Ranchers Stewardship Alliance Mapping with Maida Virtual Classroom

Series 1: Introduction to Stocking Rate Tools & Google Mapping Applications.

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I. Overview of this Learning Document

This learning series offers an introduction and hands-on tutorial to free mapping applications commonly used in rangeland agriculture: the **Rangeland Analysis Platform (RAP)**, **Stock Smart**, and **Google** mapping tools. RAP and Stock Smart are stocking rate calculation tools that help land managers assess forage production and make data-driven grazing management decisions. Google mapping tools, on the other hand, can be used for do-it-yourself (DIY) ranch mapping, allowing you to create and save detailed maps of infrastructure such as fences, pipelines, and stock tanks. Together, these mapping tools can help support grazing management decisions and give landowners practical and accessible ways to plan, visualize, and manage rangeland resources.

No prior mapping experience is needed—this series is designed for beginners! All tools and services covered are open source, completely free, and best accessed on a computer (tablets are not recommended).

Roman numerals organize the workflow of this learning series:

(II) Overview of Stocking Rate Tools. ***PAGE 2***.

(III) Introduction to the Rangeland analysis platform. ***PAGE 2***.

(IV) Utilizing the Rangeland Analysis Platform Production Explorer to Assess Stocking Rates & Trends in Vegetation. ***PAGE 4***.

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II. Overview of Stocking Rate Tools

The Rangeland Analysis Platform (RAP) and Stock Smart are stocking rate tools that use satellite imagery and ground-truthed vegetation data to estimate forage production and grazing capacity across large landscapes. These mapping tools can give you informative stocking rate estimates and additional landscape vegetation context, but they are not always standalone stocking rate solutions.

Similar to a weather forecast, these tools function as predictive forage models and work best when combined with on-the-ground observations and local knowledge. The accuracy of these tools tends to vary depending on the size of your area, however, we can roughly estimate that these tools are normally within 10% accuracy (1,2). The bigger your pasture or area of interest, the more pixels will be analyzed in your calculations which will make estimations more accurate.

For a more in-depth analysis of the accuracy, see citations 3 & 4.

In these applications, users interact with a satellite map interface, draw pasture boundaries, and receive pasture, or allotment-level stocking rate estimates. These outputs provide context for historical animal unit months (AUMs) of an area. They also support land acquisition questions, grazing and infrastructure planning, lease decisions, and advisor communication.

The images used to create these maps and stocking rate calculations come from two satellites, the Landsat satellite and the Sentinel 2 satellite. Because of this, data availability is based on these satellite's resolution, age and how long it takes them to orbit the earth.

Satellite Name	Data Availability	Spatial Resolution	Update Period
Landsat	1984- present	30 by 30-meter pixels	Every 16 days
Sentinel 2 Satellite	2018 - present	10 by 10-meter pixels	Every 10 days

Table 1: Information on the two satellites that are used in the RAP and Stock Smart Applications.

III. Introduction to the Rangeland Analysis Platform

The Rangeland Analysis Platform (RAP) offers powerful, easy-to-use tools and data that help practitioners understand, visualize, and respond to complex scenarios in Rangeland ecosystems. RAP combines satellite imagery with thousands of on-the-ground vegetation measurements collected by BLM, NPS, and NRCS to map and monitor **rangeland production** and **vegetation cover** in the United States (1, 2). These two mapping tools can produce pasture level outputs and trends that date back to 1986 (3).

When using RAP, it is important to follow key guiding principles for interpreting the modeled maps: use them within a broader decision-making framework, embrace and better understand landscape variability, keep error in perspective, and think critically about potential contradictions (3).

The Rangeland Analysis Platform is open source and was created in 2018 in partnership with the University of Montana, USDA Natural Resources Conservation Service (NRCS), the Bureau of Land Management (4).

About the Rangeland Analysis Platform & Data Products

RAP Production Explorer

The rangeland production mapping platform calculates historical and current forage and stocking rates conditions. This application compares current year production to past years, quantifies the amount above or below a long-term average, and provides an interactive estimate of the stocking rate. The data, at 30-meter spatial resolution from 1986–present, are available at annual and 16-day time steps (4). This allows tracking of historical averages/ trends, and new accumulated growth over each 16-day period (2). This platform allows for importation of spatial files like KML's to track pasture specific trends in rangeland production in addition to being able to draw polygons in the mapping interface.

Click HERE to open the platform.

RAP Vegetation cover

The vegetation cover mapping platform enables detailed analysis of rangeland dynamics by annually tracking up to nine vegetation cover classes (3). Data has been available at a 30-meter resolution since 1986 and at a 10-meter resolution since 2018. This platform allows for importation of spatial files like KML's, or the drawing of polygons within the map interface to track pasture specific trends in vegetation coverage.

For example, if a pasture has seen conifer encroachment over the years, the RAP vegetation cover map can calculate the change in coverage as a total percentage of area over time. This can give you broken down trends in vegetation coverage by category.

Vegetation Category	Pixel Resolution (meters) & Data Available (year)
Perennial forb & grass	30 m since 1986 & 10 m since 2018
Annual forb & grass	30 m since 1986 & 10 m since 2018
Shrub	30 m since 1986 & 10 m since 2018
Tree	30 m since 1986 & 10 m since 2018
Bare Ground	30 m since 1986 & 10 m since 2018
Invasive annual grass cover	10 m since 2018
Pinion Juniper (PJ) Cover	10 m since 2018
Sagebrush cover	10 m since 2018

Table 2: The vegetation categories and their pixel resolution and data availability that the RAP Vegetation Cover tracks.

Click HERE to open the platform.

IV. Utilizing the Rangeland Analysis Platform Production Explorer & Vegetation Cover Maps

Getting started with the Production Explorer

The Rangeland Analysis Platform **Production Explorer** is a stocking rate tool and has 30-meter pixel resolution that goes back to 1986.

Type into your browser **Rangeland Analysis Platform Production Explorer** or Click Here. This will take you to the platforms production explorer window.

Set your Area of Interest and Period of Analysis to Gather Results

To retrieve historical and current trends of production of a specific area, there are two steps to complete:

1. Define the area interest or import data.

The area of interest can either be drawn with a polygon or by a previously created spatial file containing polygons like a Google KML file. The benefit of importing data into the platform through a KML file is that pasture polygons can be preset to easily and

consistently track production overtime without having to draw new features each time the application is opened.

NOTE: Mapping with Maida series 2 will go over how to map pasture polygons, create and save a KML file, and import your KML pasture polygons into the RAP Production Explorer.

2. Define a start and end year for calculating the long-term average.

The defined long-term period is used to calculate the historic average vegetation production. From 2001 until 2020 is the default twenty-year period.

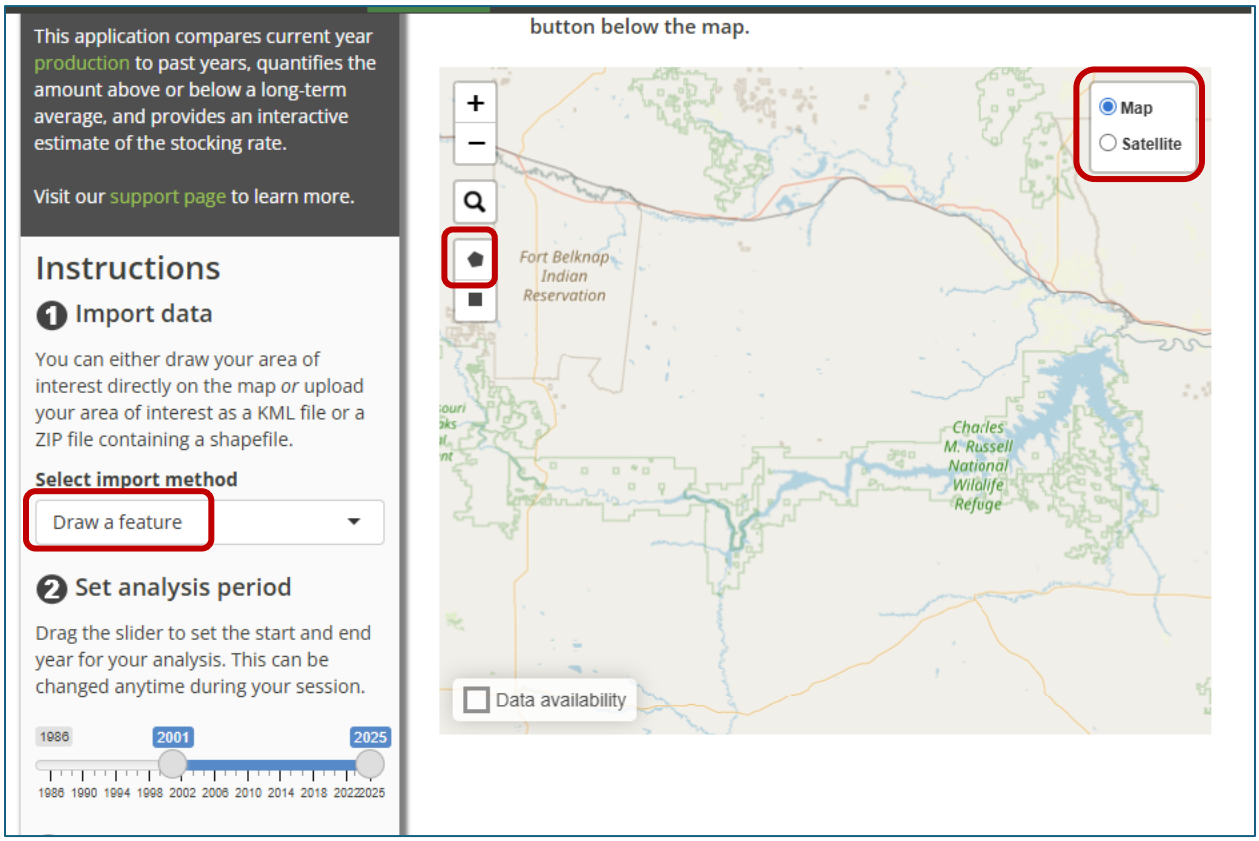


Figure 1: The RAP Production explorer when the Import Data option is set to Draw a Feature. The base map can be changed to Satellite in the top right corner, and to draw a polygon is on the left of the map.

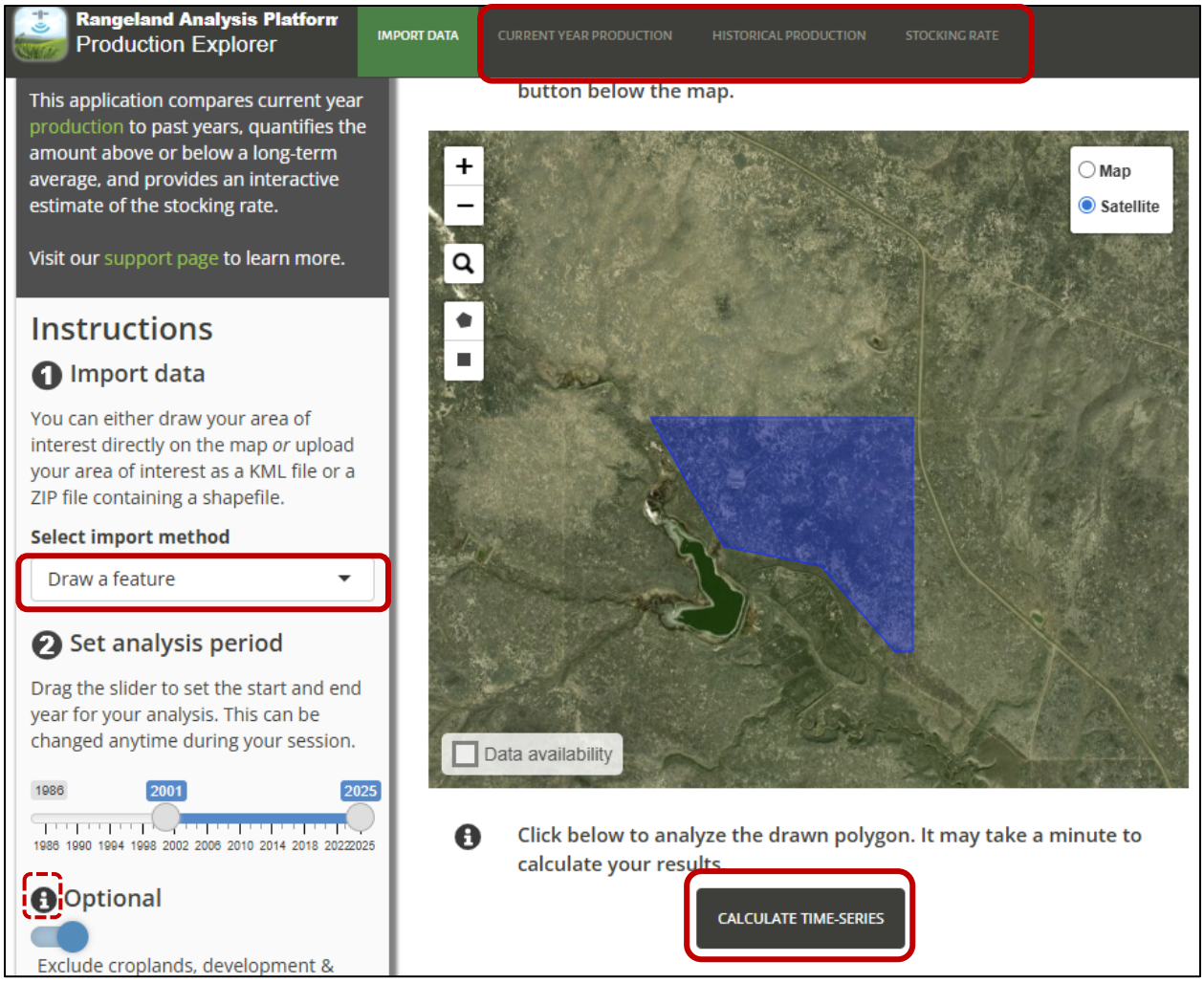


Figure 2: The RAP Production explorer when the "draw a feature" is utilized. To retrieved production results from your drawn area, click calculate time series. Once the time series has been calculated, the data results will be in the ribbon tab at the top of the screen under Current Year Production, Historical Production, and Stocking Rate.

The Rangeland Analysis Platform has information icons that give additional details when clicked on. See the red dotted box in figure 2.

Interpreting your RAP Production Results

Overview of the Current Year Production Report

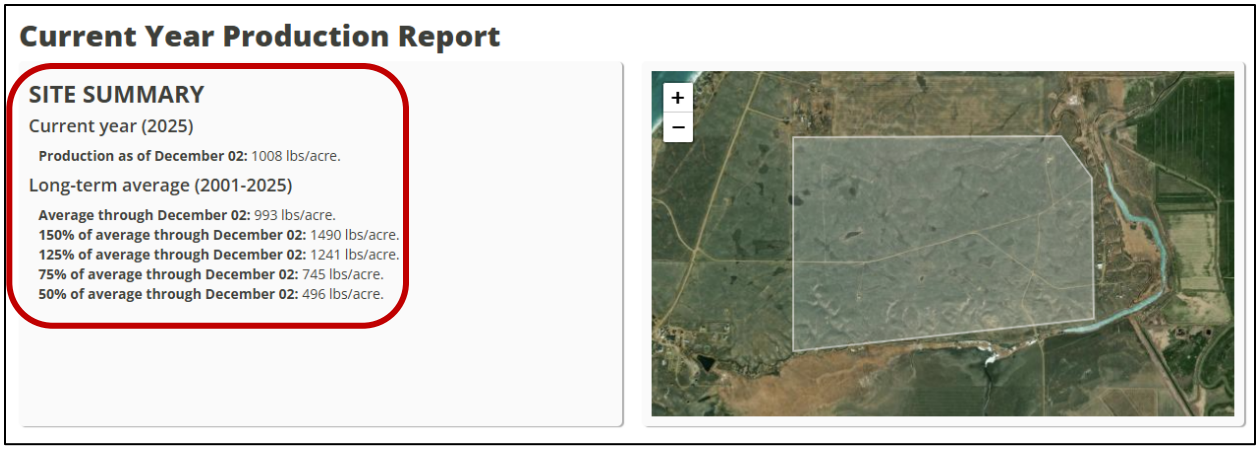


Figure 3: The current year production report. This report will give the long-term average and the most updated current year's production report from the Landsat images.

16 Day Production Plot

The 16-day production plot compares vegetation production for the current year to the selected long-term average. The black line on this plot represents this year's herbaceous vegetation production, and dotted lines represent long-term averages. The long-term averages can provide context for the highest and lowest production values this pasture as seen in the last 25 years, and how it compares to this year.

Cumulative Production Plot

The cumulative production plot shows the total vegetation production for the current year compared to the selected long-term average. Each point on the graph represents the cumulative production for its corresponding date.

Both **the 16-day production and the cumulative production plots** are essentially the same as the current year's production report, just represented in different ways.

You can export this report as an excel file and then print the reports if you would like to save a paper copy.

Overview of the Historical Production Report

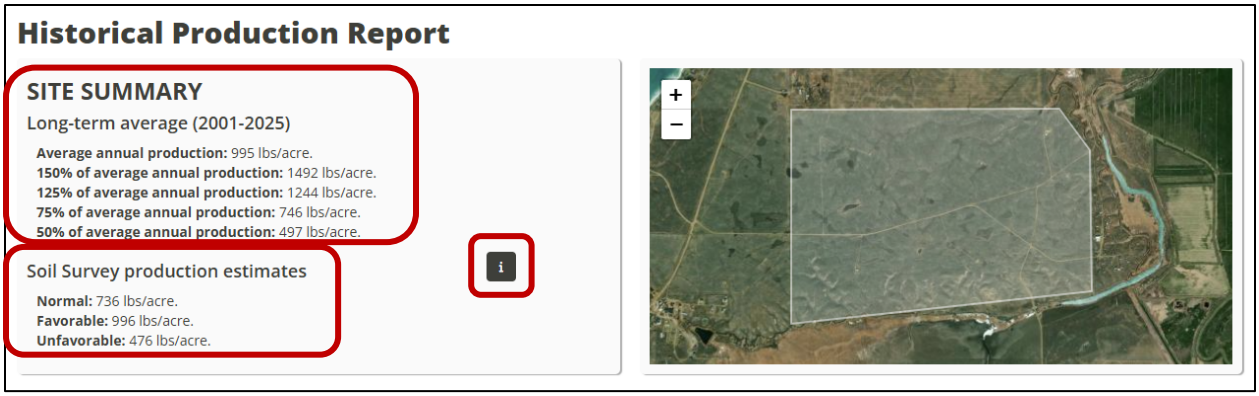


Figure 4: The historical production report. The historical production report will give a detailed historical report of the long-term average in plot and table formats. This section really focuses on the historical averages and trends from 2001 to 2025, which was that set analysis period that we looked at when we drew our polygon.

In the Historical Production Report, the long-term average statistics are shown again, with RAP also including Soil Survey production estimates. These Soil Survey estimates are static metrics derived from the Gridded Soil Survey Database and are provided to allow comparison between RAP calculations and other stocking tools. You can click the information icon to learn more about these numbers.

Historical Plot

The historical plot displays annual production estimates, in pounds per acre, for the selected analysis period. This plot allows you to track year-to-year production trends, compare them to long-term maximum and minimum values, and see how the pasture's trend line (black line) has changed over time.

Historical Table

The historical table is just the data from the historical plot in number format.

You can export this historical report as an excel file and then print the reports if you would like to save a paper copy.

Overview of the Stocking Rate Report

The RAP stocking rate tool will take the current year production, the historical production, account for your grazing variables, and landscape features to calculate a stocking rate for your area of interest. To do this, you will need to fill out the information in the stocking rate window (Figure 5).

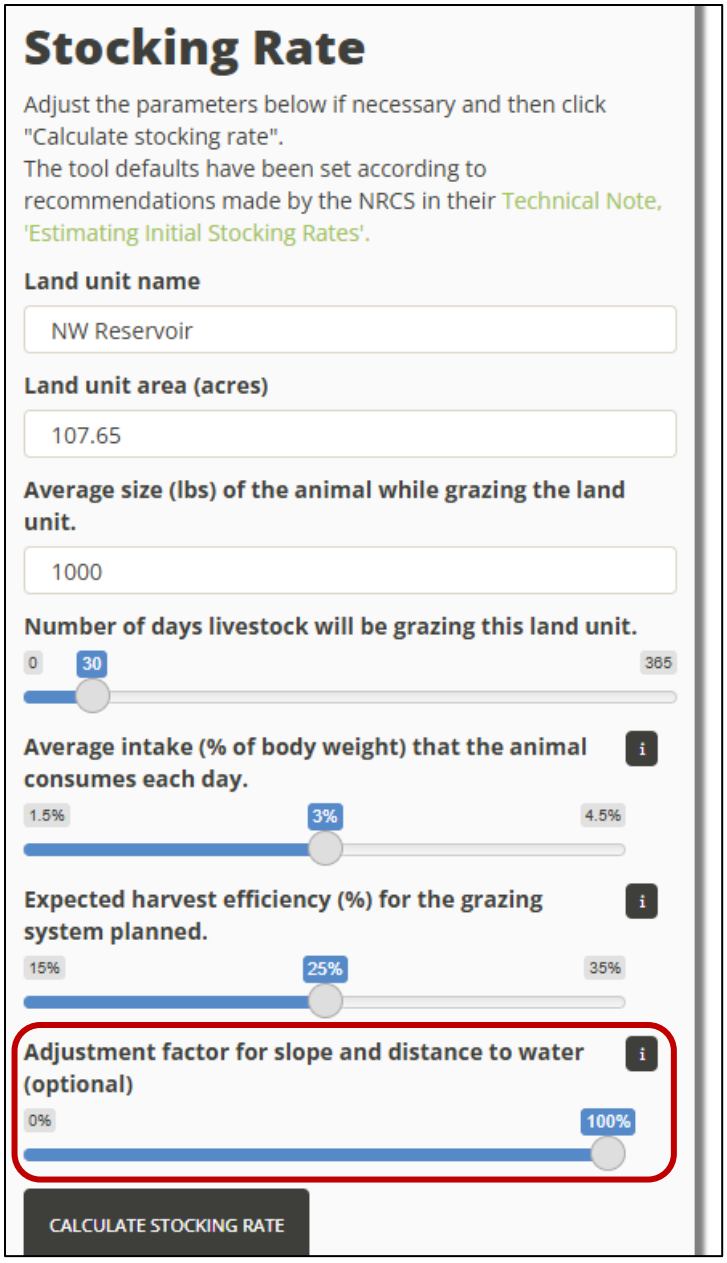


Figure 5: The Stocking Rate Calculator window for the area of interest. In this window, specific animal variables and landscape features can be set to receive a production and stocking estimation summary.

To account for slope and water sources in grazing utilization, RAP has an adjustment factor that you can set. This general matrix is used to account for the availability of forage based upon topography, distance to water, and type or class of livestock in the operation. For example, if your pasture has a percent slope of 0-15 degrees, and your distance to water is approximately 1 mile, you will set your adjustment factor to 90%. *See the information icon to view the adjustment factor table (7).*

Once you have set your variables, click Calculate Stocking Rate.

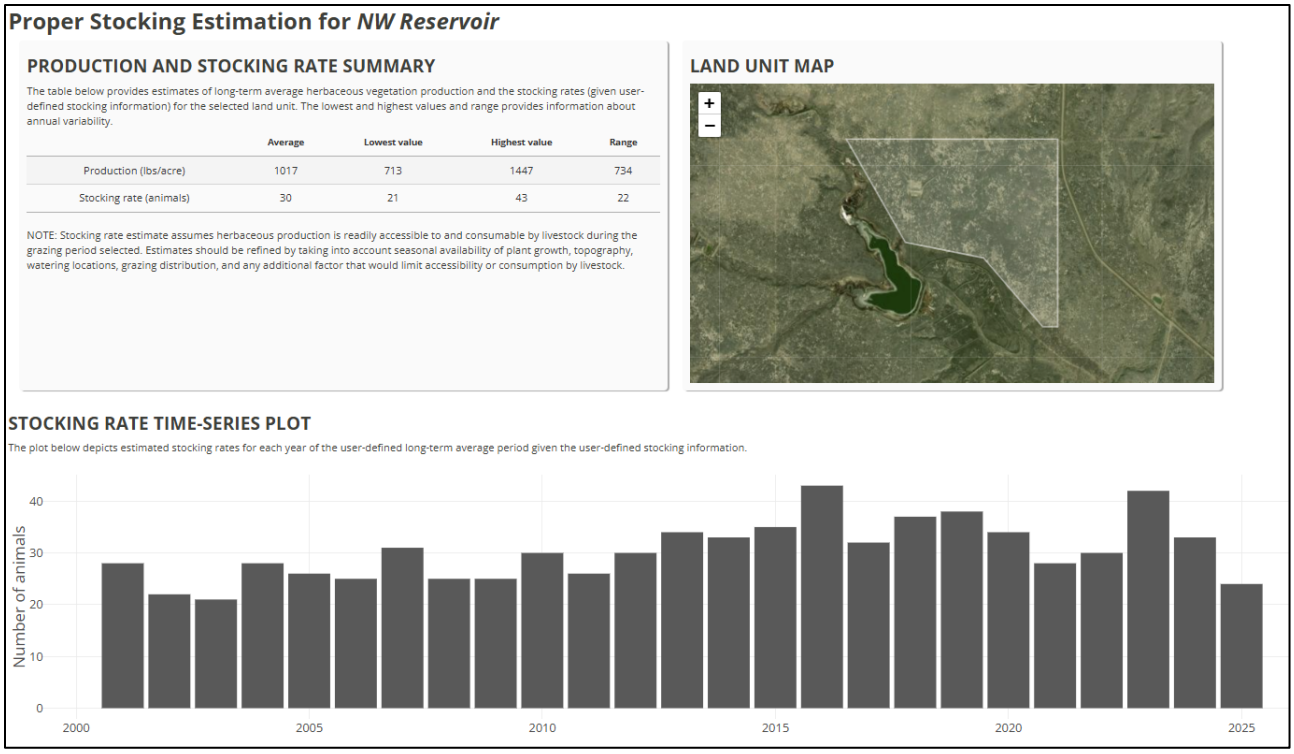


Figure 6: Results of the Stocking Rate Calculator. This page includes a production and stocking rate summary, stocking rate series plot, land unit map, details of the stocking rate calculation, and a production and stocking time series table.

The Production and Stocking Rate Summary

The Production and Stocking Rate Summary provides estimates of long-term average vegetation production and corresponding stocking rates, expressed as the number of animals, based on user-defined grazing and landscape variables.

	Average	Lowest value	Highest value	Range
Production (lbs/acre)	969	735	1354	619
Stocking rate (animals)	344	261	481	220

Table 3: The production table displays long-term average statistics for the selected analysis period and grazing period. It provides insight into pasture production variability by showing the average, minimum, maximum, and range values for the selected grazing period.

Stocking Rate Time Series Plot

The stocking rate time series plot shows the estimated stocking rate for each year of your analysis period, given the user defined stocking information. These numbers are based on the set grazing period.

Details of Stocking Rate Calculations

The details of the stocking rate calculations show the formulas used to calculate the forage available in the pasture, the individual animal's forage demand for the grazing event, and the suggested number of head. These formulations provide an opportunity for the users to critically think about the outputs and make adjustments to match their needs.

Production and Stocking Time Series Table

The production and stocking time series table provides production, stocking, and plant functional type information for each year of the user-defined long-term average period.

All data can be downloaded as an Excel report.

Details of the Stocking Rate Calculations Using Average (2001-2025) Biomass Production

Land Unit: NW Reservoir

1) Determine the Forage Available in the Fields

Acres in Field(s)		Forage Dry Matter Production (Lbs per Acre)		Total Lbs of Forage Dry Matter in Field(s)		Harvest Efficiency (%)		Available Lbs of Forage Dry Matter in Field(s)
107.65	X	1,017	=	109,524	X	25%	=	27,380

2) Determine the Individual Animal's Forage Demand for Grazing Event

Average Live Weight of each Grazing Animal (lbs)		Forage intake Rate (% of body weight per day)		Forage Dry Matter Demand per Head per Day (lbs)		Number of Planned Grazing Days		Forage Dry Matter Demand per Head per Grazing Event (lbs)
1,000	X	3%	=	30	X	30	=	900

3) Determine the Suggested Number of Head

Available Lbs of Forage Dry Matter in Field(s)		Forage Dry Matter Demand per Head per Grazing Event (lbs)		Adjustment factor for water availability and slope		Suggested Number of Head		Suggested Acres per Head
27,380	/	900	x	100%	=	30	OR	3.54

Figure 7: Excell report showing the stocking rate calculator for the area of interest. This information gives insight into how the stocking rate values are calculated. Values can be adjusted to reflect local knowledge and on the ground data.

Getting started with the RAP Vegetation Cover

The Rangeland Analysis Platform's **Vegetation Cover Maps** show the percent cover of up to nine vegetation types at 10 and 30 meter resolution.

Type into your browser **Rangeland Analysis Platform Web Map** or click HERE. This will take you to the vegetation map.

Observing the Vegetation Maps

The vegetation maps in this interface use images from both the Landsat satellite and the Sentinal-2 satellite.

Navigate through the different cover resolutions, and the vegetation categories to familiarize yourself with the layers.

Gathering Results for an Area of Interest

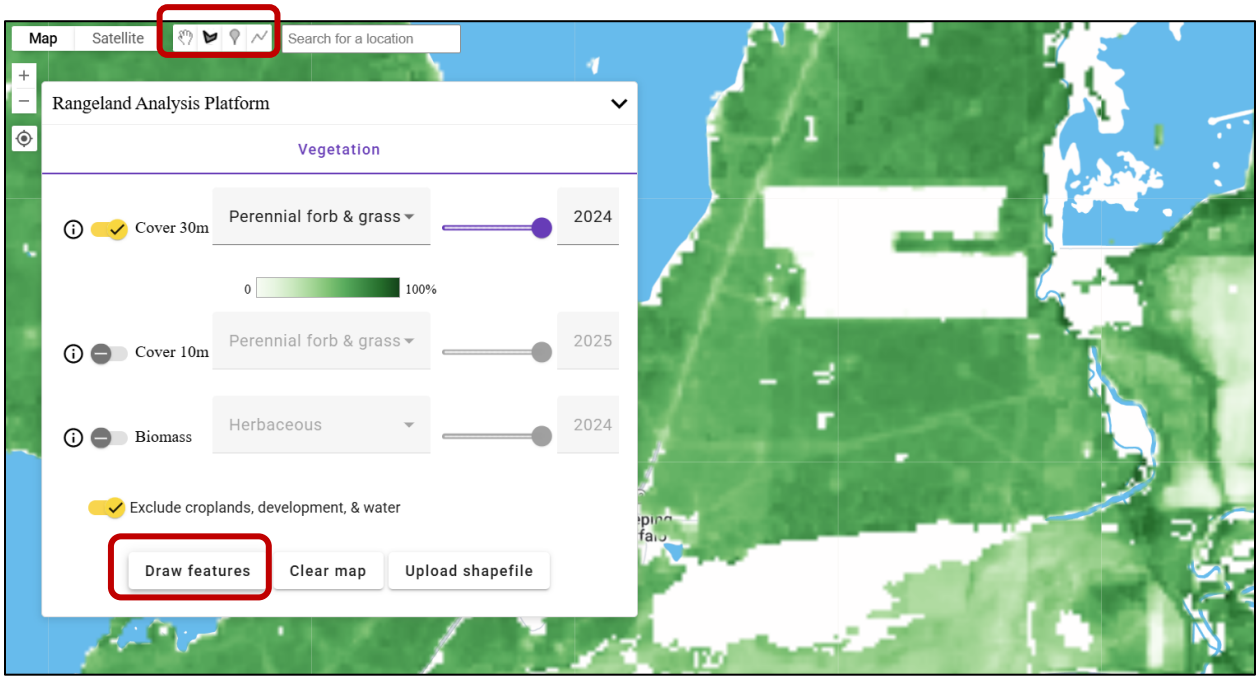


Figure 8: The vegetation map interface. Like the Production explorer, you can draw pastures and get graphs showing vegetation coverage over time. To do this, click on the draw features button and then select the polygon shape at the top left of the screen.

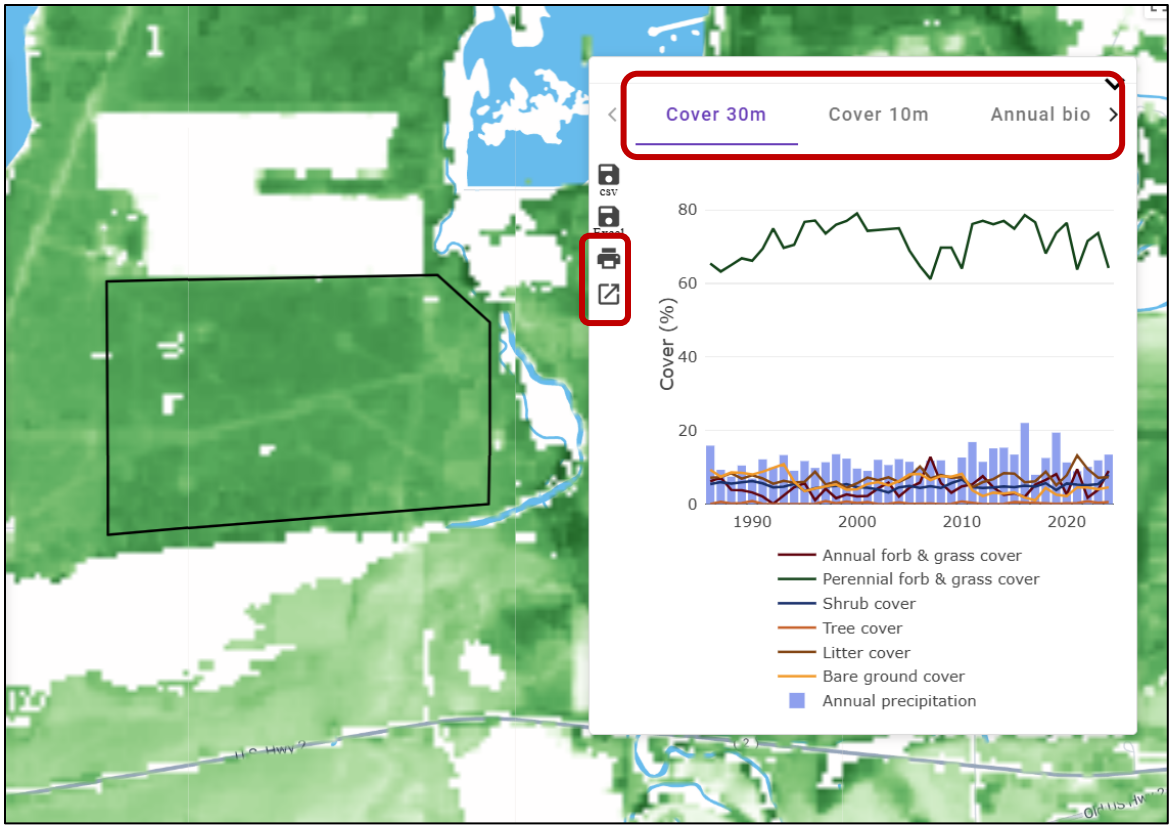


Figure 9: The graphs shown after a polygon is drawn in the vegetation cover map. To expand the graph, click the expand button below the print button.

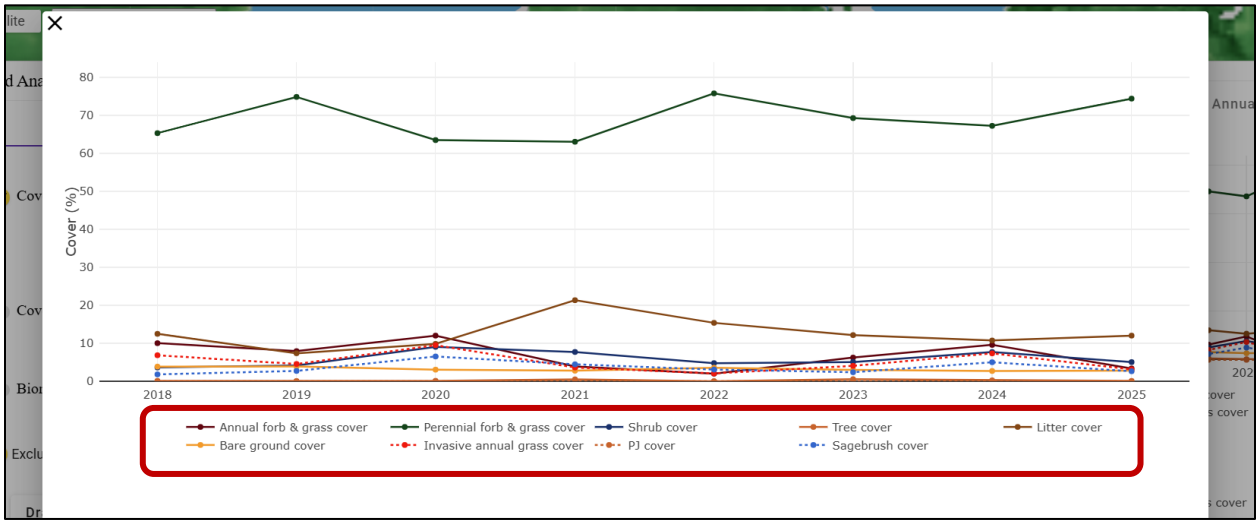


Figure 10: The10 meter vegetation cover graph that shows vegetation type and amount since 2018. By clicking on the legend, you can turn the different vegetation types on or off.

Information about Graphs from the Vegetation Cover

Once you have drawn your polygon, there will be five interactive graphs created. *Revisit table 1 to view satellite types and how they relate to resolution and vegetation classes.*

1. **Cover 30 m.** This graph uses the Landsat satellite to represent vegetation type as present cover since 1986. The resolution is 30 meters, and there are 6 vegetation classes that can be turned on and off.
2. **Cover 10 m.** This graph uses the Sentinel 2 satellite to represent vegetation type as present cover since 2018. The resolution is 10 meters, and there are 9 vegetation classes that can be turned on and off. The cover 10 m can be super useful for observing woody expansion and how it relates to forage availability.
3. **Annual biomass.** This graph uses the Landsat satellite to represent vegetation type in lbs./ acre since 1986. The resolution is 30 meters, and it includes 3 vegetation classes. This is a similar chart to the historical production plot see in the RAP production explorer, but this graph categories vegetation classes.
4. **16-day biomass.** This graph uses the Landsat satellite to represent vegetation type in lbs./ acre for a single year. The resolution is 30 meters, and it includes 3 vegetation classes. This is a similar chart to the current year's production plot seen in the RAP production explorer, but this graph gives more insight into trends in vegetation classes.
5. **Gap cover 10 m**. This graph uses the Sentinel 2 satellite to show the spatial distribution and size of openings (gaps) within the vegetation canopy. The size classes are categorized by cm, which can help when assessing erosion risks. The resolution is 10 meters.

V. Introduction to Stock Smart

Stock Smart allows users to visualize historical and current forage production and understand how landscape features—such as terrain, distance from water, and vegetation composition—interact with livestock use patterns. The application leverages data from the Rangeland Production Monitoring Service (RPMS) and the Rangeland Analysis Platform (RAP) to estimate total annual forage production and partition among shrubs, herbaceous vegetation, and trees.

To better reflect forage that is realistically accessible to livestock, Stock Smart applies terrain and canopy corrections and incorporates user-defined assumptions such as harvest efficiency, shrub utilization, and grazing distribution (5). These tools help producers evaluate production risk, test management scenarios, and make proactive decisions

before committing resources or infrastructure investments. Stock Smart is available through a free user account and is intended to complement, not replace, on-the-ground knowledge and adaptive management.

Similar to the Rangeland Analysis Platform, it is important to follow key guiding principles for interpreting the modeled maps and outputs: use them within a broader decision-making framework, embrace and better understand landscape variability, keep error in perspective, and think critically about potential contradictions (3).

Stock Smart was developed by Washington State University, the University of Arizona, and the USDA National Institute of Food and Agriculture (5).

VI. Utilizing Stock Smart to Assess Stocking Rates

Type into your browser "Stock Smart" or click HERE. Once you have made it to the Stock Smart home page, it is best to create a free account, as this will allow you to save projects.

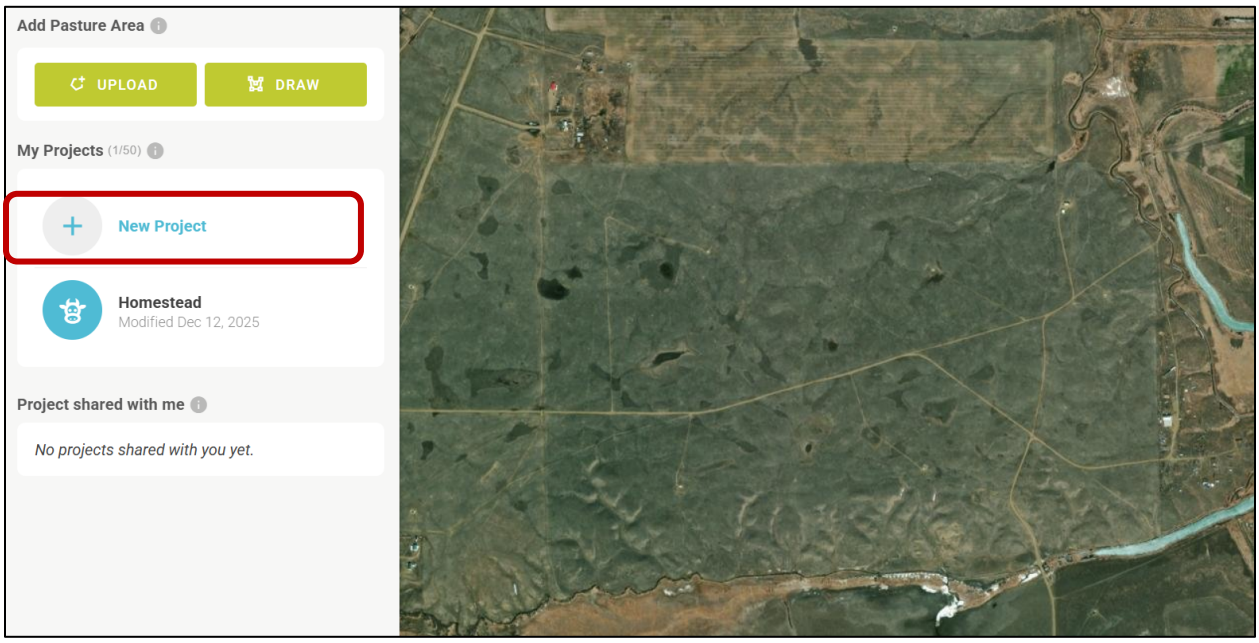


Figure 11: The Stock Smart application after you have signed into an account. After you have created an account, you can start calculating stocking rates. Click new project.

Once you have created a new project, you will first want to define your analysis period under the forage data section.

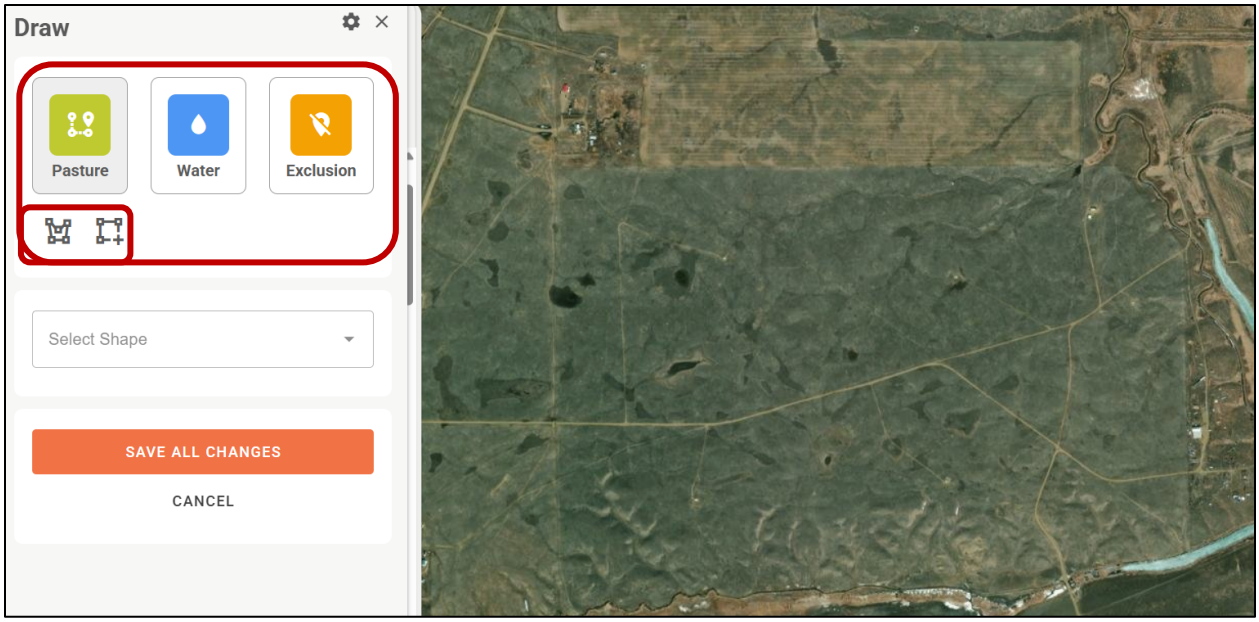


Figure 12: The drawing pane in the Stock Smart map. Here is where you can define your water sources, pastures, and any exclusion areas. After saving pastures, water, and exclusions, you can set animal details, and land details.

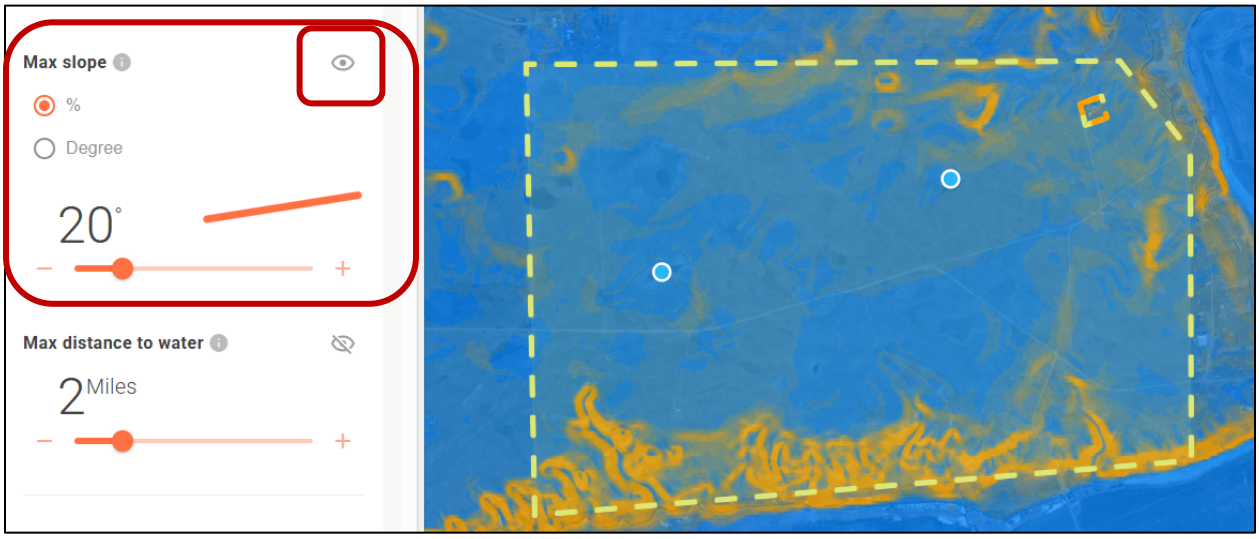


Figure 13: The slope map in the Land details pane. Within the land details pane, you can set the maximum slope that your animals will graze on. This slope correction will be considered in the final forage calculation. To view the slope map as seen in this screenshot, click on the eye icon.

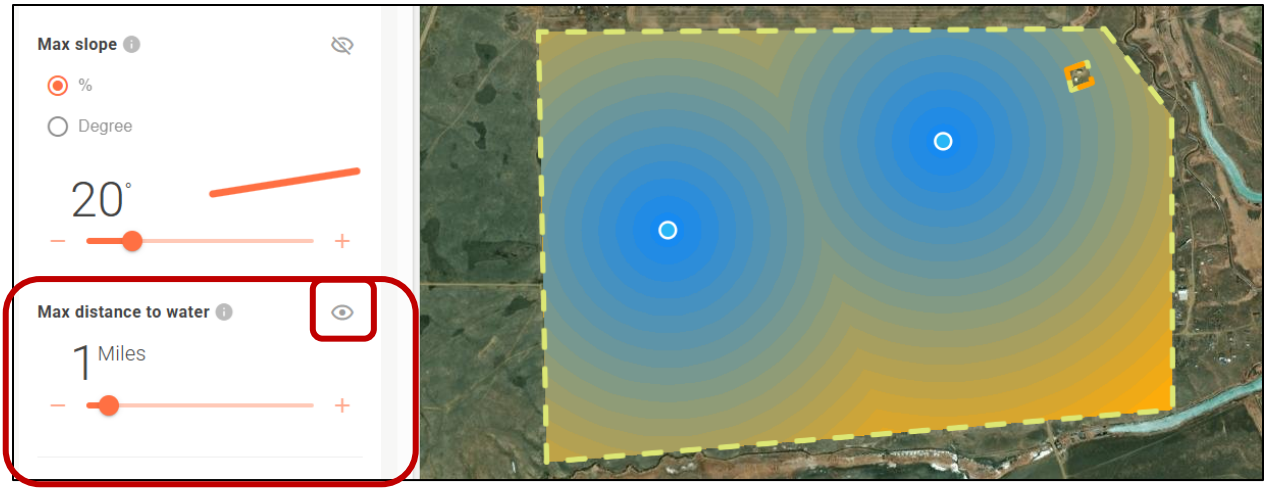


Figure 14: The water buffer map in the Land details pane. Within the land details pane, you can set the maximum distance from a water source your animals will graze on. This distance to water correction will be considered in the final forage calculation. To view the water buffer map as seen in this screenshot, click on the eye icon.

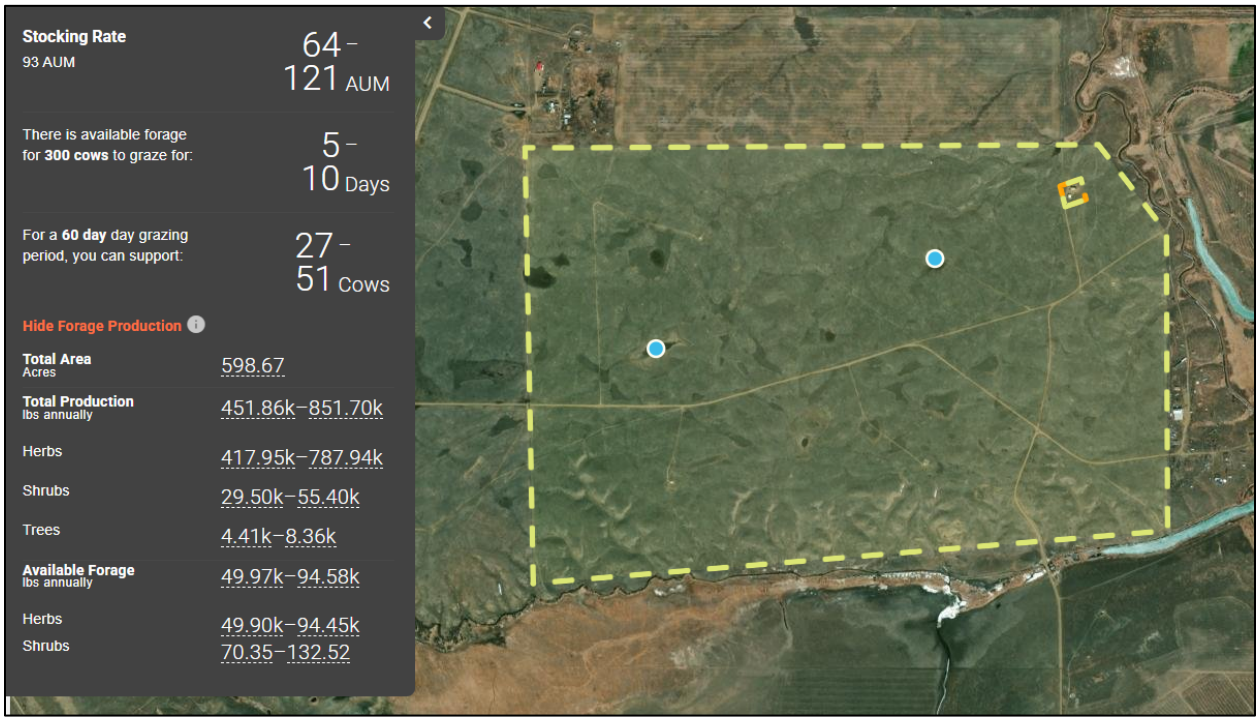


Figure 15: The outputs from the stocking rate calculations for the pasture shown after the water sources, exclusion, animal details, and land details have been accounted for.

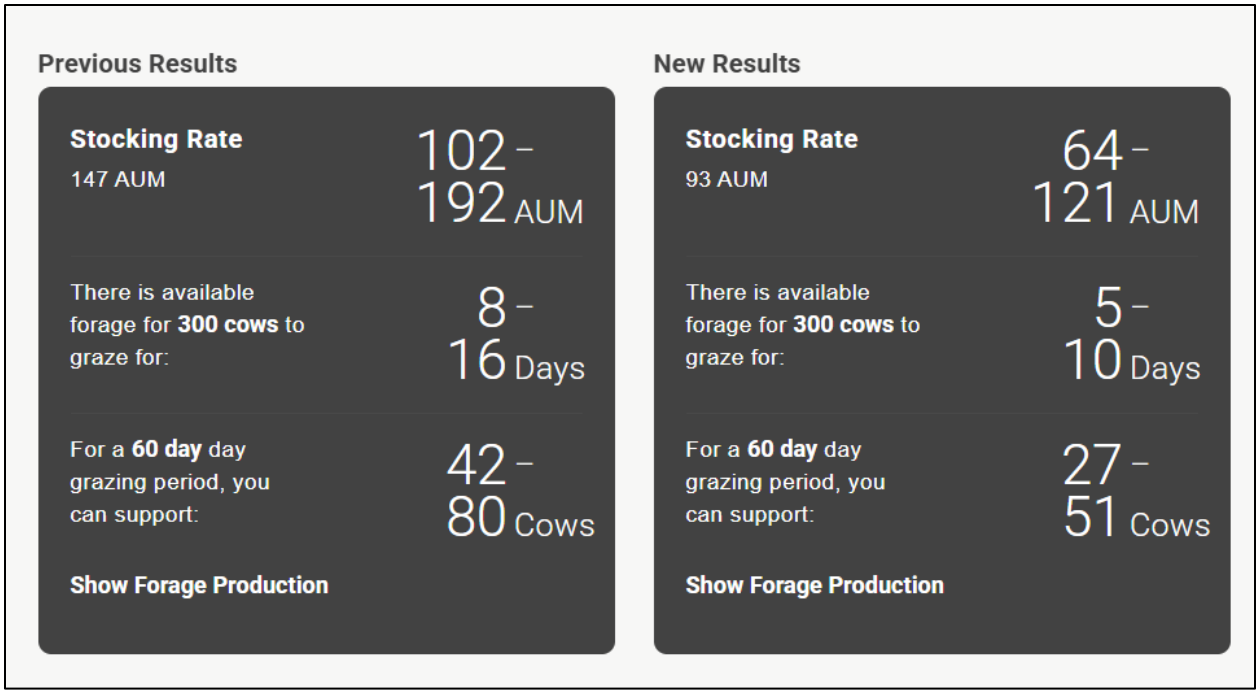


Figure 16: The results pane after a different scenario has been run. Stock Smart allows you to compare past stocking rate results to new stocking rate results if you want to adjust variables in water sources, exclusions, animal details, or land details.

VII. The Benefit of Utilizing Google Mapping Applications in DIY Ranch Mapping

Maps are a powerful tool for those who are working on the land. When land, infrastructure, and daily decisions are spread across miles, having a clear, shared map saves time, reduces confusion, and helps everyone stay on the same page.

Using **Google Earth Pro** and **Google My Maps** lets you build maps that reflect how you work across landscapes (figure 17 & 18). You can mark gates, fences, pipelines, pastures, and water sources, then carry those maps with you on your phone or share them with family members, employees, neighbors, or consultants. Instead of trying to explain directions or boundaries by memory, you can point to a map and know everyone is looking at the same thing.

Because these maps made in Google Pro and My Maps can be used in other applications, the work you put in once can support many different decisions down the road. You can import the maps you make into many applications such as the Rangeland Analysis Platform, Stock Smart, and OnX (Figure 19).

DIY ranch mapping is about making your operation easier to manage today—and easier to understand tomorrow. In series 2 of Mapping with Maida, we will dive deep into how to create personalized maps based on your needs.

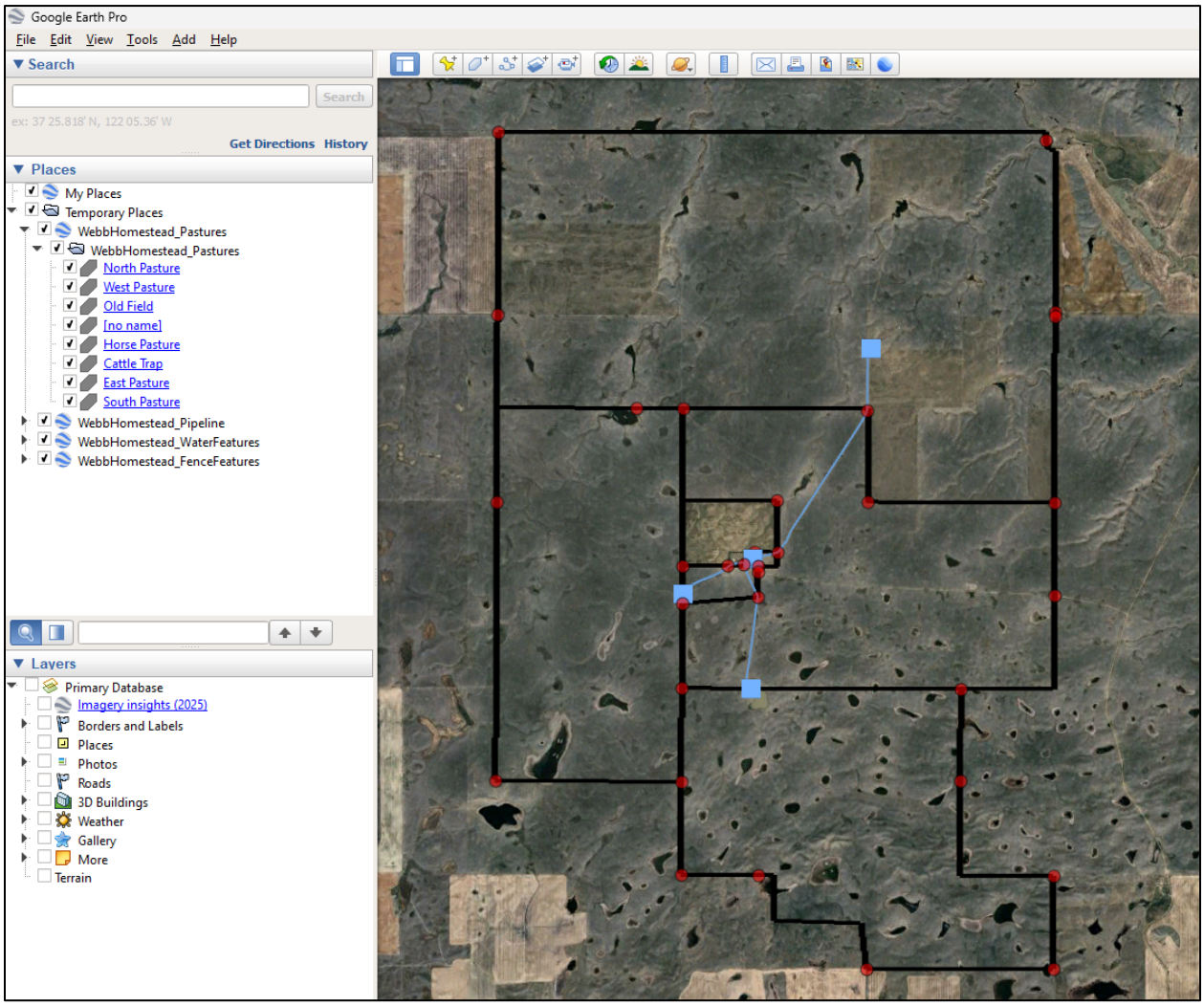


Figure 17: Rach map built with the Google Earth Pro application.

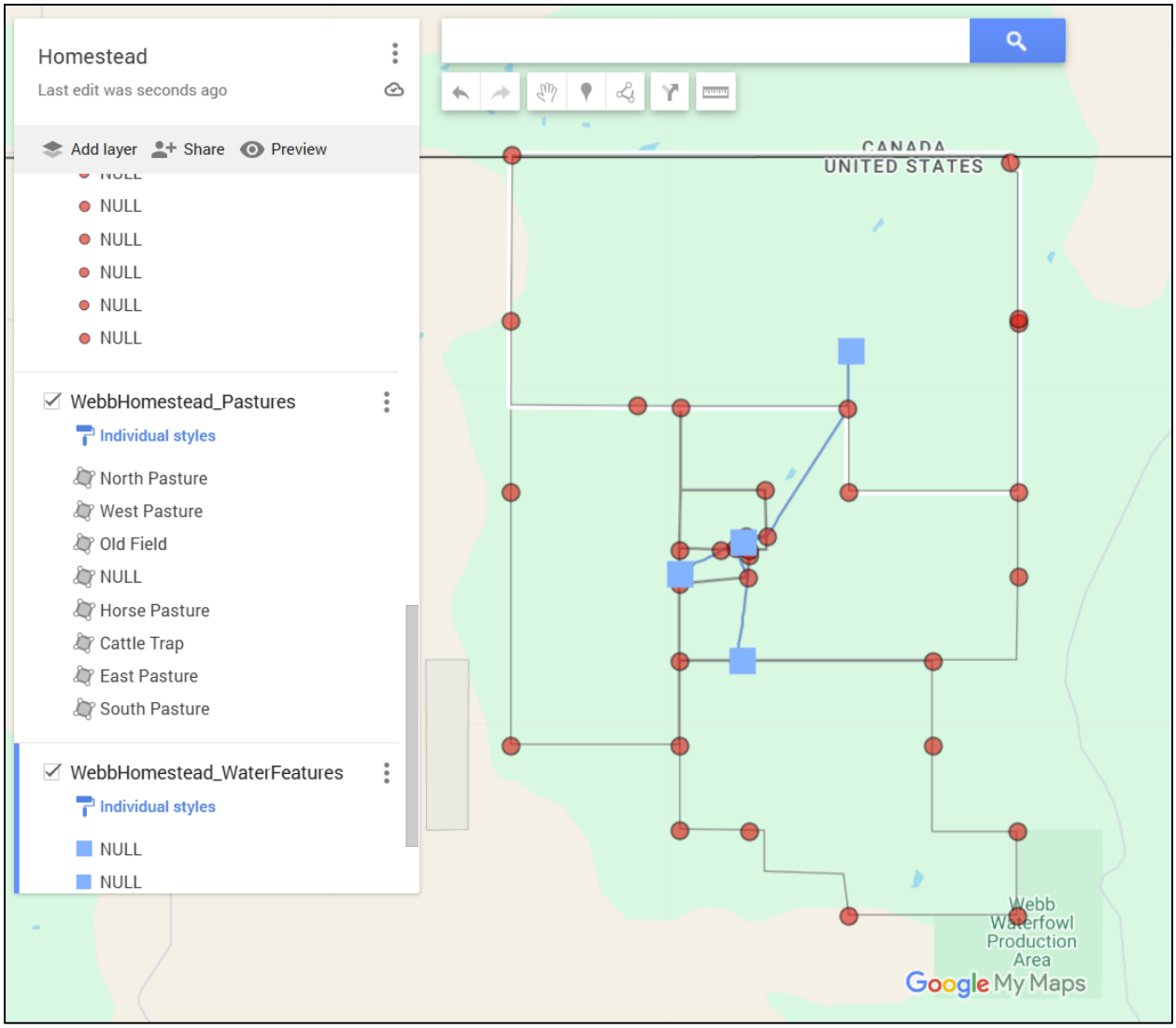


Figure 18: Ranch map built with the Google My Maps application.

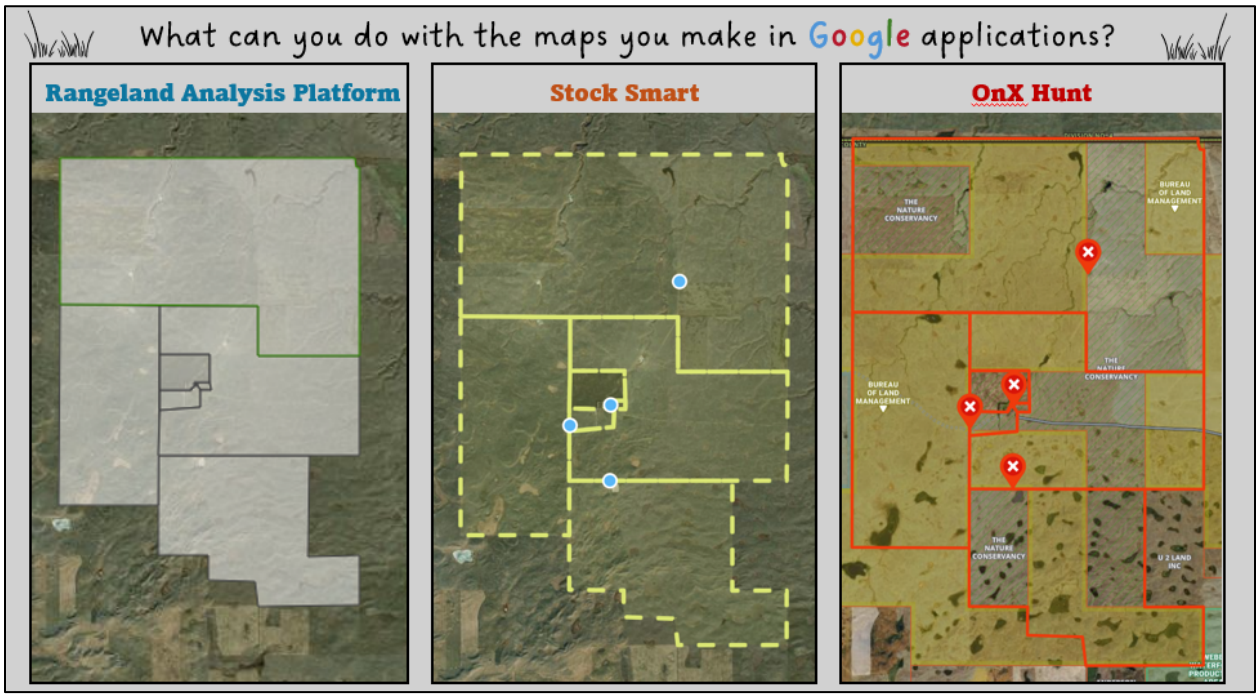


Figure 19: Ranch maps built in Google can be exported into applications such as the Rangeland Analysis Platform, Stock Smart, and OnX Hunt.

VIII. The Benefit of Utilizing Artificial Intelligence to Problem Solve

Artificial Intelligence (AI) can be a helpful tool for problem solving when using mapping applications. AI platforms allow you to describe a scenario you are facing and ask for a solution, which helps to streamline learning and progress when working new programs. The solutions AI platforms offer to a posed question give step by step instructions to solve problems like how to access a tool, or how to draw a polygon. Some AI platforms like ChatGPT can be open source and require no login credentials to use the application.

Here is the link to ChatGPT

IX. Websites Links:

- Rangeland Analysis Platform home page: https://rangelands.app/
- Rangeland Production Lost to Tree Encroachment: https://wlfw.org/yieldgap/Montana/index.html

- Landscape Explorer- historic and current aerial imagery to highlight how our landscapes have changed since the mid-20th century: https://www.landscapeexplorer.org/
- Stock Smart home page: https://www.stock-smart.com/

X. Citations:

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2. Harrison, G. R., Rigge, M., Assal, T. J., Applestein, C., James, D. K., & McCord, S. E. (2025). *An accuracy assessment of satellite-derived rangeland fractional cover*. *Ecological Indicators, 172*, Article 113267. https://doi.org/10.1016/j.ecolind.2025.113267
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