

Spring 2018

Environmental Restoration Database

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Environmental Restoration Database

Joao Nascimento.

April 2018



A.Introduction and Purpose

Environmental restoration projects face many challenges. Public awareness, funding constraints, unpredictable weather, unknown biological/chemical factors and the uncertainty about how the targeted ecosystem will develop work against the planned and ideal restoration.

One way the projects' efficiency can be improved is by using software tools for data and quality management systems, in order to share information, make field practice follow rules, keep track of maintenance tasks, measure results and, therefore, increase the rate of success by the amount of resources invested.

Since the conception of every project, all resources involved need to be focused and coherent to the final restoration goals. Rework and mistakes are highly undesirable and should be avoided.

Restoration works all over the world face these challenges. Add on top of that the usual difficulty on resource allocation, labor issues and insufficient knowledge of restoration professionals about good management practices, restoration works can turn into a quagmire of wrong decisions, poor management and waste of money. The sponsors won't be happy with losses.

Restoration is a big business today, and whoever works in this area needs to be cost efficient to win bids and be competitive. So, this is the main reason a management system is necessary to implement good administrative practices on restoration. Besides business management is not a skill frequently required for environmental professionals, when it comes for a real life projects those skills are essential. Like it or not, everything needs numbers, a figure, which represents how much resources (i.e. money) will be taken from some organization to be used on a restoration project. So, a management tool and set of procedures/good practices established on a computer database will definitely make restoration more productive.

Money and environment frequently are considered to be opposite to each other. The fact is that without wise money usage the environment can't be restored or preserved. Sponsors are willing to pay for restoration costs, provided they are necessary and justified. If they make profits or reduce losses, it's even better.

Good and correct information are crucial for a good job. A database can make it available for restoration workers when needed, and it's very true when many projects and sites have to be managed simultaneously. One of the core objectives of this project is to make restoration tasks easy to follow every participant in the project. Online field access will bring information on what to do on each site, preventing many errors during maintenance or monitoring.

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Furthermore, tasks will be updated by the field teams, reducing paperwork and filling-out errors, while making possible a fast feedback of field work.

This is the reason why some guidelines and routines should be established, with help of software tools, to make restoration more efficient with less resources. This means also more successful restoration with the same resources. If restoration works are efficient and successful, stakeholders will be more likely to support their costs, either direct or indirect ones. A good recordkeeping and monitoring routine can provide statistics and data to demonstrate the good results, or early detect the fails. Good data and metrics help the continuity of restoration projects and make statistical research much easier. This data can be used later for research, saving a lot of time on data tabulation.

Therefore, some duties could be safely delegated to people under training or without advanced specialization and experience.



B. Project Specifications

Every project requires some goals and minimum specifications. These items can change during project's phases, but they must exist to be the work guidelines.

These "customer" or "user" specifications were determined by the experience on what can go wrong, or be missed, or become hard to find or determined on a site restoration and greenhouse routine. After working for more than one year on this job and comparing to previous work experiences, the developer determined some tasks and data for which a better control would be highly recommended for efficiency purposes.

These preliminary ideas were used as the first requirements and specifications. During development, some improvements were done when feasible or when they would add value to this tool. The use of free and low cost software and hardware was sought as a way to prevent expensive maintenance costs and license fees as much as feasible.

Later on, when developing and adapting this system for BNRC under a grant, more features were added or adjusted to better fit the specifications of this end user.

System specifications:

- Area management screens with breakdown by project, site and section (polygon). Recording of site characteristics relevant for restoration, maps, links to restoration plans, coordinates, invasive species detected, address, photos, etc.
- Map visualization by links to Google Earth and other tools, like ArcGIS.
- Budgeting of restoration works with resource allocation, including labor and cost calculation hitherto and breakdown. Multiple budgets should be made and recorded for projects, sites or sections.
- Site Maintenance: task scheduling for sites, determined by site characteristics, like infestation, periodicity. Issuance of Service orders by e-mail for the supervisors/employees.
- Orchard/Greenhouse plant inventory management. Calculation of plants needed according site area and forecasts.
- Plant species database with key data for field work (photos) and projects
- Online and remote access for field work using internet to update and populate the database hosted at a website. Easy access to checking the species to keep and those to remove.
- Storage and access of plant maps for determining location on site where tall grass is present.
- Recording of monitoring data, like planted species population, weed infestation, using BRES* table data. It would be used either in the office or during field work, provided internet access is available at mobile devices.

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- Progress Analysis with statistics and graphs - helps research, problem detection and ahead planning. Can be used for monitoring data, budget, inventory, etc.
- Seed mix calculator, with stored mix data associated to sites for future reference.
- Password protected menus and features, if required.
- Printing of tags, signs, labels and other graphical info for site and plant identification, greenhouse tagging of tubes and pots.
- Easy and quick plotting of graphs from site monitoring data.
- System test with real users for adjustments and fix bugs.
- Instruction manual easy to follow for unexperienced users.
- User training.
- System designed for metric system.

These specifications and features are present in some similar management systems available in the market. However, I couldn't find a product with all these features aiming the environmental restoration and revegetation market.

Therefore, it's likely this system and its combined features have potential to be an useful tool for those involved.



C. Project Implementation

This project is divided into two parts:

- Identify good management practices, procedures and data records are necessary to be applied on environmental restoration routines in order to improve work efficiency, restoration success.
- Build these practices and procedures into a system or tool widely used today by workers.

If this project were done 50 years ago, it would be done with a set of instructions, forms and working procedures. Today, with the widespread use of computers and internet tools, this is the best way to build the project and provide a real value added solution for environmental restoration business.

At first glance, it might look this project is just an IT work, but in fact it has more to do with environmental restoration than IT. The tools used are available to common Microsoft Users without need of advanced courses.

Project's Steps.

1. Listing of preliminary system's specifications, problems to be solved, and resources needed.
2. Meetings with people involved with restoration works to determine key data used during restoration management, the system's features, and set up the project deliverables.
3. Obtain existing restoration data of projects already underway to include to the system's database and test it with real data.
4. Develop a prototype system using Microsoft Access software and accessories as needed.
5. Testing the system with future users using real data to make any necessary adjustments.
6. Write an User Manual
7. Train users on how to use the system.

The staff needed for working in this project is one graduate student to do all of developing project. A restoration ecologist and college professor was a supervisor and facilitator for interactions with BNRC.

Other restoration workers like a greenhouse manager and student workers participated in this project to provide data and to give opinions about which features would help them at work.

Most of time was spent building the database and system screens at MS Access, which is estimated at 95% of time or more. It involved building of data tables, input forms, queries, reports, URL tools and links to other applications like Google Earth.

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After each feature was created, it had to be tested with real or make-up data to make sure it worked as expected. Countless problems were found, which amongst my inexperience and lack of knowledge on the matter made the project duration longer than it should be. Many problems could be solved by searching solutions in discussion forums, or they had to be circumvented by some other way. There was no large code building, just some and it was easy for advanced MS Office users.

The online access for field works was tried using common available tools like Windows OneDrive or and telecommunication cellular services provided by major carriers.



D. System Screens

The following system's screens show the database features in the approximate order they appear.

Main menu with choices for screens



When the system is open with MS Access in a computer, the main menu appears with a set of options available for users.

Here the main categories of features can be accessed by clicking on screen buttons with the mouse. These buttons are the top of hierarchy tree.

Every button takes to another screen, or thread of screens, except the Close Database, which stop the application and MS Access.

D.1 Project, Site and Section Management

Clicking on this button:

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Project/Site/Section Mgmt

A selection screen pops up for choosing Project, Site and Section. Here the user can choose to add, search or edit projects, sites and sections. Sections can also be called as Polygons, which is an area within a site. There is also a task selection for site maintenance.

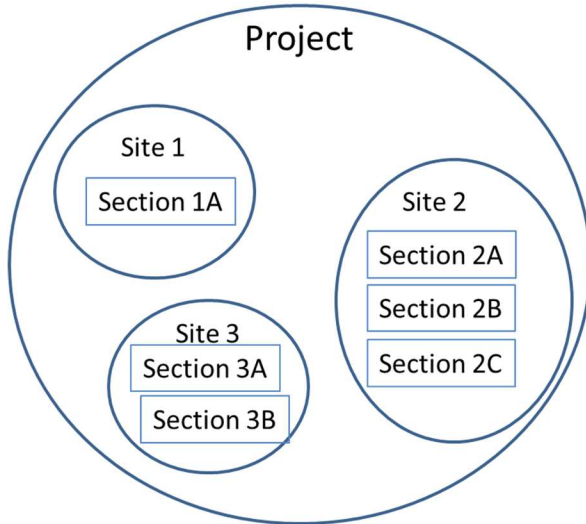
The screenshot shows a web interface for 'Area Management' and 'Site Maintenance'. The 'Area Management' section includes buttons for 'Create New Project', 'Project Search/Edit', 'Create New Site', and 'Site Search/Edit'. It features dropdown menus for 'Select Project' (currently showing 'Seminar Test') and 'Select Site' (currently showing 'Missoula Field'). The 'Site Maintenance' section includes a button for 'Add Tasks to a' and a dropdown menu for 'Select Section' with a list of options: 'Missoula Field Track', 'Missoula Field West Slope', and 'West Slope'.

This system has three tiers for restoration sites:

1. A restoration project, which can have one or more sites
2. A Site, which usually is an area for restoration which can be divided into different sections for restoration works, for example: north section, south section, Hill A, Hill B, Lagoon, flats, or whatever division the user chooses
3. A Section, which is a site subdivision, as described above.

The system can be used to manage different projects simultaneously, which is very usual in this business.

The next figure shows this division as sets.



A project is divided into sites, and sites are divided into sections. Each section has its own records. Projects and sections can be summarized to get overall statistics data.

D.1.1 Create New Project or Project Search/Edit

By clicking any of these buttons, the system will open a new screen for Project records. Depending on the button the user clicks, it will take for a screen where projects can only be created (Create New Project) or a screen for consult and/or edit existing projects (Project Search/Edit).



Project Screen, where a project is created.

Project Data	
Project Name:	<input type="text"/>
Manager:	<input type="text"/>
Restoration Project Info	
Code:	<input type="text"/>
Name:	<input type="text" value="Butte Native Plants"/>
Sponsors:	<input type="text" value="EPA Superfund, BS"/>
Starting Date:	<input type="text" value="1/1/2016"/>
Ending Date:	<input type="text" value="12/31/2017"/>
Objective:	<input type="text" value="Plant native plant species throughout Butte area on reclaimed or degraded areas, to create seed banks and propagation areas and help recover former vegetation."/>
Manager:	<input type="text" value="Robert Pal"/>
Developer:	<input type="text" value="Montana Tech"/>
Funding:	<input type="text" value="\$10,000.00"/>

Project Screen data

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This screen automatically assigns a code for every new project. All other data has to be input by the user. Autonumbered codes are assigned for sites and sections as well.

The buttons in the top right allow the navigation in project records and also add, delete, undo and close this screen when the job is done. This same set of buttons will be available in most of system screens.

The two blanks with binoculars buttons at their left allow the user search for projects registered with a specific name or for a manager. By filling a part of the name and clicking, the database will search projects which match this criteria. The user can then navigate within these results by clicking the arrows on the top right.

If the user made any change to project data, it will be recorded if he/she leaves the field or closes the screens.

The way data is added, edited or deleted is the same for all system's screens from now on, unless noted. Not all field are mandatory.

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D.1.2 Create New Site or Site Search/Edit

New sites can be created or edited under projects. For a site to exist in the system, a project needs to be created first. So, before accessing a site screen the user needs first to select a Project in the combo box, as follows.



After selecting a project, clicking Create a New Site or Site Search/Edit will take the user for the Section screen. When clicking on Site Search/Edit only the previously registered sites under the selected project will be shown.

Restoration Site

Site Code: 16

Name: Missoula Field

Project: Seminar Test

Address: W Pacific Street

City: Butte

State: MT ZIP: 59701

Landowner: BNRC

Latitude: 46.022266

Longitude: -112.543173

Attachment:

Hyperlink: D:\Users\jnasimento\Desktop\Ne...

Name	Date modif...	Type
all photos - 2 of 3		Environme... Manageme...

Ulch Ball Field

Nicabac

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- Name: Site Name Determined by user
- Project Name: same project pulled out from previous screen
- Address, City, State, ZIP and Landowner: General data for administrative purposes.
- Latitude and Longitude data must be entered in decimal degrees and with positive or negative signals depending if they are N, S, E or W.
- The Hyperlink field allows the user set a link to a document, like a site report or site restoration plan, or to a file folder with several files within.
- The attachment can be used to add files for the database. Hyperlink and Attachment have similar results. The difference between them is that Attachment add a file to the MS Access database itself, while the Hyperlink

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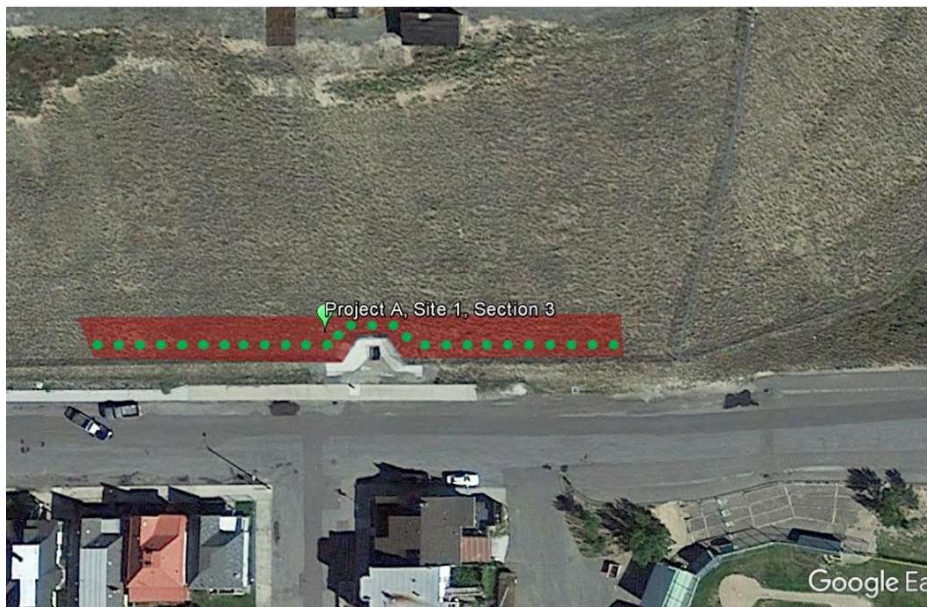


only stores to link for a folder or a file in a folder. Therefore, the Hyperlink is preferred for keeping the database slim and with fast access.

For example, a site map included on the Attachment or Hyperlink can open a map like this at Google Earth. Green is the whole site area, while the red patches are sections under restoration works.



Example of plant location map within a site and section. The green dots show the location of plants to help future site maintenance if the grass grows too tall.





Files or folders typed on Hyperlink field are shown on the bottom window. The example below shows an USDA plant guide PDF file that can be scrolled down for reading. This field can be an internet link or a local network folder.

If the user chooses to access data for a site already registered in the system, the key Site Search/Edit should be clicked. A green background screen pops-up with same data and Budget tab, as follows.

The screenshot displays the 'SiteSearch/Edit' interface. At the top, there is a navigation bar with icons for back, forward, search, and other functions. Below this, there are search fields for 'Find by Name' and 'Find by Code'. The main content area is divided into two tabs: 'Site Data' and 'Budget'. The 'Site Data' tab is active, showing the following information:

- Site Code: 1
- Name: Anselmo Mine
- Project: Butte Native Plants
- Address: Caledonia St,
- City: Butte
- State: MT ZIP: 59701
- Landowner: Butte Silver Bow County
- Latitude: 46.01737
- Longitude: -112.54747
- Attachment: [Redacted]
- Hyperlink: C:\BNRC Project\SITE RESTORATIO

To the right of the form is a map view showing an aerial view of the site with a yellow star icon and the label 'Anselmo Mine'. Below the map are links for 'Privacy and Cookies', 'Legal', 'Advertise', and 'About our'. At the bottom of the interface, a large white box contains the text:

SITE RESTORATION PLAN
MISSOULA FIELD

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Under the Site screen there is a Budget Tab. Budgets can be created at Budget screen (option available at Main Menu) and selected for a site. For a budgets, the user must use the budget screen. At this site screen the user can only select and lock a budget to be assigned for a site.

SiteSearch/Edit

Restoration Site

Find by Name: Find by Code:

Site Data Budget

Select budget # to apply: 10 Lock Budget to Site Grand Total: \$7,929.00

Description	Cost per Unit	Quantity	Total	Typeofitem
Spade	\$18.00	1	\$18.00	Tool
Auger (drill only)	\$20.00	2	\$40.00	Tool
Plant Oenotera	\$5.00	100	\$500.00	Plants
Creeping Juniper Plant	\$5.00	100	\$500.00	Plants
Artemisia Tridentada	\$5.00	150	\$750.00	Plants
Logpole	\$6.00	50	\$300.00	Plants
Ponderosa	\$7.00	20	\$140.00	Plants
Willow	\$4.00	20	\$80.00	Plants
Aspen	\$5.00	30	\$150.00	Plants
Fence 4 ft high, steel braided, g,	\$35.00	20	\$700.00	Planting supply
Graduate Student	\$15.00	20	\$300.00	Labor
Laboratory Assistant	\$12.00	320	\$3,840.00	Labor
Supervisor	\$25.00	20	\$500.00	Labor
Fuel - Gasoline with oil for 2-str	\$3.00	2	\$6.00	Fuel
Mileage - Truck travel	\$1.00	80	\$80.00	Consumable
Herbicide	\$25.00	1	\$25.00	Consumable

Right click in any of these labels to sort

The screen also shows the resource allocation, type, quantity, unit cost, total cost and grand total. Resources can be sorted by any of the criteria on the top of the list.



D.1.3 Create New Section or Section Search/Edit

For the Section (Polygon) screen the user must select the project and site. When choosing a site, only the sites previously registered under the selected project will be shown. The same happens when selecting the Section Search/Edit screen. In this case, only sections already registered under a project and site will be shown for the user.

The screenshot displays a web interface with two main sections. The top section, titled "Area Management", includes a close button (red 'x') and two buttons: "Create New Project" and "Project Search/Edit". Below these are a "Select Project" dropdown menu with "Seminar Test" selected, and two buttons: "Create New Site" and "Site Search/Edit" (which is highlighted with a dashed border). The next section, "Select Site", features a dropdown menu with "Missoula Field" selected, and two buttons: "Create New Section" and "Section Search/Edit". The bottom section, titled "Site Maintenance", contains a "Select Section" dropdown menu and an "Add Tasks to a Section" button.



Section Data

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General Info
Land Info
Seed Mix

<p>Project: <input type="text" value="Seminar Test"/></p> <p>Section Code: <input type="text" value="9"/></p> <p>Name: <input type="text" value="Missoula Field West Slope"/></p> <p>Landowner: <input type="text" value="Butte Silver Bow County"/></p> <p>Address: <input type="text" value="Missoula Avenue"/></p> <p>City: <input type="text" value="Butte"/></p> <p>State: <input type="text" value="MT"/> ZIP: <input type="text" value="59701"/></p> <p>Latitude: <input type="text" value="46.022399"/></p> <p>Longitude: <input type="text" value="-112.543009"/></p> <p>Total Area: <input type="text" value="7,436.00"/> square meters</p>	<p>Section Site: <input type="text" value="Missoula Field"/></p> <p>Climate Zone: <input type="text" value="13b"/> +18.3 to +21.1 deg C</p> <p>Climate: <input type="text" value="Bsk"/></p> <p>Soil: <input type="text" value="capping"/></p> <p>Comments:</p> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 5px;"> capping soil brought from Bozeman. Infestation of invasives, like Alfalfa, Baby's breath, Knapweed </div>
---	--

This section screen shows data in different tabs. Sections of a same site can be found by the record selectors at top right. The Seed Mix tab doesn't appear when creating a new section. It is available only at Section Search/Edit, when editing an existing section.

The same data fields existing for a site are also shown in the Section Data screen. However, the user has to type them again as a site can have different access address, coordinates and so on.

There are more data fields in this screen, as follows:

- Total area: section area
- Climate zone: determines the minimum yearly temperature at this section according climate hardiness zone map.
- Climate: Koppen-Geiger climate classification
- Soil: soil type for this section
- Comments: any useful information concerning to the site restoration works



The Section Data screen also has a Land Info tab. More data fields are available:

Section Data

General Info | **Land Info** | Seed Mix

KMZ map:

Soil Status:

Photos before:

Photos on project:

Photos after:

Planting map:

Wildlife:

Fish:

BaselinePlantList:

- Achillea millefolium
- Agoseris glauca
- Alfalfa
- Allium cernuum
- Allium textile
- Alnus incana

Achillea millefolium, Allium cernuum, Apocynum androsaemifolium, Arnica cordifolia

- KMZ map: insert a KMZ file extension Google Earth link (or ArcView) with the section map. Google Earth will open when the user clicks on this link. Additional Google Earth configuration may be required to automate this feature.
- Soil Status: soil conditions, like eroded, contaminated with lead, green field, and others.
- Photos before: link to a folder containing section photos before restoration works
- Photos after: link to a folder containing section photos during and/or after restoration works.
- Planting map: map or sketch with plant locations in the site.
- Wildlife: data regarding existing section wildlife, like deer presence, beavers, birds, frogs.
- Fish: fish present at the site.



Both Wildlife and Fish data can be used to store relevant data for the restoration project. For example, fauna can harm plants, or fish can prevent the site from being sprayed with fish-harmful herbicides.

- **Baseline Plant List:** the user can select a baseline plant list for the site before restoration works start. Every plant species checked will be shown at the text box below for easy reading.

Section Data

General Info
Land Info
Seed Mix

Select Seed Mix Mix 1

Area Applied 2 sq meters

Weight Used 40 kg

Sowing Date 1/14/2018

Grass/Forb Species	%
Achillea millefolium	0
Danthonia spicata	5
Danthonia spicata	10
Danthonia spicata	5
Danthonia spicata	10
Danthonia spicata	5
Danthonia unispicata	10
Festuca Gigantea	5
Danthonia unispicata	10
Festuca scabrella	5
Koeleria macrantha	5

The third TAB available is used to store Seed Mixes applied to the section. It supports more than one mix for the same section sowed at different dates and areas. The data shown in this screen is pulled out from Seed Mix Calculator screen. Previously stored Seed Mixes (at Seed Mix Calculator) can be selected at the combo box at top left and saved for this section with area applied, weight used and sowing date. Several seed mixes can be applied for the same section, because a restoration project can sow different seed mixes for the same section over years of restoration works.



D.2 Site maintenance screen

Site maintenance screen, with scheduled tasks. Task include workers, description, cost, and some comments to help planning ahead and prevent resources being forgot.

By setting up workers for each task, they can check their schedules and assignments for the period and get e-mail warnings.

Description	End Date	Start Date	Employee	Section Name	Comments	Code	Months	Rec	Don't forget	Compl
Cleaning	22-Jan-18	22-Jan-18	Joao Nascimento	Missoula Field	Clean Debris	S0000014		0	Cleaning Supp	2/
Mowing	23-Jan-18	23-Jan-18	Joao Nascimento	Missoula Field		S0000015		0	Lawnmower, F	2
Tagging	24-Jan-18	24-Jan-18	Krystal	Missoula Field	Flagging locati	S0000016		0	Tags, Sharpie,	2
Seeding	25-Jan-18	25-Jan-18	Robert Pal	Missoula Field		S0000017		0	Seeds, Plastic	
Monitoring	08-Feb-18	08-Feb-18	Joao Nascimento	Missoula Field		S0000018		0	Quadrant, Fiel	
Spraying	09-Feb-18	09-Feb-18	Joao Nascimento	Missoula Field		S0000019		0	Backpack spray	
*				Missoula Field		(New)		0		

This screen can be used to set tasks for a section, like monitoring, maintenance, planting, watering, weeding and others.

Each task is automatically assigned an individual code. The user input fields are:

- Description: What to be done in the site. The system provides a comprehensive list of tasks to be selected by this combo box.

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- Start Date: Date the task should either happen (for short term tasks) or started.
- End Date: Date the task is expected to be completed according user scheduling.
- Employee: Employee responsible to execute the task or the team supervisor
- Months: A task can be assigned a monthly recurrence, so every selected month this task will be shown in a to-do list in the system.

Under each task the user can assign resources for each scheduled task. The resources can be labor, tools, supplies, fuel, etc. So, the employee in charge of this task can have an idea of what should be taken to the section, and the estimated resources to be spend on each specific task. It helps keep control of the budget and do not spend more than planned.

The user starts selecting the type of resource, then the resource's description. At this point the system will autofill the cost per unit and the unit for this resource.

In the next step the user types the quantity of the resource to be assigned for this task and clicks on the Save button. Assigned resources can also be browsed, edited and deleted with the buttons in the same area.



D.3 Resource Configuration

For the resources to be selected to a budget or to a task, they need to be created first in the system, so they can be applied throughout all database screens.

Resources fall into categories for easy sorting and search, and statistical calculation as well.

The resources require some data to be sorted and selected at other system's screens.

- **Type of resource:** It's the category of the resource. It helps finding the resource amongst many available in the system and allows breakdown calculations when doing budgets.
- **Description:** name of the resource to be created
- **Suppliers:** organizations, business or people which can provide the resource
- **Unit:** The measuring unit the resource is supplied, like Kg for sugar, man/hour for labor, gallons for liquids. The system can store the same resource in different units, like pot mix in kg and ton, or cubic meter. Resources in different units will be different records.
- **InStock:** The user may control the inventory for a resource, if needed.

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- Cost per Unit: The unit cost is required to perform budget calculations. It should include an estimate of taxes, fees and labor taxes for man/power. It should be the final cost to be paid by the user.
- Comments: this field can be used to store any extra information about the resource, like specifications, special instructions for purchasing, handling or storage, etc.



D.4 Plant Species - New and Search/Edit

This screen is used to store data for plant species. The user can either register new plant species in the database or search/edit existing plant records.

Plant Species Database

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Find by Code

Find by Common Name 🔍

Find by Scientific Name 🔍

PlantCode **Six Letter Code**

Scientific Name

Common Name

Planting Method

Plant Type **Invasive ?**

Plant Hardiness

Planting Period Start


Planting Period End

Weeding Months

Seeds per Kilogram

Datasheet

Photo



United States Department of Agriculture

Natural Resources Conservation Service

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- Plant Code: Autonumbered code assigned for plant species registered in the database. No user action required.
- Six Letter Code: USDA six letter code for easier plant species identification
- Scientific Name: Scientific Name of plant species
- Common Name: popular name of plant species
- Planting Method: Pot, seedling, sowing, saplings,
- Plant type: tree, shrub, forb, graminoid
- Plant Hardiness: classification of minimum yearly temperature the plant can withstand
- Plant period start: start of planting season for this plant
- Plant period end: end of planting season for this plant
- Weeding months: Months when weeding is recommended to encourage good survival rates and growth
- Seeds per Kilogram: data used for Seed Mix Calculator. Provided by USDA or other reliable sources
- Datasheet: link to internet or network drive file, which can redirect the user for a plant datasheet or other useful information
- Photo: link to internet or network drive file containing BMP photo for plant species. It helps identify how the plant species looks like during field work.



D.5 Monitoring Data

The Restoration Management System can record monitoring data in three different types of forms:

- BRES Form
- MTech Form
- Population Statistics

The data can be typed at desktop computers, notebooks in the field with internet and VPN access, and, for the Population Statistics Form, also in tablets without internet access for later data upload by the user.

The main screen for monitoring data allows the user to select parameters for adding new data or search previously stored data and ask the system to plot graphs or make reports.

Monitoring Data
✖

Select Criteria for Monitoring Data

Project	<input type="text" value="Butte Native Plants"/>	Plant Species	<input type="text"/>
Site	<input type="text" value="Anselmo Mine"/>	Start Date	<input type="text"/>
Section	<input type="text" value="BNP001 - Anselmo Mine Dr"/>	End Date	<input type="text"/>
Date	<input type="text"/>		

Add Monitoring Data - BRES Form

Search/Edit Data - BRES Form

Search By Date - Bres Form

Add Section Population Batch

Search Section Population to Monitor

Import Field Data

Add Monitoring Data - MTech Form

Search Monitoring Data - MTech Form

Search By Date - MTech Form

Plot Soil Cover Graph

Plot Plant Species Statistics

Plot Plant Species Statistics Aggregated



The user can select the project, site and section to add data and click on the Add Buttons for each type of form. The combo drop down lists will only show sites under the previously select project, and sections under previously selected sites. Therefore, the user must first select a project, then a site, and a section at the last.

If searching for monitoring data the user must select project, site and section and click on search. If the user is looking for monitoring data of a specific date, then the date field should be filled. Then the user can click on the search button for whatever form he/she wants.

For soil cover graph and plant species statistics graph, the user must select also the date range and the plant species to be plotted.

Monitoring Data ✖

Select Criteria for Monitoring Data

Project	<input type="text" value="Butte Native Plants"/>	Plant Species	<input type="text"/>
Site	<input type="text" value="Anselmo Mine"/>	Start Date	<input type="text"/>
Section	<input type="text" value="BNP001 - Anselmo Mine Dr"/>	End Date	<input type="text"/>
Date	<input type="text" value="2/27/2018"/>		

Add Monitoring Data - BRES Form

Search/Edit Data - BRES Form

Search By Date - Bres Form

Add Section Population Batch

Search Section Population to Monitor

Import Field Data

Add Monitoring Data - MTech Form

Search Monitoring Data - MTech Form

Search By Date - MTech Form

Plot Soil Cover Graph

Plot Plant Species Statistics

Plot Plant Species Statistics Aggregated



BRES Monitoring Form cover stores monitoring data chosen by Butte Remediation and Evaluation System.

SITE MONITORING FORM (BRES Standard)

Project: >>> Site: >>> Section:

Monitored Section ID: Date:

Team Members:

<p>Vegetation % of ground covered by:</p> <p>Live Desirable Species <input type="text" value="55"/></p> <p>Live Undesirable weedy species <input type="text" value="10"/></p> <p>Noxious weeds <input type="text" value="5"/></p> <p>TOTAL % LIVE <input type="text" value="70"/></p> <p>Litter <input type="text" value="20"/></p> <p>Rocks > 2% <input type="text" value="10"/></p> <p><small>*Up to 5% of undesirable species and 0% of noxious weeds may count toward live cover.</small></p> <p>Species present</p> <p>Sheep Fescue <input type="text" value=""/> <input type="text" value=""/></p> <p>Crested Wheatgrass <input type="text" value="Infrequent"/> <input type="text" value=""/></p> <p>Slender Wheatgrass <input type="text" value=""/> <input type="text" value=""/></p> <p>Yellow Sweetclover <input type="text" value=""/> <input type="text" value=""/></p> <p>Alfalfa <input type="text" value="Infrequent"/> <input type="text" value=""/></p> <p>Other: <input type="text" value=""/> <input type="text" value=""/></p> <p><input type="text" value=""/> <input type="text" value=""/></p> <p><input type="text" value=""/> <input type="text" value=""/></p> <p><input type="text" value=""/> <input type="text" value=""/></p> <p><input type="text" value=""/> <input type="text" value=""/></p>	<p>Erosion (BLM Form)</p> <p>Surface Litter <input type="text" value="20"/></p> <p>Surface Rock Movement <input type="text" value="0"/></p> <p>Pedestalling <input type="text" value="0"/></p> <p>Flow Patterns <input type="text" value="0"/></p> <p>Rills <input type="text" value="0"/></p> <p>Gullies <input type="text" value="0"/></p> <p>Soil Movement <input type="text" value="0"/></p> <p>Weeds Present</p> <p>Spotted Knapweed <input type="text" value=""/> <input type="text" value=""/></p> <p>Dalmatian Toadflax <input type="text" value=""/> <input type="text" value=""/></p> <p>Cheatgrass <input type="text" value=""/> <input type="text" value=""/></p> <p>BabysBreath <input type="text" value="Infrequent"/> <input type="text" value=""/></p> <p>Kochia <input type="text" value="Infrequent"/> <input type="text" value=""/></p> <p>Thistle <input type="text" value=""/> <input type="text" value=""/></p> <p>Other: <input type="text" value=""/> <input type="text" value=""/></p> <p><input type="text" value=""/> <input type="text" value=""/></p> <p><input type="text" value=""/> <input type="text" value=""/></p> <p><input type="text" value=""/> <input type="text" value=""/></p>	<p><input type="checkbox"/> lime rock barrier <input type="checkbox"/> depositional area</p> <p><input checked="" type="checkbox"/> more weeds <input type="checkbox"/> steeper slope</p> <p><input type="checkbox"/> increased erosion <input type="checkbox"/> less vegetation</p> <p><input checked="" type="checkbox"/> gullies</p> <p>Estimate width of affected edge <input type="text" value="0"/> ft</p> <hr/> <p>Exposed Waste Material <input type="checkbox"/></p> <p>Estimated pH <input type="text" value="0"/></p> <p>Approximate Area <input type="text" value="0"/> sq ft</p> <p>Number of areas with exposed waste <input type="text" value="0"/></p> <hr/> <p><input type="checkbox"/> BulkSoilFailure <input type="checkbox"/> LampSlumps</p> <p><input checked="" type="checkbox"/> Subsidence</p> <hr/> <p>BarrenAreas <input type="checkbox"/></p> <p><small>* At Least 75 ft2 * Not a rock outcrop *Less than 10% total cover (live and litter)</small></p> <p>Number of Barren Areas <input type="text" value="0"/></p> <p>Do barren areas cover over 25% of polygon? <input type="checkbox"/></p> <hr/> <p>Gullies Present? <input checked="" type="checkbox"/></p> <p>Are any gullies actively eroding? <input type="checkbox"/></p> <p>Gullies Number <input type="text" value="2"/></p>
--	--	--

The user can either type or select the data found during field work to register it to the database.



To Add a new population monitoring, the user must select a project, site and section first, then Click at Add Section Population Batch. The following screen will be shown.

Plant Population - Start new batch

Batch Monitored

Project

Site

Section

Planting Date

Plant Species	Date	Population	Batch Monitored
*		0	



Plant Population - Start new batch

Batch Monitored:

Project:

Site:

Section:

Planting Date:

Plant Species	Date	Population	Batch Monitored
* <input type="text" value="Achillea millefolium"/>		0	Batch 1

A Batch Name (Batch 1, for example) and a Planting Date must be input to start a new population batch.

The system requires counting plant population in batches because planting can be repeated over time in a restoration project, and every time a section is planted, it may have different species and/or the same species planted before. Different section can have batches with same name, for example, several sections may have a planting batch named Batch 3.



Plant Species	Date	Population	Batch Monitored
Arnica genus	3/1/2018	100	Batch 1
*		0	Batch 1

Plant species and their starting population can be typed in the list, where "Arnica genus" is listed. It's not needed type them in order, like planting date or alphabetical plant species order. The system will organize this data when necessary.

When add new population monitoring data to an existing batch, the button Search Section Population to Monitor should be clicked. It opens a new screen which allows data from all batches related to the selected section to be open.



Plant Population - Input new monitoring data

Batch Monitored

Project

Site

Section

Planting Date

Plot Plant Species Graph

Choose Plant Species

	Plant Species	Date	Population	Batch Monitored	Batch ID
*	<input type="text"/>	<input type="text"/>	0	(New)	

The user must select the batch to receive new data in the top left combo box. The screen will show the planting date for each batch after selection.



Plant Population - Input new monitoring data

Batch Monitored Batch 3 ⏪ ⏩ ⏴ ⏵

Project Seminar Test

Site Missoula Field

Section Missoula Field Track

Planting Date 2/22/2018

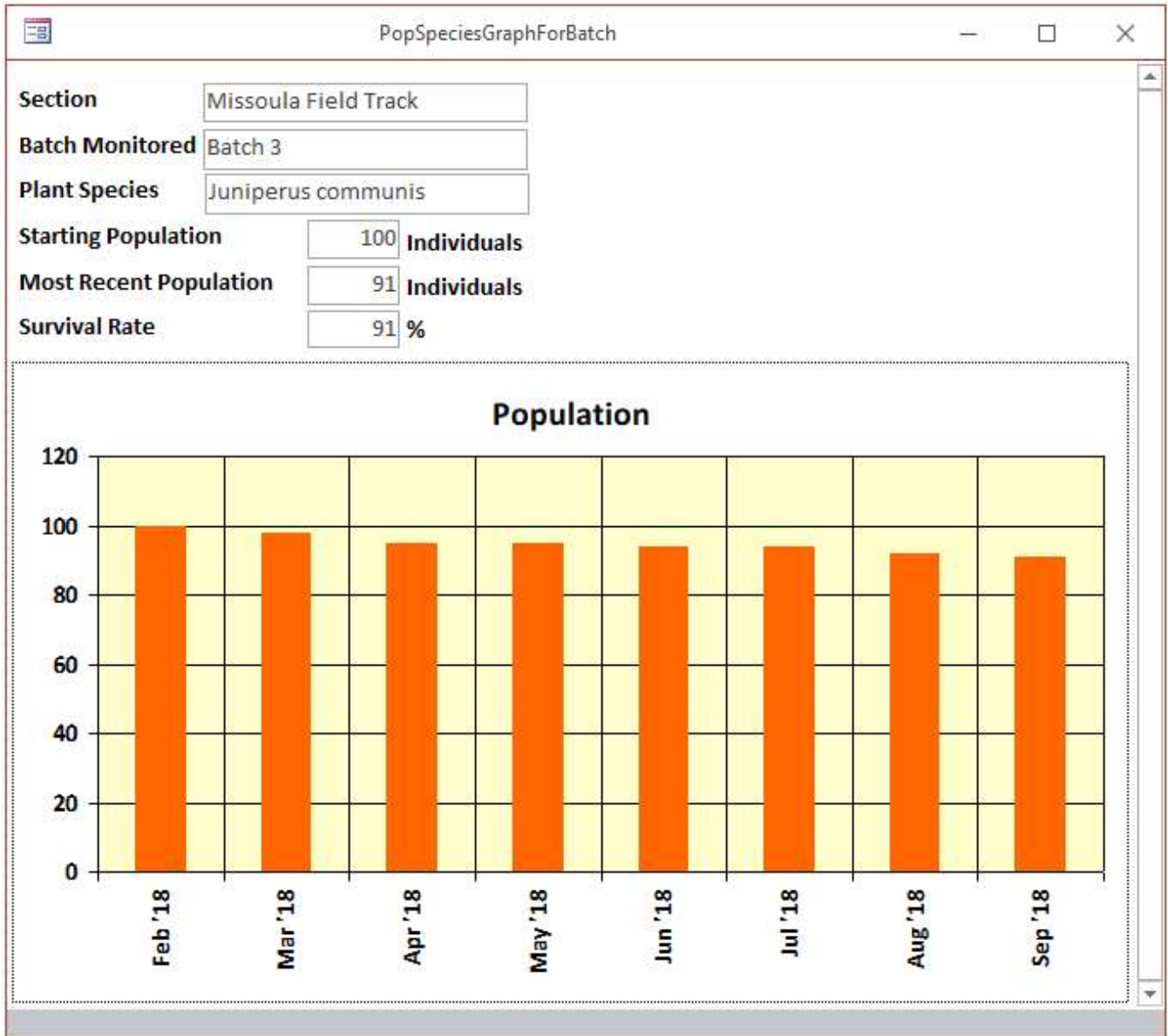
Plot Plant Species Graph

Choose Plant Species

Juniperus communis Plot Chart

Plant Species	Date	Population	Batch Monitored	Batch ID
Juniperus communis	2/22/2018	100	8 Batch 3	
Hymenoxys acaulis	2/22/2018	200	9 Batch 3	
Hymenoxys acaulis	2/28/2018	180	11 Batch 3	
Juniperus communis	3/28/2018	98	12 Batch 3	
Juniperus communis	4/4/2018	95	14 Batch 3	
Hymenoxys acaulis	3/4/2018	178	15 Batch 3	
Juniperus communis	5/15/2018	95	16 Batch 3	
Hymenoxys acaulis	3/15/2018	175	17 Batch 3	
Juniperus communis	6/22/2018	94	18 Batch 3	

After selecting the Batch (in the example Batch 3), all previously stored data is shown in table style. To plot a plant species population over time, choose the plant species on the right combo box and click in the Plot Chart Button.



A column chart is plotted with section, batch, plant species, number of plants planted in the section and the most recent population monitored. The system also calculates de survival rate over the period.



Site Monitoring Form (MTech Type)

Plant Pop. Report Print Monitoring
Export Plant Pop. Print this record

Monitoring ID: 20 Date: 16-Jan-17
 Employees: Joao Nascimento
 Site: Smelter Hill Section: Hill - Northeast Slope
 Latitude: 46.1234 Aspect: South
 Longitude: -112.9821 Slope: 12 deg
 Elevation: 1750 meters
 Target Invader: Gypsophila paniculata

	%	mm
Bare Material Soil	50	Veget Height 1: 250
Pebble	20	Veget Height 2: 200
Cobble	1	Veget Height 3: 180
Rock	8	Veget Height 4: 150
Rodent	0	Veget Height 5: 120
Deer Feces	1	Litter Height 1: 18
Cryptogamic	10	Litter Height 2: 20
Litter	30	Litter Height 3: 15
Overstory	20	Litter Height 4: 25
Basal Ground Cover	15	Litter Height 5: 22

PlantSpecies	PercentCoverage	IndividualsNumber
Lolium perenne	0	0
Alfalfa	50	48
*	0	0

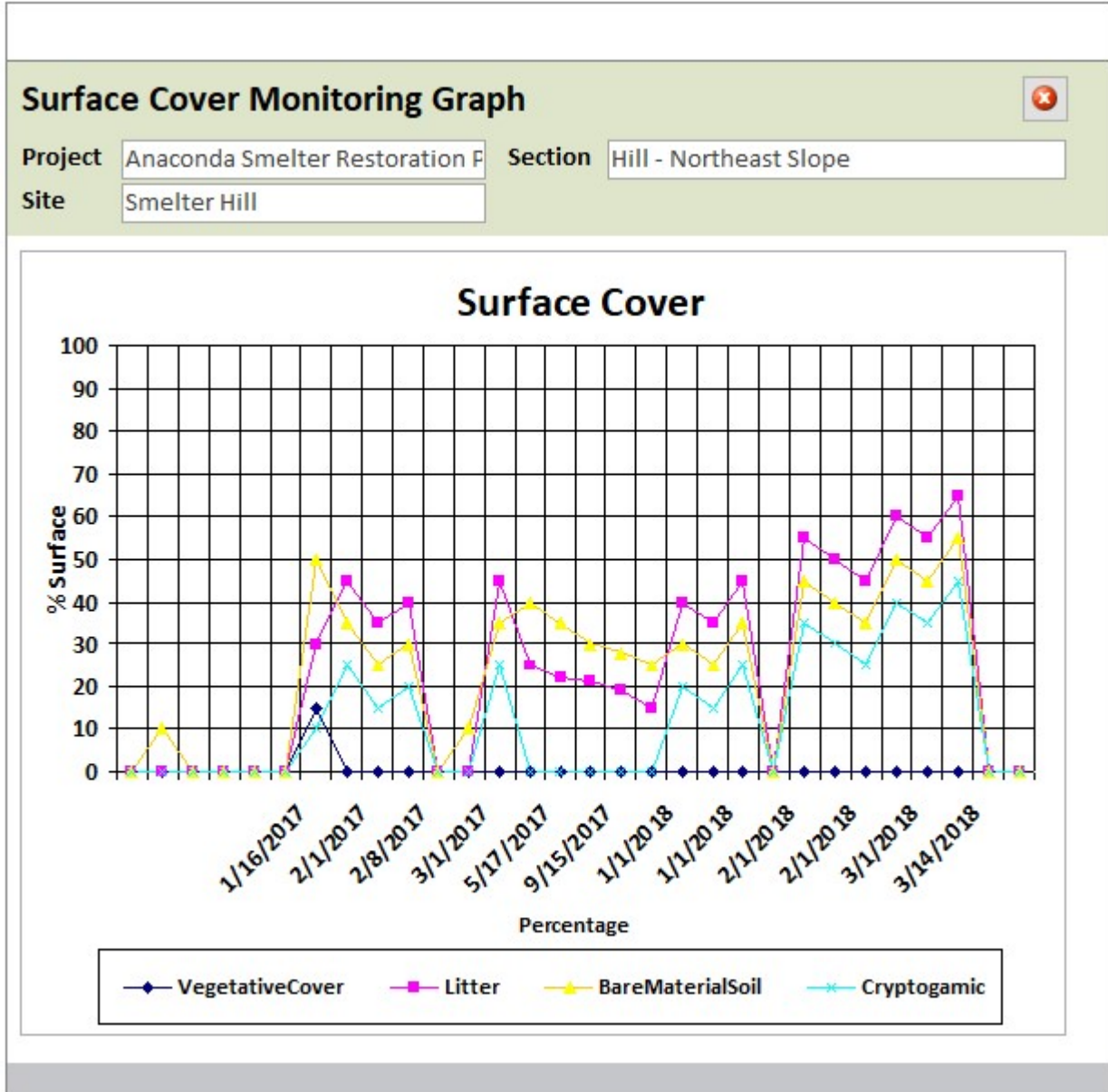
Comments

When clicking on the MTech Monitoring Forms, the systems opens a monitoring form used for general restoration purposes. It has several parameters present in other form, like general site info, but also more data for the soil cover. It's usually applied for quadrant monitoring.

Plant species found in this monitoring can be registered at the left table, with scientific name, percent coverage and number of individuals found on each quadrant.

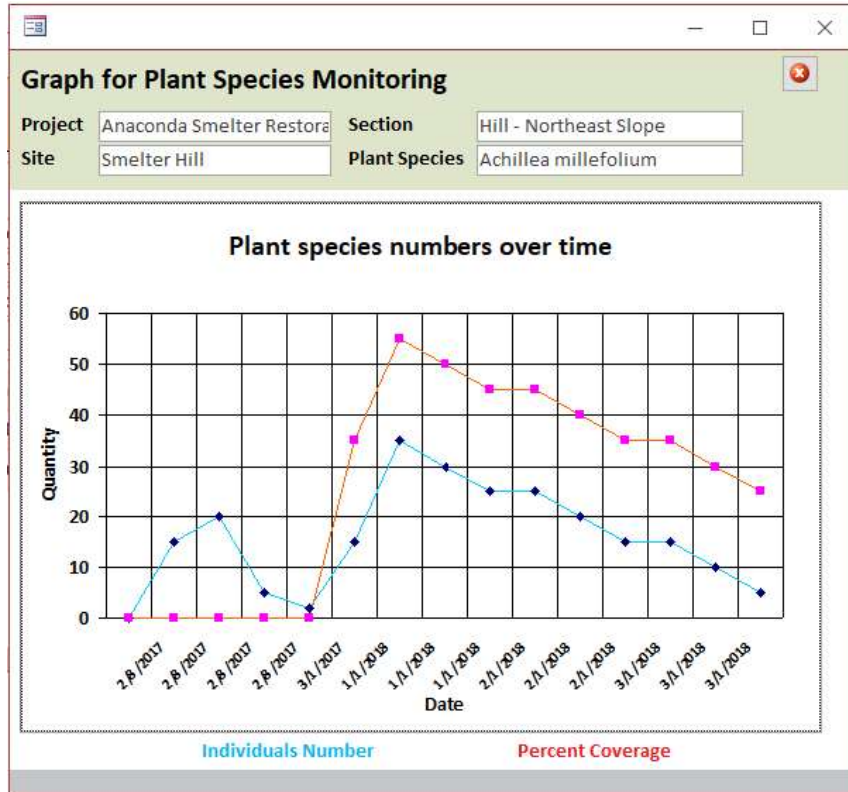


The soil Cover Monitoring Graph plots data from quadrant monitoring over time for the selected section.





The Plant Species Monitoring Graph plots both the Individuals number in quadrants and percentage of soil coverage for the species.





D.6 Plant Batches At Greenhouse

This screen can be used to manage plant batches in nurseries, greenhouses or orchards. It helps tracking the plant origin since seed collection location, seed bag in stock and the final planting spot.

As many state regulation require planting of native species with local origin to best fit climate and genetic issues, only a careful tracking of origin and destination can assure the restoration project complies with legal requirements.

Plant Batch Inventory at GreenHouse ✕

⏪ ⏩ ⏴ ⏵ 📄 ✖ ↶ ✓

Plant Species Search
 🔍

Batch 1 of 11

Batch ID

Scientific Name

Initial Quantity **Pot Size**

Qty After Winter **Date Planted**

Quantity Available **Date Last Update**

Seed Origin

Seed Bag Used

Comments

Plant Allocation

Project

Site

Section

Allocate Plants to Section

Number of Plants

Allocation Summary

Allocation Number **Plant Batch ID**

Project

Site

Section

PlantSpecies

Quantity Allocated **Pot Size**

Date To Plant **Allocation Date**

Record: ⏪ 1 of 18 ⏩ 📄 No Filter Search

Tasks for a Batch

⏪ ⏩ ⏴ ⏵ 📄 ✓ ↶ ✖ ⊕

Task Code **Batch for this task**

Task Description

Scheduled Task Date

Start Date **End Date**

CompletionDate

Employee

Comments

Record: ⏪ 1 of 5 ⏩ 📄 No Filter Search

The user may search plant batches according plant species, on the combo box in the top and click in the magnifier glass button.

To enter a new plant batch, click on the new record button and the system will open a completely empty plant batch screen to enter data.



The data fields are:

- **Batch ID:** This field is autonumbered by the system to give an unique ID for the plant batch.
- **Initial Quantity:** The initial number of good planting tubes or saplings in the starting of the batch.
- **Pot Size:** Type of pot used for this batch, like 10 cu in pot, 1 gallon pot, etc.
- **Date Planted:** Planting date for this batch
- **Quantity after winter:** plants aliver after overwintering
- **Quantity available:** most recent quantity of live plants in this batch good for planting.
- **Date Last Update:** Date when the quantity available was updated after inventory counting.
- **Seed Origin:** Place from where the seeds or saplings came from to make this batch, as registered at the Seed Collection Location screen. It will show as options only the places registered for the plant species chosen
- **Seed Bag:** Seed bag in the Seed Stock from where the seeds came from to plant this batch. Only the seed bags registered in Seed Stock for the selected plant species will be shown as options.
- **Comments:** general information data field

This screen has also a Tasks for a Batch area, where the user can schedule tasks for this batch in the same way tasks are assigned for Sections under restoration. The fields are:

- **Task Code:** unique identifier for this task. This value is autonumbered by the system
- **Batch for this Task:** Batch which this task is assigned for
- **Task Description:** what should be done in this batch
- **Scheduled Task Date:** date the task should be executed
- **Start Date and End Date:** Determine a period for continuous tasks
- **Completion Date:** Date when the task was completed
- **Employee:** employee in charge of this task
- **Comments:** general information field

This screen can also be used to allocate plants of this batch for a Section under restoration. The user must select the Project, Site and Section, then type the quantity of plants to be allocated for the section and click the button Allocate Plants to Section.

At this point, the system will reduce the amount of plants available in this batch, reducing the field Quantity Available. The system blocks allocations when the quantity available would be less than zero plants.

Environmental Restoration Database



The Allocation Summary area show all allocations made for this batch. The user can browse through allocations by clicking the arrows in the bottom of this area.

Environmental Restoration Database



D.7 Facility / Equipment Task Set Up

This screen can be used to schedule and control tasks for facilities like a greenhouse, orchard, laboratory and other buildings operated by the user and organization. It can also be used to schedule maintenance tasks for equipment, like oil change for trucks, preventive maintenance of sprinklers, lawnmowers, water pumps, calibration of scales and other instruments, etc.

Facility / Equipment Task Set UP

Search By Facility ▼ ▼
Search By Date ▼

Search By Description ▼ ▼
Completed by ▼

Incomplete by ▼
Incomplete Today ▼

Task Code

Facility ▼

Description ▼

Employees ▼

Recurrence

Comments

Completion Date

Task Date

Start Date

End Date

Months

Resources for this facility/equipment task

Task Code
Type of Resource ▼

ItemDescription ▼

CostperUnit **Unit**

Quantity

Total

Record: ◀ ▶ 1 of 2 ▶▶ ⌵ No Filter

<	Description ▼	Task Code ▼	End Date ▼	Facility ▼	Employees ▼	Start Date ▼	Commer
	⊕ Spraying ▼	F0000007		Orchard	Joao Nascimer		
	* (New)						



The user can either enter new tasks, or modify and reschedule existing tasks, edit the resources needed. Search options can be chosen at the top of the screen:

Task list shown can be filtered by facility it should occur, description, due date. The user can also search for tasks incompletes by a certain date, completed by a date, or incomplete at the current day. This last one can be chosen by just clicking a check box to update data in this screen.

Every time a task is completed, its completion date should be registered in the system, so it will not show up anymore unless the user chooses to see it by unchecking the Incomplete Today check box.

Each new task is automatically assigned an individual code. The user input fields are:

- Facility: Which facility or equipment the task is assigned for.
- Description: What to be done in the facility or equipment. The system provides a comprehensive list of tasks to be selected by this combo box.
- Task Date: Date the task is due.
- Start Date: Date the task should start, for continuous tasks.
- End Date: Date the task is expected to be completed according user scheduling.
- Employee: Employee in charge of the task or the team supervisor
- Months: A task can be assigned a monthly recurrence, so every selected month this task will be shown in a to-do list in the system.
- Comments: general information data field
- Completion Date: Date when the task was completed.

Under each task the user can assign resources. The resources can be labor, tools, supplies, fuel, etc. So, the employee in charge of this task can have an idea of what should be taken to the facility, and the estimated resources to be spend on each specific task. It helps keep control of the budget and do not spend more than planned.

The user starts selecting the type of resource, then the resource's description. At this point the system will autofill the cost per unit and the unit for this resource.



In the next step the user types the quantity of the resource to be assigned for this task and clicks on the Save button. Assigned resources can also be browsed, edited and deleted with the buttons in the same area.

D.8 Send Notification e-Mails

This screen is used to search for tasks under criteria like employee in charge, date the task is due, or tasks within a date interval.

SendTaskNotification

Scheduled Tasks

Employee Name: Joao Nascimento

Date: 28-Feb-18

From: 01-Jan-18 to: 28-Feb-18

When selecting an employee in the combo box and clicking on the button Tasks for Employee by Date, the database will search for tasks assigned for this employee and make a printable report, like the next example.



ReportTasksOnDateForEmployee
_ □ ×

Tasks due on **for**

Task Code	7	Description	Spraying
Where	Facility	:	Orchard
Task Code	19	Description	Spraying
Where	Section	:	Missoula Field Track

Printed on Thursday, March 1, 2018

This report shows tasks due on the selected date for the selected employee, regardless if they are for facilities, sections of plant batches. It can be printed by clicking at the printer icon at top right corner.



ReportTasksOnDate
— □ ×

Tasks due on 2/9/2018

Task Code	7
Task Description	Spraying
Where	Facility : Orchard
Task Code	7
Task Description	Tagging
Where	Batch : 1
Task Code	19
Task Description	Spraying
Where	Section : Missoula Field Track

Printed on Thursday, March 1, 2018

This report shows tasks due on the selected date, regardless if they are for facilities, sections of plant batches. It can be printed by clicking at the printer icon at top right corner.



ReportTasksWithinPeriod
— □ ×

Tasks due between 1/1/2018 **and** 2/28/2018

Task Code	5	Task Date	2/17/2018
Task Description	Weeding		
Where	Facility : Orch-Greenhouse3		
Task Code	6	Task Date	2/8/2018
Task Description	Cleaning		
Where	Plant Batch : 1		
Task Code	6	Task Date	2/8/2018
Task Description	Mowing		
Where	Facility : Orchard		
Task Code	7	Task Date	2/9/2018
Task Description	Spraying		
Where	Facility : Orchard		
Task Code	7	Task Date	2/9/2018
Task Description	Tagging		
Where	Plant Batch : 1		
Task Code	8	Task Date	2/20/2018
Task Description	Collect Seeds		
Where	Facility : Orch-Greenhouse2		
Task Code	8	Task Date	2/22/2018
Task Description	Weed Whacking		

This report shows tasks due between (and including) the selected dates, regardless if they are for facilities, sections of plant batches. It can be printed by clicking at the printer icon at top right corner.



When clicking to the button

Send e-mail with tasks due today

The system will send an e-Mail for a previously set e-mail will all task due at the current day. To configure this feature, the user has to enable MS Access Add In for Microsoft Outlook and configure MS Outlook for an e-mail account. Users may need help for IT professionals to set up this feature.



D.10 Seed Mix Calculator

Seed Mix Calculator

Seed Mix ID Made at

Seed Mix Name Section Planted

Desired Seeds/m2

	Species	%	Seeds / Kg	Kg/hectare	Section area Area <input type="text" value="35"/> m2 Kg/Section	user defined area Area <input type="text" value="0"/> m2 Kg/Section			
Seed 1	Achillea millefolium	0	4500	0.000	0.000	0.000			
Seed 2	Danthonia spicata	5	300000	0.167	0.001	0.000			
Seed 3	Danthonia spicata	10	300000	0.333	0.001	0.000			
Seed 4	Danthonia spicata	5	300000	0.167	0.001	0.000			
Seed 5	Danthonia spicata	10	300000	0.333	0.001	0.000			
Seed 6	Danthonia spicata	5	300000	0.167	0.001	0.000			
Seed7	Danthonia unispicata	10	300000	0.333	0.001	0.000			
Seed8	Festuca Gigantea	5	227000	0.220	0.001	0.000			
Seed9	Danthonia unispicata	10	300000	0.333	0.001	0.000			
Seed10	Festuca scabrella	5	87000	0.575	0.002	0.000			
Seed11	Koeleria macrantha	5	100000	0.500	0.002	0.000			
Seed12	Danthonia spicata	5	300000	0.167	0.001	0.000			
Seed13	Juncus L.	5	45000	1.111	0.004	0.000			
Seed14	Festuca Gigantea	15	227000	0.661	0.002	0.000			
Seed15	Achillea millefolium	5	4500	11.111	0.039	0.000			
Total %		100.00	Total kg		1.167	Total kg	0.057	Total kg	0.000

This screen allows the user to easy calculate seed mixes and store mixes for future use. It can have up to 15 types of seeds, which can be selected at Species combo boxes at left.

The user can browse through previously stored mixes or create a new one by using the buttons at top right corner.

To create a new mix, click on the New button. Write a seed mix name (it should be different from the already stored mixes). Type a date and choose a seed density at Desired Seeds/m2.

Select up to fifteen types of plant species. Only graminoids and forbs will be shown as an option. After selecting a plant species, the database will pull out data for the Seeds/Kg, if previously available at Plant Database.

Environmental Restoration Database



The user writes the percentage and the system calculates the Kg/ha, Kg/section (if a section is selected in the combo box), and Kg/Section for a user set area at the rightmost column. The user can write a specific area to calculate how much seed mix would be necessary.

When typing the percentages, make sure their sum do not totalize more than 100%.



D.11 Seed Collection Locations

Seed Collection Location

Search Plant Species

▼

Code	<input type="text" value="4"/>	
Species Found	<input type="text" value="Achillea millefolium"/>	▼
Area	<input type="text" value="Delmoe Lake 1"/>	Access Restrictions <input type="text" value="None, public land. Dirty road may be accessed only by all wheel drive vehicles."/>
Landowner	<input type="text" value="USFS"/>	
Address	<input type="text" value="NA"/>	Disturbance <input type="text" value="road and campground nearby"/>
City	<input type="text" value="Butte"/>	
State	<input type="text" value="MT"/>	Comments <input type="text" value="many small lodge poles . No invasive species found."/>
ZIP	<input type="text" value="59701"/>	
Latitude	<input type="text" value="45.979828"/>	
Longitude	<input type="text" value="-112.348284"/>	
KMZ map	<input type="text"/>	
Photos	<input type="text"/>	
Climate	<input type="text" value="Bsk"/>	
Soil	<input type="text" value="good"/>	
Wildlife	<input type="text" value="deer, elk, birds"/>	
Fish	<input type="text" value="creek nearby"/>	

Delmoe Lake 1

This screen is used to store seed, plant and saplings collection locations to track their origin when planting in restoration projects and plan seed collection works for future years. With seed collection locations readily available, it won't be necessary drive for long time searching for seed bank spots. It helps to create genetic diversity on restoration projects by choosing different plant origin spots to be transferred to restoration project. When using local specimens, the manager can choose plants and seeds from different seed origins to make a diverse mix to sites under restoration. Therefore, restored site can have both local native species and diverse gene pool.

Environmental Restoration Database



- Species found: Name of plant species found in this seed collection location
- Area: user defined area name
- Landowner: person or organization which owns the area.
- Address, City, State, ZIP: information for travel planning
- Latitude, Longitude: coordinates to easily find the seed collection location.
- KMZ map: a Google Earth KMZ file can be added for easy visualization
- Photos: site photos
- Climate: Koppen-Geiger climate classification
- Soil: type of soil
- Wildlife: details about wildlife present at the site
- Fish: details about fish present at the site
- Access Restrictions: data about how to enter and collect materials from this site.
- Disturbance: human or natural site disturbance relevant for seed collection purposes, like cattle presence, campground nearby, construction works, lumber extraction
- Comments: general information data field.

Data entered in this screen will be used in other system screens, like Plant Batch and Seed Stock screens.



D.12 Seed Inventory

Seed Stock

Filter by Species

Filter by Year

Item Of

Seed Bag Number

Plant Species

Date of Collection

Origin place

Weight g Seed Status UpdateDate

Comments

Seed inventory can be registered at this screen to keep track of seed stock. It can assign unique number for labeling seed bags, record when the seeds of a seed bag where collected in the field and where they where collected.

Seed bags can be searched by plant species and year of collection. To browse, add or edit the records just click on the buttons located at top right corner.

- Seed Bag Number: unique number assigned by the system for the seed bag
- Plant Species: seed plant species
- Date of Collection: date the seeds where collected at the field
- Origin Place: Seed Collection location as registered at Seed Collection Location Screen. Only the locations registered for the chosen plant species will be shown as options.
- Weight: mass of seed available in the seed bag
- Seed Status: current status of the seed, like collected, cleaned or treated
- Update Date: date of the last status, weight and data update for this bag
- Comments: general information data field.

Environmental Restoration Database



Reports can be printed for all seed stock or for a single plant species, according user selection.

Seed Stock Report						
Bag Code	Collection Date	SeedStatus	Weight	SeedCollectionLocation	UpdateDate	Comments
714			g			
Acer glabrum						
438	12/31/2013	Cleaned	44.8 g	N/A	2/18/2017	
Achillea millefolium						
516	12/31/2015	Cleaned	45.6 g	N/A	2/18/2017	
704	12/31/2008		g			
699	12/31/2009		g			
291	12/31/2012	Cleaned	10.5 g	N/A	2/18/2017	
81	12/31/2010	Cleaned	11.4 g	N/A	2/18/2017	
637	12/31/2016	Cleaned	3 g	N/A	2/18/2017	
169	12/31/2011	Cleaned	8 g	N/A	2/18/2017	
Aconitum species						
292	12/31/2012	Cleaned	1 g	N/A	2/18/2017	
Agoseris 1(13)						
373	12/31/2013	Cleaned	0.2 g	N/A	2/18/2017	
Agoseris 2(13)						
374	12/31/2013	Cleaned	1.2 g	N/A	2/18/2017	

Seed Stock Report						
Bag Code	Collection Date	SeedStatus	Weight	SeedCollectionLocation	UpdateDate	Comments
Achillea millefolium						
719			g			
704	12/31/2008		g			
699	12/31/2009		g			
637	12/31/2016	Cleaned	3 g	N/A	2/18/2017	
516	12/31/2015	Cleaned	45.6 g	N/A	2/18/2017	
291	12/31/2012	Cleaned	10.5 g	N/A	2/18/2017	
169	12/31/2011	Cleaned	8 g	N/A	2/18/2017	
81	12/31/2010	Cleaned	11.4 g	Delmoe Lake 1	2/18/2017	
Thursday, March 1, 2018						Page

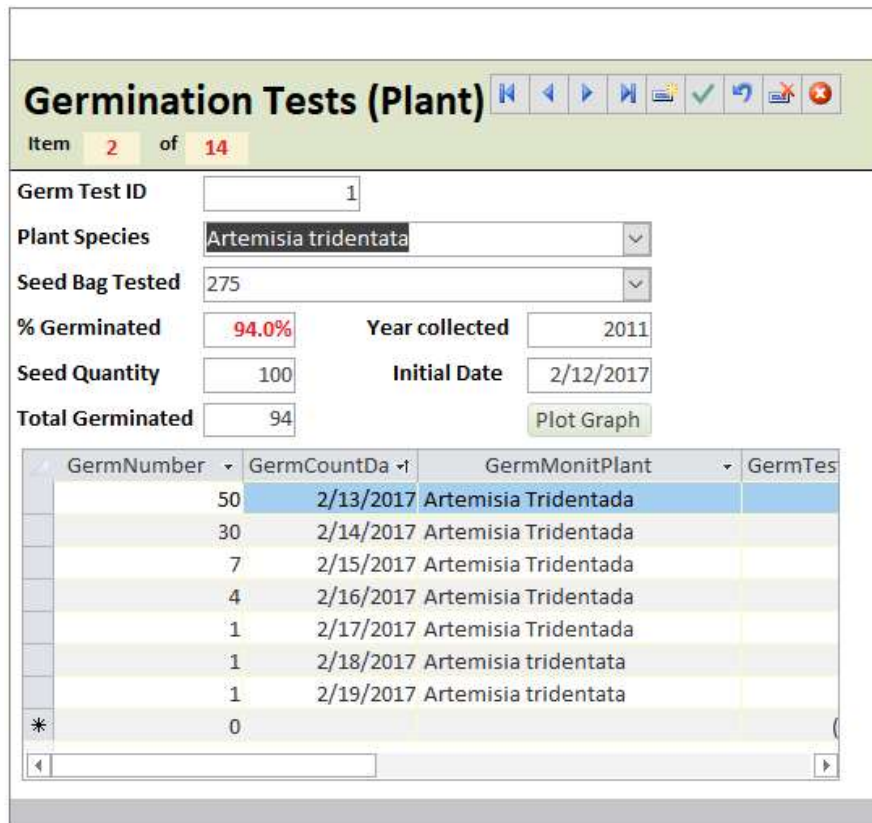


D.13 Germination Tests



Prior to treating seeds and/or planting a batch, germination tests are required to determine if the seeds are ready for sowing. Statistical data can be collected and used as information and guideline for planting process.

Tests can be added by clicking at Input Data on Test. Existing test data can be searched by typing the plant species scientific name or a Test ID.

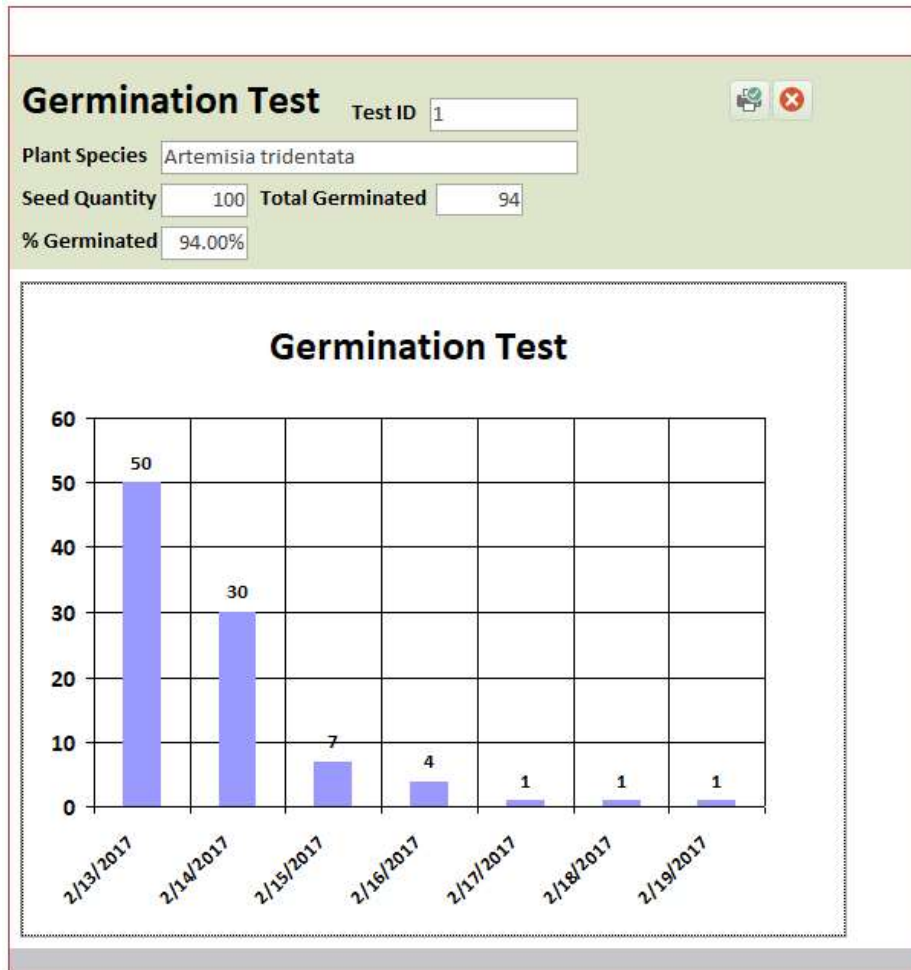


- Germ Test ID: unique ID number for each test. It's autonumbered by the system.



- Plant Species: scientific name for the plant species seed under test
- Seed Bag Tested: Seed bag in stock from where the seeds came from
- % Germinated: percentage of seeds germinated during test
- Seed Quantity: Seed quantity tested
- Total Germinated: total of germinated seeds during test
- Year collected: Year the seed was collected
- Initial Date: Test starting date

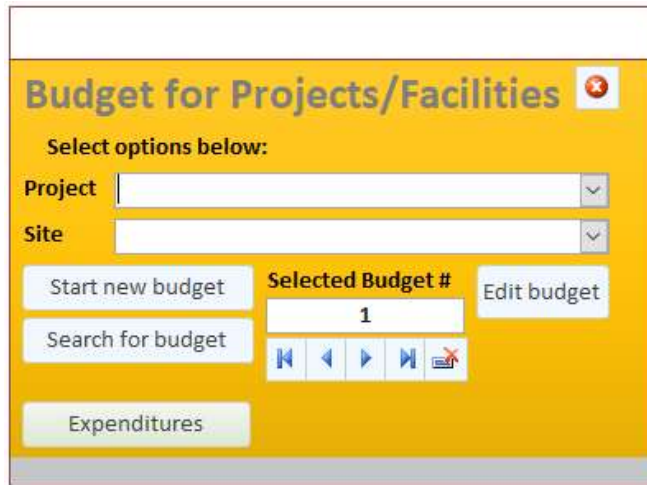
A graph is plotted with test data by clicking at Plot Graph button.





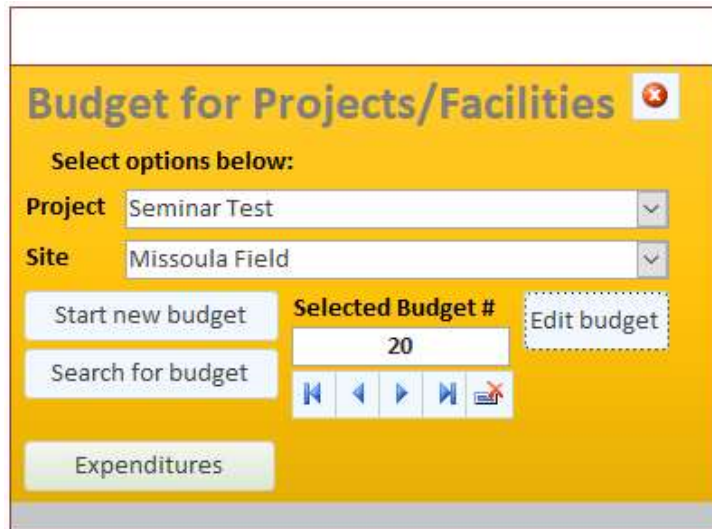
D.14 Budget

Budget screens are used to start new budgets, search, edit and assign them to sites under restoration. Budgets are linked to sites, so a single project with several sites can have individual budgets for every site. However, the user can't assign individual budgets for each section. This is because a site may have one or more section inside it and restoration works in a site can't be totally separated for each section. Every time a restoration professional or team goes to a site, usually he or she looks for the entire site and its sections, transportation costs are shared, etc.



If starting a new budget, the user should select a project and a site in the combo boxes than click in Start new budget button.

If searching for a previously stored budget, select project and site and then click in search. Budgets under these criteria can be browsed by the arrow buttons in the bottom.



Environmental Restoration Database



To edit a budget, search and select its number and click Edit Budget.

After clicking Start new budget, the database will show the next screen.

The screenshot shows a web application window titled "BudgetDetailsFormAdd". The main heading is "Budget Details" with a sub-heading "Budget for:". Below this, there are two text input fields: "Project" containing "Seminar Test" and "Site" containing "Missoula Field".

Below the project and site information, there are several form fields and a table:

- Budget Code:** A text input field containing "16".
- Type:** A dropdown menu.
- Description:** A dropdown menu.
- Cost per Unit:** A text input field containing "\$0.00".
- Unit:** A text input field.
- Quantity:** A text input field containing "0.00".
- Total:** A text input field containing "\$0.00".

To the right of the form fields, there is a button labeled "Add Item to Budget" and a label "Grand Total". Below the form fields, there is a set of navigation icons: a left arrow, a right arrow, a double left arrow, a double right arrow, a checkmark, and a close button.

Below the form fields, there is a table with the following columns: Description, Cost per Unit, Budget Code, Quantity, Type, Total, and Unit. The table contains two rows:

Description	Cost per Unit	Budget Code	Quantity	Type	Total	Unit
	\$0.00	16	0.00		\$0.00	
*	\$0.00	0	0.00		\$0.00	

At the bottom of the window, there is a status bar with the text "Record: 1 of 1", "No Filter", and a "Search" input field.

A budget is made of several different resources to be spent in a site. Therefore, this screen is used to add resources and calculate their extended and total cost. Resources select come from Resource configuration screen. Only previously registered resources will be

- Budget code: unique autonumbered code assigned for this budget
- Type: Type of resource to be added to this budget, like labor, tools, fuel.
- Description: Name of the resource to be used.
- Cost per unit: Unit cost of the resource
- Unit: unit the resource is measured

Environmental Restoration Database



- Quantity: user determined quantity of resource to be used
- Total: extended cost for this resource. Unit price x quantity
- Grand Total: Sum of all extended costs in this budget

After choosing the resource and quantity, click on Add Item to Budget to add this resource to the budget. It will be transferred to the bottom resource list and the selection fields will be cleared.

Budget Details Budget for:

Project: Seminar Test
Site: Missoula Field

Budget Code: 16
Type: Plants
Description: Artemisia tridentata
Cost per Unit: \$5.00 Unit: each Quantity: 50.00
Total: \$250.00
Grand Total: \$2,500.00

Description	Cost per Uni	Budget Cod	Quantity	Type	Total	Unit
Supervisor	\$25.00	16	100.00	Labor	\$2,500.00	man/hour
Artemisia tride	\$0.00	16	50.00	Plants	\$0.00	each
*	\$0.00	0	0.00		\$0.00	

Record: 2 of 2 No Filter Search

The Grand Total will be updated every time a new resource is added to the list.

When editing budgets, the same screen will be show for adding, editing or delete resources in budgets.



The next screen shot shows a detailed budget.

Budget Details

Budget for:

Project

Site

Budget Code

Type Add Item to Budget

Description

Cost per Unit Unit Quantity Grand Total

Total \$5,879.00

Description	Cost per Unit	Quantity	Unit	Total	Type
Herbicide	\$25.00	1.00	gallon	\$25.00	Consumable
Mileage - Truck travel	\$1.00	300.00	kilometer	\$300.00	Consumable
Fuel - Gasoline for 4-strok	\$3.00	1.00	gallon	\$3.00	Fuel
Fuel - Gasoline with oil fo	\$3.00	1.00	gallon	\$3.00	Fuel
Laboratory Assistant	\$12.00	20.00	man/hour	\$240.00	Labor
Supervisor	\$25.00	40.00	man/hour	\$1,000.00	Labor
Work-Study Students	\$10.00	160.00	man/hour	\$1,600.00	Labor
Fence 4 ft high, steel brai	\$35.00	10.00	yard	\$350.00	Planting suppl
Sign (No mowing, no spra	\$9.00	10.00	unit	\$90.00	Planting suppl
Artemisia tridentata	\$5.00	100.00	each	\$500.00	Plants
Creeping Juniper Plant	\$5.00	50.00	unit	\$250.00	Plants
Logpole	\$6.00	20.00	each	\$120.00	Plants
Ponderosa	\$7.00	10.00	each	\$70.00	Plants
Willow	\$4.00	200.00	each	\$800.00	Plants
Front Loader	\$100.00	2.00	hour	\$200.00	Rental
Truck Haul	\$8.00	10.00	mile	\$80.00	Service
Drill	\$180.00	1.00	each	\$180.00	Tool
Spade	\$18.00	1.00	each	\$18.00	Tool
Watering hose - 100 ft reel	\$50.00	1.00	each	\$50.00	Tool
	\$0.00	0.00		\$0.00	Vehicle

Record: 19 of 20 | No Filter | Search



The user can get a breakdown of resources spent on a site as registered on Site Maintenance screens by clicking on Expenditures button.

The screenshot shows a web interface titled "Budget for Projects/Facilities" with a close button (X) in the top right. Below the title, it says "Select options below:". There are two dropdown menus: "Project" and "Site". Below these are four buttons: "Start new budget", "Search for budget", "Selected Budget # 1", and "Edit budget". The "Selected Budget #" field contains the number "1". Below the "Search for budget" button is a set of navigation icons (back, forward, search, etc.). At the bottom of the panel, the "Expenditures" button is circled in red.

This button will open another selection menu, as follows:

The screenshot shows a selection menu titled "BudgetExpenditureCriteria". It has a close button (X) in the top right. The main heading is "Select Section for Budget Summary". There are three dropdown menus: "Project" (selected: Seminar Test), "Site" (selected: Missoula Field), and "Section" (selected: Missoula Field Track). Below these are three buttons: "Expenditures for Site", "Expenditure by Section", and "Site Expenditures by Type". Below this section is another heading: "Select Facility/Equipment and/or date". There is a dropdown menu for "Facility/Equipment" and two input fields for "From" and "To". Below these is a button labeled "Facility Expenditure by Period".

Environmental Restoration Database



By clicking on Expenditures by site, it will return the total expenditures so far for the selected site.

SumOfTotal	DestinationSite
7997.5	Smelter Hill

Record: 1 of 1 | No Filter | Search

By clicking on Expenditures by section, a breakdown of expenditures by section will be shown.

SumOfTotal	DestinationSite	DestinationSection
7517.5	Smelter Hill	Hill - Northeast Slope
480	Smelter Hill	Hill - West Slope

Record: 2 of 2 | No Filter | Search

By clicking on Expenditures by Type a breakdown of expenditures will be shown according resource types.

SumOfTotal	DestinationSite	TypeofItem
265.5	Smelter Hill	Consumable
5640	Smelter Hill	Labor
72	Smelter Hill	Planting supply
1725	Smelter Hill	Plants
115	Smelter Hill	Service
180	Smelter Hill	Tool

Record: 1 of 6 | No Filter | Search

By selecting a facility and time interval, the user can get a breakdown of expenditures, by date, for each facility.



D.15 Plant Calculator

Plant Calculator			
Plant Calculator		Print Calculations	
Project	<input type="text" value="Seminar Test"/>		
Site	<input type="text" value="Missoula Field"/>		
Section	<input type="text" value="Missoula Field West Slope"/>		
Section area	<input type="text" value="7436"/>	m2	User set area <input type="text"/>
Spacing	<input type="text" value="0"/>	m	Spacing <input type="text" value="0"/>
Quantity	<input type="text" value="0"/>	Trees	Quantity <input type="text" value="0"/>
Spacing	<input type="text" value="0"/>	m	Spacing <input type="text" value="0"/>
Quantity	<input type="text" value="0"/>	Shrubs	Quantity <input type="text" value="0"/>
Spacing	<input type="text" value="0"/>	m	Spacing <input type="text" value="0"/>
Quantity	<input type="text" value="0"/>	Forbs	Quantity <input type="text" value="0"/>
Spacing	<input type="text" value="0"/>	m	Spacing <input type="text" value="0"/>
Quantity	<input type="text" value="0"/>	Grass	Quantity <input type="text" value="0"/>
Total	<input type="text" value="0"/>	Plants	Total <input type="text" value="0"/>

This screen can be used to calculate the quantity of plants to be planted in a section using square shaped pattern. Select project, site and section with the combo boxes and the database will automatically fill the section area in square meters, as it is registered in the Section screen.

In the left column, choose a plant spacing distance for each type of plants, like trees, shrubs, forbs and grasses and the system will calculate how many specimens will be necessary to fill the section.

The same calculation can be performed for a user set area in the right column.



Plant Calculator

Plant Calculator

Print Calculations
✕

Project

Site

Section

Section area <input type="text" value="7436"/> m2	User set area <input type="text" value="1200"/> m2
Spacing <input type="text" value="5"/> m	Spacing <input type="text" value="6"/> m
Quantity <input type="text" value="297"/> Trees	Quantity <input type="text" value="33"/> Trees
Spacing <input type="text" value="2"/> m	Spacing <input type="text" value="1.5"/> m
Quantity <input type="text" value="1,859"/> Shrubs	Quantity <input type="text" value="533"/> Shrubs
Spacing <input type="text" value="1"/> m	Spacing <input type="text" value="0.8"/> m
Quantity <input type="text" value="7,436"/> Forbs	Quantity <input type="text" value="1,875"/> Forbs
Spacing <input type="text" value=".5"/> m	Spacing <input type="text" value=".40"/> m
Quantity <input type="text" value="29,744"/> Grass	Quantity <input type="text" value="7500"/> Grass
Total <input type="text" value="39,336"/> Plants	Total <input type="text" value="9,942"/> Plants

Final results can be printed by clicking the top right corner button.



D.16 Stratification Tests

Stratification Tests (Plant)

Item **48** of **356** Start

Plant Species End

Test ID Plant 6 Digit Code

Plant Species

Start Date End Date

Test #Days Test Date

Comments

This screen can be used either to register and search for seed stratification tests. The user can add a new test by clicking on the New Record button, or search test by plant species or start and end test date.

- Test ID: Unique test identifier autonumbered by the system
- Plant 6 Digit Code: USDA 6 digit code for plant species under test
- Plant species: field filled according user selection of 6 digit code
- Start Date: starting date for stratification test
- End Date: end date for stratification test
- Test #Days: test duration time in days
- Comments: general Information Data field



D.17 Cut Tests

% Survival	Plant Code	Plant Species	Test ID
24	SOLGIG	Solidago gigantea	58
24	KOEMAC	Koeleria macrantha	37
38	OENBIE	Oenothera biennis	8
41	PINCON	Pinus Contorta	2
44	ORYHYM	Oryzopsis hymenoid	3
44	CHADOU	Chaenactis douglasi	48
46	PRUVIR	Prunus virginiana	13
46	RIB CER	Ribes cereum	27

The Cut Tests Screen is used to store data about survival rate of cuttings used for planting.

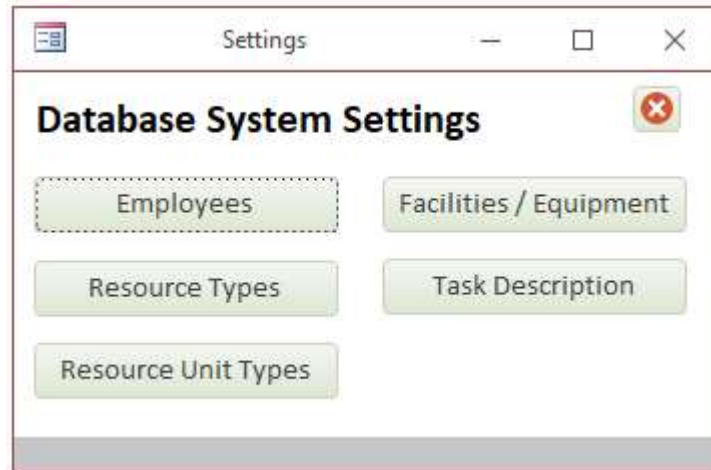
Using the top buttons the user can add, browse or delete records.

Cut test data can be found by searching for plant species or percentage of survival rate in the shaded area.

- Test ID: unique test ID number assigned by the system
- Plant Code: Six digit USDA plant code chosen by the user for the plant species under test
- % Survival: user entered percentage of survival rate
- Plant Species: plant species of cuts filled by the system according user selected six letter code



D.20 Settings



The Settings menu option opens this screen, which takes the user for database internal tables with configuration settings. These tables store some key data used throughout many screens and should be accessed by the system manager only.

For example, the system manager will have to update employees' list over time, add new resource types, add or remove facilities, create new task descriptions or add resource measuring units not included in the first software release.



D.20.A Employee screen

Employee Code	Name	Active Employee
799001	Robert Pal	<input checked="" type="checkbox"/>
799002	Mark Mariano	<input checked="" type="checkbox"/>
799003	Jared Trilling	<input checked="" type="checkbox"/>
799004	Krystal	<input checked="" type="checkbox"/>
799005	Rachel LeTenga	<input checked="" type="checkbox"/>
799006	Luke Domanico	<input type="checkbox"/>
799135389	Joao Nascimento	<input checked="" type="checkbox"/>
*		<input type="checkbox"/>

This screen can be used to edit the employee listing as needed. The Active Employee Checkbox, if left unchecked, blocks the employee from being assigned for tasks. It's an useful feature for vacations, leaves or lay off.

- Employee Code: employee ID for the organization
- Name: Employee full name
- Active Employee: check box to determine if the employee is currently eligible to be assigned tasks to.

D.20.B Resource type

Environmental Restoration Database



D.20.C Resource Unit Types

The screenshot shows a window titled "ResourceUnit" with a list of resource unit types. The list includes: bag, bottle, box, bundle, can, centimeter, cubic feet, cubic ft, cubic meter, cubic yard, day, and dozen. The "bag" entry is highlighted. The window has a status bar at the bottom showing "Record: 1 of 48" and "No Filter".

ResourceUnit	Click to Add
bag	
bottle	
box	
bundle	
can	
centimeter	
cubic feet	
cubic ft	
cubic meter	
cubic yard	
day	
dozen	

D.20.D Facilities / Equipment List

The screenshot shows a window titled "Facilities" with a list of facility names. The list includes: Greenhouse, HoopHouse, Orchard, Orch-Greenhouse1, Orch-Greenhouse2, Orch-Greenhouse3, Tool Shelter, and Truck. The window has a status bar at the bottom showing "Record: 1 of 8" and "No Filter", along with a search box.

FacilityName	Address	ZIPCode	Comments	Click to Add
Greenhouse				
HoopHouse				
Orchard				
Orch-Greenhouse1				
Orch-Greenhouse2				
Orch-Greenhouse3				
Tool Shelter				
Truck				

D.20.E Task description

The screenshot shows a window titled "ListofTasks" with a list of task descriptions. The list includes: Weeding, Mowing, Seeding, Monitoring, Tagging, Inspection, Spraying, Weed Whacking, Collect Seeds, Planting, and Cleaning. The window has a status bar at the bottom showing "Record: 1 of 11" and "No Filter", along with a search box.

TaskCode	TaskDescription	Comments	ResourcesNeed	Click to Add
1	Weeding		Gloves, Plastic Bags	
2	Mowing		Lawnmower, Fuel,	
3	Seeding		Seeds, Plastic Bags	
4	Monitoring		Quadrant, Field Mc	
5	Tagging		Tags, Sharpie,	
6	Inspection		Depends on type o	
7	Spraying		Backpack sprayer, f	
8	Weed Whacking		Weed Whacker, Pl	
9	Collect Seeds		Bags, Tapes, Pen, G	
10	Planting		Tubes, Shovel,	
11	Cleaning		Cleaning Supplies	
*	(New)			



E. Project Benefits

The Restoration Management System can benefit the restoration projects in Butte by improving data management which, therefore, will lead to a better efficiency on restoration projects. This goal can be met by adopting the following resources this system provides:

- Store all relevant data regarding projects in a single source will make it easier to search and find information.
- Multi-user database will help disseminating information for those who need access project data, preventing long waiting time for searching documents.
- Improve the efficiency of field maintenance tasks by providing necessary information on-site to abide them to the best practice rules.
- Keeping track of maintenance tasks, measure results, find mistakes and addressing them quickly will increase the success rate of projects.
- Providing updated statistics to demonstrate project results and evolution over time, to help decision-making.
- Pro-active system, which identifies scheduled tasks and issues service orders.
- Save working time, save labor costs, save resources and money. Provide more restoration with less funds, which means more public support.

