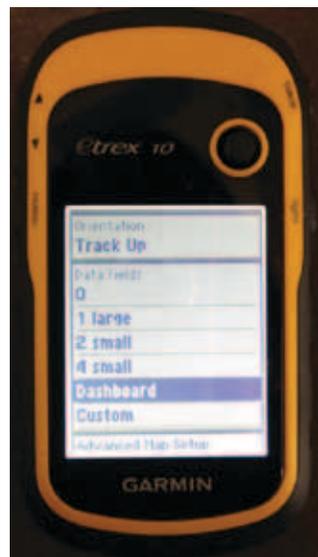
From the Setup Menu select the “Map” option.

INSTRUCTIONS FOR INITIAL SET-UP OF THE GARMIN eTREX10

STEP 9

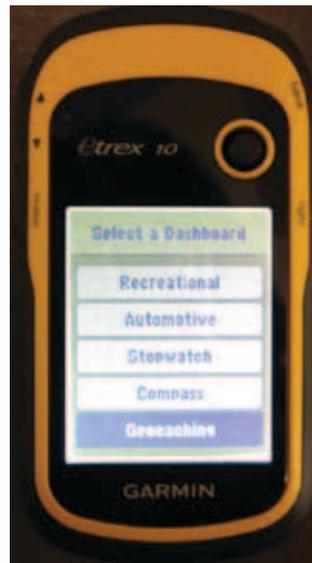


From the map setup window we want to select the “Data Fields” option to the “Dashboard” display so we have a scale-bar, compass, and direction displayed on the screen to assist us in locating our points.



INSTRUCTIONS FOR INITIAL SET-UP OF THE GARMIN eTREX10

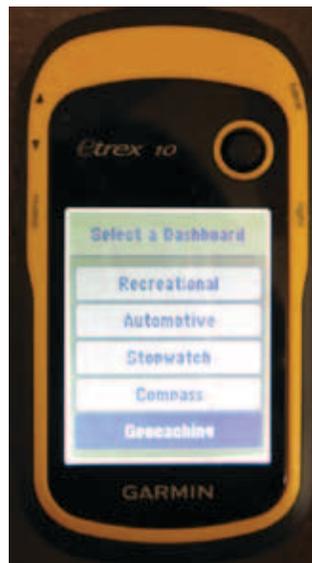
STEP 10



Select the "geocaching option then push the menu button twice to return to the main menu. The GPS unit is now ready for use.

INSTRUCTIONS FOR USING THE GARMIN eTREX10 FOR FINDING WAYPOINTS ALREADY LOADED ONTO THE GPS

STEP 1



Turn the power on and use the joystick to navigate to the "Satellite" option on the main menu

STEP 2



While the GPS is searching for and acquiring signals from satellites, there will not be any coordinates on the Satellite page. When it has acquired sufficient signals to determine location, there will be coordinates for the location of the GPS displayed on this page. Once the GPS has found its position, push the menu button twice to return to the main menu.



INSTRUCTIONS FOR USING THE GARMIN eTREX10 FOR FINDING WAYPOINTS ALREADY LOADED ONTO THE GPS

STEP 3



From the Main Menu select the “Where to?” option

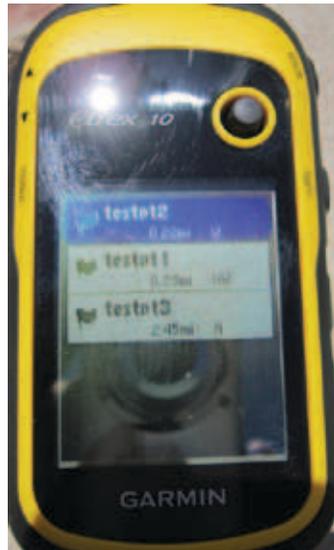
STEP 4



Select the “Waypoints” option within the Where to sub-menu.

INSTRUCTIONS FOR USING THE GARMIN eTREX10 FOR FINDING WAYPOINTS ALREADY LOADED ONTO THE GPS

STEP 5



There are 3 points preloaded into each GPS unit. Select one of the 3 points to find the location, then repeat for the other 2 points. Note that 2 of the points will be close by and you can find them. The 3rd point is several miles away and you will have to estimate based on the distance and compass direction what feature might be represented by that point.

STEP 6



Once you have selected a point, the screen will show your position connected to the point by a line, a scale bar indicating approximately how far you are from the point, and a distance and direction to the point above the top line.

Select "GO" and start moving toward the point

INSTRUCTIONS FOR USING THE GARMIN eTREX10 FOR FINDING WAYPOINTS ALREADY LOADED ONTO THE GPS

STEP 7



You will need to move for the GPS to determine your relative location to the waypoint. As you move, the compass direction will change as your position relative to the waypoint changes. As you close in on your destination. Use the “zoom in” button as you get closer. Note the scale bar changes as you get closer. Record what you think the waypoint might be. Be aware that your error factor may be several meters...that means the actual position might be 10 or 20 feet from where you think it is



Winterfat Planting Data
2009-2010

Planted	Observation Dates																
	1/5/2010	1/11	1/13	1/15	1/19	1/22	1/25	25-Jan	2/1	2/5	5-Feb	2/9	2/12	2/17	26-Feb	3/3	3/10
# Seeds																	
Soil Mixes																	
Control #1 = Hyponex	92	2	20	27	42	37	37	40.22%	33	30	32.61%	21	18	17	18.48%	17	17
Control #2 = MiracleGro	98			11	17	17	19	19.39%	22	22	22.45%	8	9	8	8.16%	10	10
Tray #1 - Site 1 Soil	38		2	4	9	9	10	26.32%	9	9	23.68%	9	6	7	18.42%	6	6
Tray #2 - Site 2 Soil	46		5	12	23	23	30	65.22%	8	6	13.04%	5	5	5	10.87%	4	4
Tray#3 - Site1 Sterilized	77		3	14	25	36	39	50.65%	35	31	40.26%	30	30	30	38.96%	29	28
Tray#4 - Site 2 Sterilized	44		1	9	9	9	10	22.73%	7	8	18.18%	7	7	7	15.91%	6	6
Tray #5 - Zion Mix	98	1	13	40	59	59	65	66.33%	26	20	20.41%	17	15	15	15.31%	15	15
Tray#6-ZM +Site1 Soil	49		13	25	26	30	35	71.43%	23	22	44.90%	19	19	19	38.78%	18	17
Tray #7 - ZM + Sterilized Site 1 Soil	69		5	8	15	20	21	30.43%	18	14	20.29%	12	9	8	11.59%	7	5
Tray#8-ZM+Site2Soil	22			1	5	5	5	22.73%	2	2	9.09%	1	1	1	4.55%	1	1
Tray#9-ZM + Sterilized Site 2 Soil	49		10	19	18	24	24	48.98%	19	16	32.65%	16	16	16	32.65%	15	13
Totals	682	3	72	170	248	269	295	43.26%	202	180	26.39%	145	135	133	19.50%	128	122

Planted	Observation Dates									
	2/3/2010	2/9	2/12	2/17	2/17	2/22	2/26	2/26	3/3	3/10
# Seeds										
Soil Mixes										
Winterfat Planting #2 (2/3/2010)	98	26	30	24	24.49%	25	26	26.53%	25	22
Tray #1 - Zions Mix	98	22	21	18	18.37%	15	15	15.31%	14	13
Tray #2 - Zions Mix	98	16	21	21	21.43%	18	18	18.37%	17	15
Tray #3 - Zions Mix	98	18	21	16	16.33%	12	13	13.27%	10	8
Tray #4 - Zions Mix	98	20	28	26	26.53%	22	23	23.47%	21	20
Tray #5 - Zions Mix	490	102	121	105	21.43%	92	95	19.39%	87	78

Planted	Observation Dates									
	2/10/2010	2/22	2/26	3/3	3/3	3/8	3/10	3/10	3/10	3/10
# Seeds										
Soil Mixes										
Winterfat Planting #3 (2/10/2010)	98	9	10	8	8.16%	9	9			
Tray #6 - ZM + Site 1 Soil	98	6	14	14	14.29%	13	12			
Tray #7 - ZM + Site 2 Soil	98	4	9	17	17.35%	14	16			
Tray #8 - ZM + Sterilized Site 1 Soil	72	11	18	16	22.22%	15	15			
Tray #9 - ZM + Sterilized Site 2 Soil										

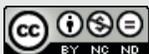


This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Winterfat Planting Data
2009-2010

Totals	366	30	51	55	15.03%	51	52
Winterfat Planting #4 (3/4/2010)	Planted 3/5/2010	3/8	3/10	Observation Dates			
Soil Mixes - All Zion Mix + Fredonia Seeds	# Seeds	# of Seedlings		% Grmtd			
Tray #10 - ZM +FrdSeeds	0	0	0				
Tray #11 - ZM +FrdSeeds	0	0	0				
Tray #12 - ZM +FrdSeeds	0	0	0				
Tray #13 - ZM +FrdSeeds	0	0	0				
Totals	0	0	0				



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Natural Resource Science Native Plant Project Site Data

Student Name: _____

Date of Data Collection: _____

Site Data

1. Location: GPS / UTM coordinates (attach map of location)
GPS:
UTM :

2. General Description: (include soil type, topography, altitude)

3. Vegetation identified onsite: (common name and scientific name)

Common Name	Scientific Name	Vegetation Symbol
Grasses		
Forbes (Herbs)		
Trees/Shrubs		



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Vegetation frequency data: Belt # _____

Species (Use Symbol)	Nested Frequency Totals				Total (multiply # of hits by frame area)
	1	2	3	4	

Cover					
Vegetation	Litter	Rock	Pavement	Moss/Lichen	Soil

Vegetation frequency data: Belt # _____

Species (Use Symbol)	Nested Frequency Totals				Total (multiply # of hits by frame area)
	1	2	3	4	

Cover					
Vegetation	Litter	Rock	Pavement	Moss/Lichen	Soil



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Summary of Vegetation Frequency Data:

Species (Use Symbol)	Nested Frequency Belt Totals			Totals
	2	3	4	
Grasses				
Forbes				
Trees/Shrubs				

Cover					
Vegetation	Litter	Rock	Pavement	Moss/Lichen	Soil



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Natural Resource Science Native Plant Project Site Data

Student Name: _____

Date of Data Collection: _____

Site Data

1. Location: GPS / UTM coordinates (attach map of location)
GPS:
UTM :

2. General Description: (include soil type, topography, altitude)

3. Vegetation identified onsite: (common name and scientific name)

Common Name	Scientific Name	Vegetation Symbol
Grasses		
Blue Grama Grass	<i>Bouteloua gracilis</i>	BOGR2
Sand Dropseed	<i>Sporobolous cryptandrus</i>	SPCR
Indian Ricegrass	<i>Achnatherum hymenoides</i> (also known as - <i>Oryzopsis</i> or <i>Stipa hymenoides</i>)	ACHY
Carex	<i>Carex</i> species	CA spp
Forbes (Herbs)		
Buckwheat species	<i>Eriogonum</i> sp	ER spp
Douglas' Dustymaiden	<i>Chaenactis douglasii</i>	CHDO
Tansy Aster (Utah daisy)	<i>Machaeranthera pinnatifida</i>	MAPIG
Haplopappus	<i>Haplopappus</i> sp	HAPL
Trees/Shrubs		
Utah Juniper	<i>Juniperus osteosperma</i>	JUOS
Gambel's Oak	<i>Quercus gambelii</i>	QUGA
Big Sage	<i>Artemisia tridentata</i>	ARTR2
Sand Sage	<i>Artemisia filifolia</i>	ARFI1
Rubber rabbitbrush	<i>Chrysothamnus nauseosa</i> (now called <i>Ericameria nauseosa</i>)	CHRY9



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Winterfat Germination Data

Soil Mixes	Planting Date / # of Seeds planted	Date / # of seeds germinated	Date / # of seeds germinated	Date / # of seeds germinated	Date / # of seeds germinated	Date / # of seeds germinated	Date / # of seeds germinated	Date / # of seeds germinated	% of Seeds Germinated
Site 1 Soil									
Site 2 Soil									
Sand									
Miracle Gro Potting Soil									
Zion Mix Potting Soil									

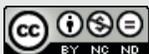


This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Nested Vegetation Frequency

	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	Total	
Site 1 Belt 1																						
Winterfat	2	1	2	2	2	3	2	2	1	2	3	2	2	2	3	2	2	2	2	2	2	41
Musk Mustard								1	1	2	1	2	2	2	1	1	2	2	2	1	1	19
Flixweed								1	1													1
Burr Buttercup							2	2	2	2	3				2	2				2	2	17
Site 1 Belt 2																						
Winterfat	2	1	2	3	1	2	3	2	2	2	3	1	2	3	2	1	2	3	2	2	2	41
Burr Buttercup					1	2	2	2	2	2	2	2	3		3	1	2	2	2	2	2	28
Indian Ricegrass							1															3
Musk Mustard			2	2	1	2	2		2		2		1	1	1	1	2	2	2	2	2	22
Russian Thistle															1							1
Site 1 Belt 3																						
Winterfat	2	1	2	1	2	1	2	3	2	2	2	2	2	3	1	2	2	3	2	2	2	39
musk mustard	1		2		2		1	1	1		1	1	2	1	1	1	1				1	14
burr butter cup			1			3	2	2	2	3	2	3		2	3		2	2	2	2	2	31
globe mallow								2	2		1											3
indian ricegrass									2	2	1	3		2	1	1	1	1				13
squirrel tail							1			1	1			1	1							5



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



GSENM Vegetation Sampling November 2009
Nested Frequency Method

GSENM Site 1 - Winterfat Seed Source

	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	Total
--	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-------

Site 1 Belt 1

Winterfat	2	1	2	2	2	3	2	2	2	1	2	2	2	2	3	2	2	2	2	2	2	41
Musk Mustard								1	1	2	1	2	2	2	1	1	2	2	2	1	1	19
Flixweed								1														1
Bur Buttercup								2	2	2	2	3			2	2	2			2	2	17

Site 1 Belt 2

Winterfat	2	1	2	3	1	2	3	2	2	2	3	1	2	3	2	1	2	3	2	2	2	41
Bur Buttercup					1	2	2	2	2	2	2	2	3	3	3	1	2	2	2	2	2	28
IndianRicegrass				2				1														3
Musk Mustard		2	2	1	2	2	2		2		2		1	1		1	2	2	2	2	2	22
Russian Thistle															1							1

Site 1 Belt 3

Winterfat	2	1	2	1	2	1	2	3	2	2	2	2	3	1	2	2	2	3	2	2	2	39
musk mustard	1		2		2		1		1		1		2	1	1	1					1	14
Bur Buttercup			1			3	2	2	2	3	2	3		2	3			2	2	2	2	31
Globe Mallow								2			1											3
IndianRicegrass									2	2	1	3		2	1	1	1					13
Squirrel Tail							1			1	1			1	1							5

Site 1 Frequency Totals

Winterfat - <i>Krascheninikovia lanata</i> (KRLA2)	
Musk Mustard - <i>Chorisporea tenella</i> (CHTE2)	
Flixweed - <i>Descurainia sophia</i> (DESO2)	
Bur Buttercup - <i>Ranunculus testiculatis</i>	
Indian Ricegrass - <i>Achnatherum hymenoides</i>	
Russian Thistle - <i>Salsola iberica</i> (SAIB)	
Globe Mallow - <i>Sphaeralcea grossulariifolia</i> (SPGR2)	
Squirrel Tail - <i>Elymus elymoides</i> (ELEL5)	



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



GSENM Vegetation Sampling November 2009
Nested Frequency Method

GSENM Site 2 - Revegetation Location

	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	Total	
Site 2 Belt 1																						
Russian Thistle	3	3	3	3		2		3	2	2	2	3	2	2	3	3	3	3	3	3	3	48
Crested Wheatgrass	1			2	2		1	1			1	1	1							1		12
Sego Lily					2	1																3
Site 2 Belt 2																						
Russian Thistle	3	2	2	2	2	3	2	3	3	2	2	3	3	3	2	2	2	2	2	2	3	48
Globe Mallow		1		1													1					3
Crested Wheat																1						1
Squirreltail																1	1	1	1			3
Rabbitbrush																	1	1				1
Sego Lily																		1	1			2
Site 2 Belt 3																						
Russian Thistle	3	2	3	3	2	2	3	1	2	3	2	2	3	2	3	2	2	2	2	3	2	47
Globe Mallow	3	2	1	1			1					1	1	1	1	1	1					14
Crested Wheat																						
Grass		2		1				2		1		1			1							8
Rabbitbrush									2											2		4

Site 2 Frequency Totals	
Russian Thistle - <i>Salsola iberica</i> (SAIB)	
Globe Mallow - <i>Sphaeralcea grossulariifolia</i> (SPGR2)	
Squirrel Tail - <i>Elymus elymoides</i> (ELEL5)	
Sego Lily - <i>Calochortus nuttallii</i> (CANU3)	
Crested Wheatgrass - <i>Agropyron cristatum</i> (AGCR)	
Rabbitbrush - <i>Chrysothamnus Nutt.</i> (CHRY59)	

GSENM Vegetation Sampling November 2009
Nested Frequency Method



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



GSENM Vegetation Sampling - November 2009
Nested Frequency Method

GSENM Site 1 - Winterfat Seed Source

	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	Total	
Site 1 Belt 1																						
Winterfat	2	1	2	2	2	3	2	2	1	2	3	2	2	2	3	2	2	2	2	2	2	41
Musk Mustard								1	1	2	1	2	2	2	1	1	2	2	2	1	1	19
Flixweed								1														1
Bur Buttercup								2	2	2	3				2	2				2	2	17
Site 1 Belt 2																						
Winterfat	2	1	2	3	1	2	3	2	2	2	3	1	2	3	2	2	1	2	3	2	2	41
Bur Buttercup					1	2	2		2	2	2	2	2	3		3	1	2	2	2	2	28
IndianRicegrass								1														3
Musk Mustard			2	2	1	2	2		2		2		1	1		1	2	2	2	2	2	22
Russian Thistle															1							1
Site 1 Belt 3																						
Winterfat	2	1	2	1	2	1	2	3	2	2	2	2	2	3	1	2	2	3	2	2	2	39
musk mustard	1		2		2		1		1		1		2	1	1	1					1	14
Bur Buttercup			1			3	2	2	2	3	2	3		2	3		2	2	2	2	2	31
Globe Mallow								2			1											3
IndianRicegrass									2	2	1	3			2	1	1					13
Squirrel Tail								1			1				1	1						5

Site 1 Frequency Totals	
Winterfat - <i>Kraschennikovia lanata</i> (KRLA2)	121
Musk Mustard - <i>Chorispora tenella</i> (CHTE2)	55
Flixweed - <i>Descurainia sophia</i> (DESO2)	1
Bur Buttercup - <i>Ranunculus testiculatis</i>	76
Indian Ricegrass - <i>Achnatherum hymenoides</i>	16
Russian Thistle - <i>Salsola iberica</i> (SAIB)	1
Globe Mallow - <i>Sphaeralcea grossularifolia</i> (SPGR2)	3
Squirrel Tail - <i>Elymus elymoides</i> (ELEL5)	5



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



GSENM Vegetation Sampling - November 2009
Nested Frequency Method

GSENM Site 2 - Revegetation Location

	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	Total	
Site 2 Belt 1																						
Russian Thistle	3	3	3	3	2	2	3	2	2	2	2	3	2	2	3	3	3	3	3	3	3	48
Crested Wheatgrass	1			2	2		1	1			1	1	1		1				1			12
Sego Lily					2	1																3
Site 2 Belt 2																						
Russian Thistle	3	2	2	2	2	3	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2	48
Globe Mallow		1		1													1					3
Crested Wheat																1						1
Squirreltail																1	1	1	1			3
Rabbitbrush																	1	1				1
Sego Lily																	1	1	1			2
Site 2 Belt 3																						
Russian Thistle	3	2	3	3	2	2	3	1	2	3	2	2	3	2	3	2	2	2	2	3	2	47
Globe Mallow	3	2	1	1			1					1	1	1	1	1	1					14
Crested Wheat																						
Grass		2		1				2		1					1							8
Rabbitbrush									2											2		4

Site 2 Frequency Totals	
Russian Thistle - <i>Salsola iberica</i> (SAIB)	143
Globe Mallow - <i>Sphaeralcea grossulariifolia</i> (SPGR2)	17
Squirrel Tail - <i>Elymus elymoides</i> (ELEL5)	3
Sego Lily - <i>Calochortus nuttallii</i> (CANU3)	5
Crested Wheatgrass - <i>Agropyron cristatum</i> (AGCR)	21
Rabbitbrush - <i>Chrysothamnus Nutt.</i> (CHRY9)	5

GSENM Vegetation Sampling - November 2009
Nested Frequency Method



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.



Next Generation Science Standards for Native Plant Restoration (Kanab UT)

2nd Grade

2-ESS2.A: Earth Materials and Systems

- Wind and water can change the shape of the land. (2-ESS2-1)

Students who demonstrate understanding can:

2-ESS2- Compare multiple solutions designed to slow or prevent wind or water from changing

1. **the shape of the land.** *[Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.]*

4th Grade

4-ESS2.B: Plate Tectonics and Large-Scale System Interactions

- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)

- Students who demonstrate understanding can:

4-ESS2- Analyze and interpret data from maps to describe patterns of Earth's

2. **features.** *[Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]*

5th Grade

5- ESS2.C: The Roles of Water in Earth's Surface Processes

- Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

- Students who demonstrate understanding can:

5-ESS2- Describe and graph the amounts and percentages of water and fresh water in various

2. **reservoirs to provide evidence about the distribution of water on Earth.** *[Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]*

Middle School

LS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

Students who demonstrate understanding can:

MS-LS2- Analyze and interpret data to provide evidence for the effects of resource availability

1. **on organisms and populations of organisms in an ecosystem.** *[Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]*

MS-LS2- Construct an argument supported by empirical evidence that changes to physical or

4. **biological components of an ecosystem affect populations.** *[Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]*





High School

LS2.A: Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (*secondary to HS-LS2-7*)
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.(*secondary to HS-LS2-7*) (*Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.*)

ETS1.B: Developing Possible Solutions

- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.(*secondary to HS-LS2-7*)

Students who demonstrate understanding can:

- HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]
- HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]
- HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]
- HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

