

LANDCART USER GUIDE

LandCART is a NASA-funded collaboration between the BLM, UCLA, and the USGS.
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LANDSCAPE COVER
ANALYSIS AND REPORTING
TOOLS

V1.0

LANDCART

LANDSCAPE COVER ANALYSIS AND REPORTING TOOLS

USER GUIDE (V1.0)

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QUICK LINKS

V1.0 Homepage (best location for updated apps): <https://landcart.org>
or <https://landcart-301816.wm.r.appspot.com//#/>

User Guide (this document): [LandCART Guide V1.pdf](#)

FAQ: [Frequently Asked Questions](#)

Metadata Template: [Appendix F](#)

Report Templates: [Appendix G](#)

Email: BLM_OC_LandCART@blm.gov

Peer-reviewed articles:

Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.

Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.

Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

INTRODUCTION

Welcome to LandCART V1.0. This document provides detailed instructions on how to use the NASA ROSES LandCART online mapping applications (henceforth, “the Apps”).

Use this document as a guide for working through each application. These apps have been through two years of alpha and beta testing. We hope these tools are usable, useful, and used by rangeland managers throughout the western lower 48 states.

Notes to the Guide: This document is best viewed on your computer to use web links and to show Bookmarks in Adobe so that you can find your way around easily.



To use Bookmarks in Adobe Reader, click on the Arrow (mid left) and click on the Bookmarks icon.

LandCART V1.0 – release date 2022.02.15

LandCART V.B.4 – release date 2021.11.18

LandCART V.B.3 – release date 2021.10.20

LandCART V.B.2 – patch update 2021.08.30

LandCART V.B.2 – release date 2021.07.21

LandCART V.B.1 – release date 2021.04.28

NOC On-site Meeting – 2019.10.16 and 2019.10.17

Alpha Testing Stage 2 – 2019.08.09 through 2019.09.06

Alpha Testing Stage 1 – 2019.06.14 through 2019.08.09

LandCART V.A.3 – release date 2019.08.09

LandCART V.A.2 – release date 2019.06.21

LandCART V.A.1 – release date 2019.06.14

For any questions or comments please send an email to BLM_OC_LandCART@blm.gov

ABOUT NASA ROSES AND LANDCART

NASA ROSES: Research Opportunities in Space and Earth Science

<https://science.nasa.gov/researchers/sara/grant-solicitations>

LandCART: Landscape Cover Analysis and Reporting Tools

The goals of the LandCART Project:

- Our collaboration intends to build on existing ideas to provide the BLM with the ability to fuse AIM field data with remote sensing information to make predictions of AIM indicators in places and times where they were not measured.
- To create **continuous maps of core indicators based on AIM field data using on-the-fly model making** with machine learning (Random Forest) and prediction using all available information.
- Analysis and data storage/serving by **Google Earth Engine**.
- **Sub-annual** (seasonal, monthly, bi-weekly) map-making and **inter/intra- annual time series capability**.
- Backed by rigorous analyses of the effect of training data from **different places and times** in production of relatively small-scale maps.
- With **spatial estimates of uncertainty/confidence** associated with predictions.
- Ability to output all necessary information to the **NEPA Administrative Record**.
- A tool created in response to **needs expressed by Field Office staff**.
- **Assess** the utility of this tool for BLM staff.

Not your usual researcher-resource manager relationship:

- The NASA Applied Sciences Program promotes the discovery and demonstration of innovative and practical uses of Earth observations for **decision-making**.
- This Program funds applied science research and applications projects to enable near-term uses of Earth observations, formulate new applications, integrate Earth observations and related **products within practitioners' decision-making**, and transition the applications to **sustained use** by partner organizations.
- The goal is for these partner organizations to achieve **sustained use** of and benefits from the Earth observations.

Ecological Forecasting Element:

- *Remote Sensing as a Catalyst for Large-scale Conservation*
 - Effectively linking natural landscapes and seascapes for enhanced connectivity and large-scale conservation requires a "big-picture" perspective.
 - Satellite imagery can enable organizations to understand the broader contexts for conservation planning and assist in assembling integrated landscapes and seascapes.
 - Proposals to this topic should identify and describe a conservation challenge dependent upon enhancing connectivity and/or biological movement at spatial scales sufficient for satellite remote sensing to have a positive impact. **Proposals must plan for the development—and deployment—of an Earth observations-based solution to this challenge.**

What made the LandCART proposal possible?

- Massive amounts of high-quality data collected over large areas in diverse ecosystems through many years
 - The BLM Assessment, Inventory, and Monitoring (AIM) program!
- Availability of cloud-computing architecture with remote sensing data to perform analyses
 - Google Earth Engine
- Similar efforts include:
 - The Rangeland Analysis Program (RAP) – an online mapping tool with annual, static data
 - United States Geological Survey National Land Cover Database (USGS NLCD) Rangeland Condition Monitoring Assessment and Projection (RCMAP, formerly known as Grass/Shrub Mapping and Monitoring)– large datasets covering the Western US available for download

ABBREVIATION DEFINITIONS:

AIM – Assessment, Inventory, and Monitoring

AOI – Area of interest

TOI – Time period of interest

IOI – Indicator of interest

GCP – Google Cloud Platform

GEE – Google Earth Engine

UI – User interface

NASA Science Mission Directorate

Research Opportunities in Space and Earth Science – 2016

NNH16ZDA001N-ECO4CAST

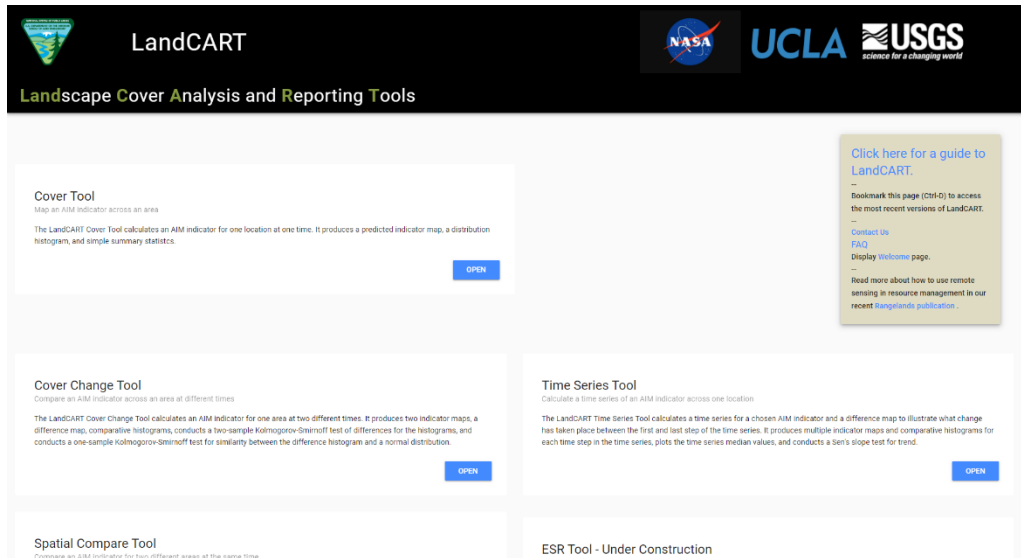
A.46 Earth Science Applications: Ecological Forecasting

16-ECO4CAST-0025

LANDCART HOMEPAGE

Please always start your LandCART session at this homepage: landcart.org

- This page will always have the most up-to-date Apps and any notes we want to send out to the testing group, for instance, if this user guide is updated and uploaded to the homepage.
- It also has links to a FAQ page and the LandCART email address for other questions.



STATISTICS REVIEW

THE LARGE-N PROBLEM

Traditional parametric statistics usually denote ‘n’ as the number of samples taken from some larger population of potential samples. If, for example, a rangeland management specialist was monitoring a pasture with 10 plots (plots are the independent sample units) that were measured in 1980 and remeasured in 2000, n would equal 10. A paired t-test could be used in this case to determine whether the means of the 1980 measurements and the 2000 measurements were different. Generally speaking, the larger n is, the smaller the difference that can be detected with traditional parametric statistics like the t-test, ANOVA, and more sophisticated approaches. Because it is assumed that it is more difficult to collect more data (e.g., measure more plots), much of traditional statistical training and practice is focused on determining the smallest n that can be used to detect the difference or change that is determined to be important for a study or management question.

In remote sensing, we often measure the entire area of interest (i.e. the entire pasture), so there is not a ‘sample’ in the traditional sense. In addition, there are often thousands or even millions of pixels in an area of interest. For reference, a 1000-pixel square is only ~32 pixels on a side and if those pixels are 30 m each, as they are for LandCART, this square is slightly less than 1-km on a side (1km² or 247 acres; 1 acre is approximately 4 30-m pixels), which is smaller than most all BLM management units. If each pixel is treated as a sample, as we usually do with plot-level data, then n is very large and even the smallest difference will be deemed significant even if is clearly inconsequential. This is termed the “large-n problem”.

Because of the large-n problem, traditional parametric statistics (like t-tests) cannot be used with remote sensing data in most cases. Luckily, there are ways to test for differences using nonparametric statistics to do much of the work done by traditional statistical tests.

NON-PARAMETRIC STATISTICS: THE KOLMOGOROV-SMIRNOV (KS) TEST

The KS test is a nonparametric statistic that tests whether two distributions are different. The two distributions can be two observed distributions (i.e., the histograms from an AOI), called a two-sample KS test, or they can be an observed distribution compared to a reference distribution (e.g., a normal distribution), called a one-sample KS test.

In both a two-sample and one-sample KS test, n is the number of bins in the histogram rather than the number of pixels that went into making the histogram. Thus, a large AOI with millions of pixels can be represented as a distribution (histogram) with a small number of n, thus avoiding the large-n problem. Because the size of the bins used to construct an empirical distribution is arbitrary, the KS test does require some choices. LandCART uses 20 bins of 5% cover.

LandCART constructs histograms for the two-sample KS test from the pixels within the AOI at the two times chosen. For the one-sample KS test, the difference between the pixels in the AOIs (i.e., the “difference map”) is used to construct a histogram and the standard deviation of the difference map is also calculated. For the one-sample KS test, LandCART reports the probability (i.e., p-value) that the difference map histogram is different from a normal distribution with mean equal to zero and standard deviation equal to that of the standard deviation of the difference map.

As with parametric statistics the larger n (i.e., the more bins in the histogram), the smaller the difference that can be detected (i.e., that is, the p-value decreases with increasing n). Thus, the exact p-value

calculated is dependent upon the construction of the histogram. This is one of the reasons that we discourage use of strict thresholds in interpreting the importance of differences. It could easily be the case, for example, that histograms constructed using 20 bins would be considered “significant” with 95% probability (i.e., $p\text{-value} \leq 0.05$) and histograms constructed using 10 bins from the same data would be considered “not significant” with 95% probability (i.e., $p\text{-value} > 0.05$). However, as long as the number of bins remains constant a lower $p\text{-value}$ means that a difference is more likely to be important. We use the word “important” here because the word “significant” is often associated with statistical significance, (i.e., interpretation of a $p\text{-value}$ based on whether it is above or below a threshold value).

For instance, you will likely find that the following statistics reflect **an important difference** between the two prediction distributions AND **an important difference** between the difference distribution and a normal distribution:

Two Sample KS Test

p-value: **0.000**

One Sample KS Test

p-value: **0.000**

Total Foliar 2015

Mean: 50%

Standard Deviation: 7%

5th Percentile: 37%

10th Percentile: 39%

50th Percentile: 51%

90th Percentile: 60%

95th Percentile: 63%

Total Foliar 2020

Mean: 50%

Standard Deviation: 7%

5th Percentile: 35%

10th Percentile: 38%

50th Percentile: 51%

90th Percentile: 58%

95th Percentile: 61%

Difference 2020 minus 2015

5th Percentile: -9%

10th Percentile: -6%

50th Percentile: 0%

90th Percentile: 4%

95th Percentile: 7%

On the other hand, the following statistics reflect that the difference between the two prediction distributions AND between the difference distribution and a normal distribution are **not important** – BUT – you might decide a threshold of $\alpha = 0.05$ does not apply to the question you are asking of the data and there IS, in fact, an important difference between the two prediction distributions:

Two Sample KS Test

p-value: **0.053**

One Sample KS Test

p-value: **0.098**

Shrubs 2015

Mean: 17%

Standard Deviation: 2%

5th Percentile: 13%

10th Percentile: 14%

50th Percentile: 17%

90th Percentile: 21%

95th Percentile: 22%

Shrubs 2020

Mean: 17%

Standard Deviation: 2%

5th Percentile: 13%

10th Percentile: 13%

50th Percentile: 16%

90th Percentile: 21%

95th Percentile: 22%

Difference 2020 minus 2015

5th Percentile: -5%

10th Percentile: -4%

50th Percentile: 0%

90th Percentile: 3%

95th Percentile: 3%

NON-PARAMETRIC STATISTICS: SEN'S SLOPE TEST FOR A TREND

Sen's Slope test (sometimes called the Thiel-Sen Estimator) is a way to determine if a trend in data (here, a temporal trend) is meaningful. It is a nonparametric alternative to the parametric least-squares linear regression of change vs. time. It is calculated by a) first, finding all possible pairs of observations, 2) second, calculating the slope between all possible pairs (e.g., change in foliar cover/separation in time between the two points), and 3) finally, calculating the median on all of the slopes. A p-value can be calculated to determine how likely a trend is to be real and not arising by chance.

LandCART calculates the mean value within an AOI for the chosen indicator for each time period and then calculates the p-value of Sen's Slope based on this. Therefore, in LandCART, the p-value provides an estimate of whether there is a meaningful trend in the mean for an indicator within the AOI.

Sen's Slope test for a trend is less sensitive to outliers than least squares linear regression. And, if the same number of points are used in each year of the analysis, it is also insensitive to regular seasonal variation.

As with parametric statistics the larger n (i.e., the more bins in the histogram), the smaller the difference that can be detected (i.e., that is, the p-value decreases with increasing n). For Sen's Slope, n is the number of possible pairs between time periods which, in turn, depends directly upon how many time periods are used in the analysis (number of pairs = $0.5n(n-1)$). Thus, the exact p-value calculated is dependent upon the number of time periods used, but not when those time periods are. This dependence upon the number of time periods is one of the reasons that we discourage use of strict thresholds in interpreting the importance of trends. It could easily be the case, for example, that slopes calculated using 10 time periods would be considered "significant" with 95% probability (i.e., p-value ≤ 0.05) and slopes using 8 time periods would be considered "not significant" with 95% probability (i.e., p-value > 0.05). However, as long as the number of time periods remains constant, a lower p-value means that a difference is more likely to be important (this word is better here, because the word "significant" is often associated with statistical significance, i.e., interpretation of a p-value based on whether it is above or below a threshold value).

For instance, you will likely find that the following statistics reflect that there is **not a meaningful trend** in the mean for the Total Foliar prediction:

Sen's Slope Test for Trend

Time Series from 2015 thru 2020

p-value: **0.372**

Average Slope: **-0.3%/year**

Total Foliar 2015

Mean: 50%

Standard Deviation: 7%

5th Percentile: 37%

10th Percentile: 39%

50th Percentile: 51%

90th Percentile: 60%

95th Percentile: 63%

Total Foliar 2016

Mean: 53%

Standard Deviation: 8%

5th Percentile: 38%

10th Percentile: 42%

50th Percentile: 54%

90th Percentile: 63%

95th Percentile: 67%

Total Foliar 2017

Mean: 54%

Standard Deviation: 8%

5th Percentile: 38%

10th Percentile: 43%

50th Percentile: 54%

90th Percentile: 66%

95th Percentile: 68%

Total Foliar 2018

Mean: 43%

Standard Deviation: 8%

5th Percentile: 29%

10th Percentile: 31%

50th Percentile: 44%

90th Percentile: 54%

95th Percentile: 55%

Total Foliar 2019

Mean: 53%

Standard Deviation: 7%

5th Percentile: 38%

10th Percentile: 43%

50th Percentile: 53%

90th Percentile: 63%

95th Percentile: 66%

Total Foliar 2020

Mean: 50%

Standard Deviation: 7%

5th Percentile: 35%

10th Percentile: 38%

50th Percentile: 51%

90th Percentile: 58%

95th Percentile: 61%

Difference 2020 minus 2015

5th Percentile: -9%

10th Percentile: -6%

50th Percentile: 0%

90th Percentile: 4%

95th Percentile: 7%

Whereas a p-value of **0.004** and an average slope of **-4.9%/year** likely reflects a meaningful trend.

A NOTE ON INTERPRETATION OF P-VALUES AND STATISTICAL SIGNIFICANCE

Whether in parametric (t-test, ANOVA) or nonparametric statistics (KS test, Sen's Slope), the p-value provides an indication of how likely a result is to be real and not arising by chance. The statistical jargon for this is "significant", and significance is often determined by whether the p-value is less than or greater than a specific threshold (e.g., 95% confidence that a result is significant is associated with a p-value threshold of 0.05).

The use of such a threshold has taken root across the sciences and is a pervasive problem in the application of statistical reasoning to decision- and policymaking. Such a threshold tells us that a p-value of 0.049 is "significant" and a p-value of 0.051 is "not significant". It does not tell us whether an effect is likely *meaningful*. It also does not tell us whether there is no difference between populations, only that we cannot tell that there is a difference with a certain degree of confidence given specific statistical assumptions. An excellent Comment in *Nature* discusses the problems with this sort of statistical reasoning: <https://www.nature.com/articles/d41586-019-00857-9>.

Mark Twain popularized the saying that "There are three kinds of lies: lies, damn lies, and statistics," which he attributed to Benjamin Disraeli. This sentiment underscores the many ways that statistical reasoning can be misused, either intentionally or unintentionally. The use of a hard threshold for p-value is just one example of the potential of statistics for misuse. Another way is how things like p-values, which seem concrete, can be manipulated to make differences seem more or less important than they may be. For instance, depending on the assumptions (i.e., whether two populations have the same variance, homoscedastic, or different variance, heteroscedastic; or, whether the direction of an effect is known, one-tail, or not known, two-tail) the same populations will yield different p-values. These assumptions say nothing about the actual populations, only our assumptions about them. The problem is amplified when there is inconsistency in assumptions from one test to another. A one-tailed test will yield a lower p-value than a two-tailed test, and a homoscedastic test will yield a lower p-value than a heteroscedastic test.

Additionally, traditional parametric (and some nonparametric) statistics entirely ignore the spatial correlation between measurements and assume that error is likewise aspatial, thus the use of a p-value threshold (e.g., $p \leq 0.05$) risks misinterpreting the importance of a difference when this effect isn't taken into account. Tobler's First Law of Geography is "everything is related to everything else, but near things are more related than distant things". Thus, in spatial data, such as those provided used in and provided by LandCART, there is almost always a spatial relationship between measurements/predictions.

We urge care in the use of statistical tests in interpreting LandCART results. The following guidelines are intended to help:

- 1) Parametric statistics (e.g., ANOVA, t-test) should not be used with raster data, like that provided by LandCART. LandCART provides nonparametric statistics (e.g., the KS test and Sen's Slope) that will work with raster data by avoiding the large-n problem and, further, carry no assumptions about normality or variance.
- 2) Thresholds to determine "significance" should not be used (e.g., the result is significant with 95% confidence if $p \leq 0.05$, or $\alpha = 0.95$).
- 3) Lower p-values suggest that a difference or trend is more likely to be real than higher p-values.

- a. When testing if the difference in an area between two time-periods is different (KS Test), also test if the difference between two time-periods in a nearby area with a different history that can serve as a control or comparison.
 - b. Similarly, when testing if a trend in an area is meaningful (Sen's Slope), also test the trend in a nearby area that has a known management that can serve as a control or comparison.
 - c. For example, when evaluating the history of grazing allotment (either KS test from LandCART's Cover Change Tool or Sen's Slope from LandCART's Time Series Tool), calculate the p-value of a nearby exclosure or area known to be meeting rangeland health standards over the same time period to see if the p-value is lower for the target vs. comparison pastures.
- 4) p-values should only be compared when assumptions and the number of measurements (i.e., n) are the same. In LandCART, the assumptions will always be consistent for the difference tool. However, care must be taken when comparing p-values for different time series. Because the p-value of Sen's Slope depends on the number of time periods in a time series, only p-values that use the same number of time periods should be compared. There is no requirement that the time of the predictions (beginning date, end date, or in-between dates) be the same.
- 5) For most cases, the spatial dependence of error and spatial correlation of measurements can be ignored when calculating or comparing p-values for the same area using the KS Test or Sen's Slope. This because the underlying spatial autocorrelation in the area will likely be similar during two different times.
 - a. The major exception to this guideline is when the something in an area drastically changes the landscape.
 - b. For example, *immediately* after a fire, cover in the fire scar should not be compared with cover before the fire due to the spatial autocorrelation being changed by the fire. Spatial variations in burn intensity and firefighting, for example, could produce difficult-to-interpret results. After some time has elapsed, these fire- or firefighting-induced spatial variations will be reduced, and this guideline can be relaxed. In either case (immediately after a fire and after some time has elapsed), the burn area could be segmented into other or smaller areas that have experienced similar impacts (for example, use LandCART's ability to choose specific areas by hand to only include the fire scar in the AOI, or separate different lobes of a fire scar into different AOIs), to calculate a useful p-value.

FRACTIONAL COVER TYPES

Choices available for fractional cover types with the [AIM](#) indicator definitions used to define them. All indicator calculations are derived from the Line Point Intercept method (typically 150 points on three transects per plot).

Annual Forb = AH_AnnForbCover

The cover of annual forbs in the plot/pixel.

Annual Grass = AH_AnnGrassCover

The cover of annual grasses in the plot/pixel.

Annual Herbaceous = AH_AnnForbGrassCover

The cover of annual forbs and grasses in the plot/pixel.

Bare Ground = BareSoilCover + FH_DepSoilCover + FH_RockCover

The basal cover of soil, rocks, and deposited soil (all first hit) in the plot/pixel, not including ground with cover above it. For example, points with sagebrush over bare ground are not counted in the indicator.

Bare Soil = BareSoilCover

The basal cover of soil in the plot/pixel, not including soil that has cover above it. For example, points with sagebrush over bare soil are not counted in this indicator, also points with rock as the soil surface code are not counted in this indicator.

Canopy Gaps greater than 25cm = GapCover_25_plus

The percentage of the plot/pixel's soil surface covered by gaps between plant canopies that are greater than 25 cm in size.

Canopy Gaps greater than 100 cm = GapCover_101_200 + GapCover_200_plus

The percentage of the plot/pixel's soil surface covered by gaps between plant canopies that are greater than 100 cm in size.

Canopy Gaps greater than 200 cm = GapCover_200_plus

The percentage of the plot/pixel's soil surface covered by gaps between plant canopies that are greater than 200 cm in size.

Herbaceous = AH_ForbGrassCover

The cover of forbs and grasses (annual, perennial, and biennial) in the plot/pixel.

Perennial Forb = AH_PerenForbCover

The cover of perennial forbs in the plot/pixel.

Perennial Grass = AH_PerenGrassCover

The cover of perennial grasses in the plot/pixel.

Perennial Herbaceous = AH_PerenForbGrassCover

The cover of perennial forbs and grasses in the plot/pixel.

Sagebrush = AH_SagebrushCover

The cover of sagebrush in the plot/pixel.

Shrubs = AH_ShrubCover

The cover of shrubs in the pixel, including sub shrubs.

Shrubsucculent = AH_ShrubSucCover

The cover of shrubs in the pixel, including sub shrubs and succulents.

Succulent = AH_SucculentCover

The cover of succulents in the plot/pixel.

Total Foliar = TotalFoliarCover

The foliar cover of plants in the plot/pixel.

Trees = AH_TreeCover

The cover of trees in the plot/pixel.

Woody = AH_WoodyCover

The cover of woody vegetation in the plot, including trees, shrubs, sub shrubs, and succulents in the plot/pixel.

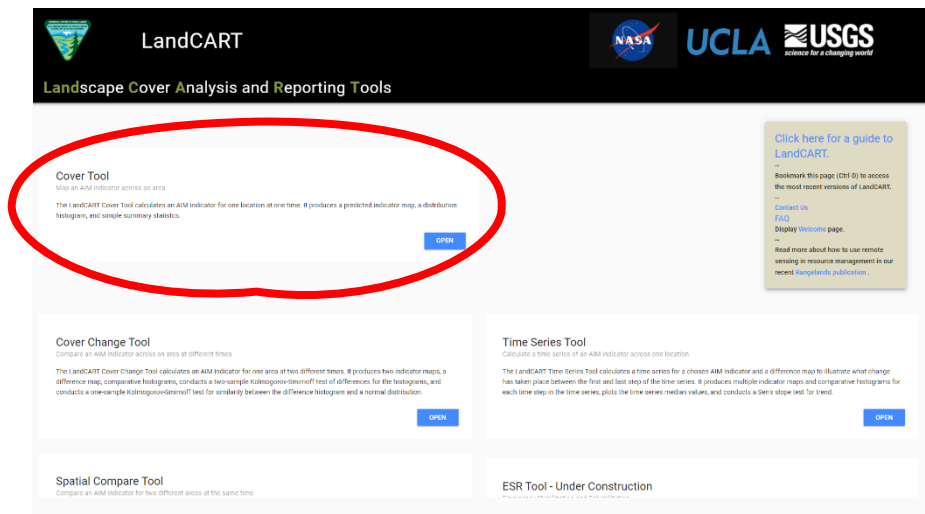
APPS AVAILABLE IN LANDCART

Remember, always start at the [LandCART homepage](#) to access the most up-to-date apps!

Four Apps are available in LandCART:

1. [LandCART Cover Tool calculates fractional cover.](#)
2. [LandCART Cover Change Tool compares versions of an indicator mapped at two different times on a split-panel screen.](#)
3. [LandCART Spatial Compare Tool compares an indicator mapped for two different areas at the same time.](#)
4. [LandCART Timeseries Tool creates a time series chart and/or video.](#)

LANDCART COVER TOOL



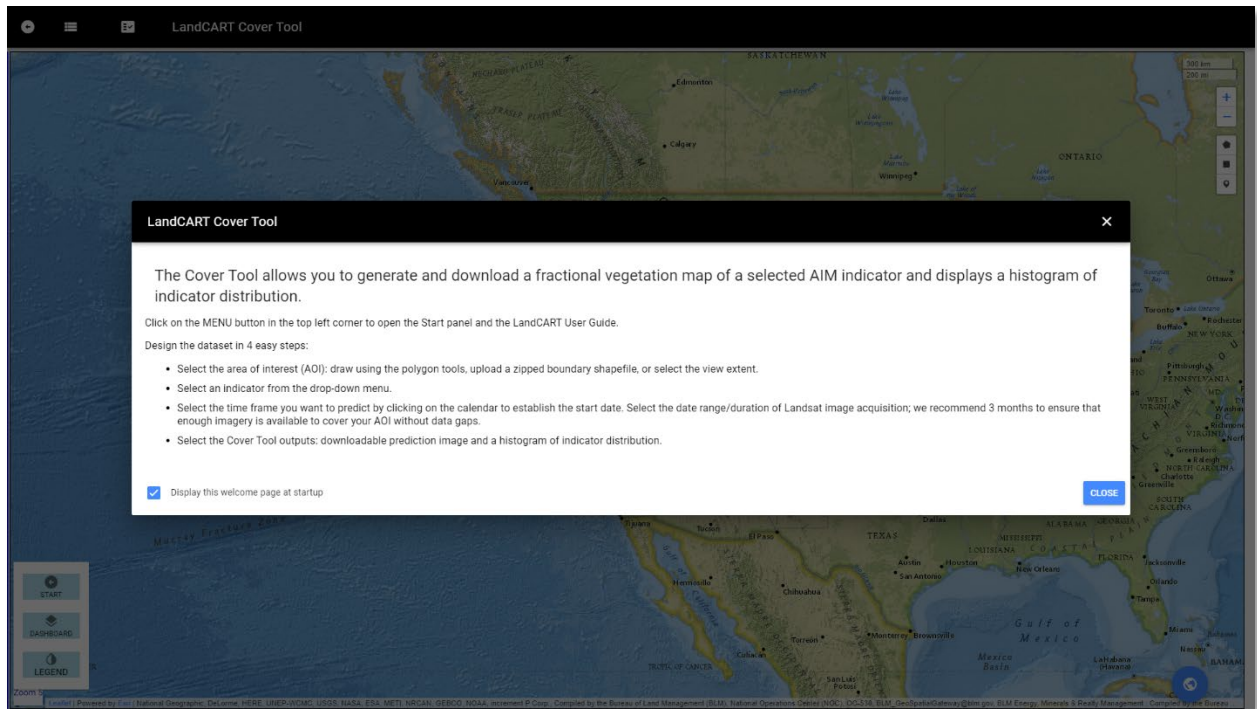
This app allows the user to predict a continuous fractional cover map to represent AIM indicators for a selected AOI and TOI. It produces an indicator map, simple summary statistics, and a histogram for the indicator you have chosen.

List of fractional cover types available in LandCART V1.0 (see [LandCART Fractional Cover Types](#) for details of how the AIM indicators are calculated/defined).

- Annual Forb
- Annual Grass
- Annual Herbaceous
- Bare Ground
- Bare Soil
- Canopy Gaps greater than 25cm
- Canopy Gaps greater than 100 cm
- Canopy Gaps greater than 200 cm
- Herbaceous
- Perennial Forb
- Perennial Grass
- Perennial Herbaceous
- Sagebrush
- Shrubs
- Shrubsucculent
- Succulent
- Total Foliar
- Trees
- Woody

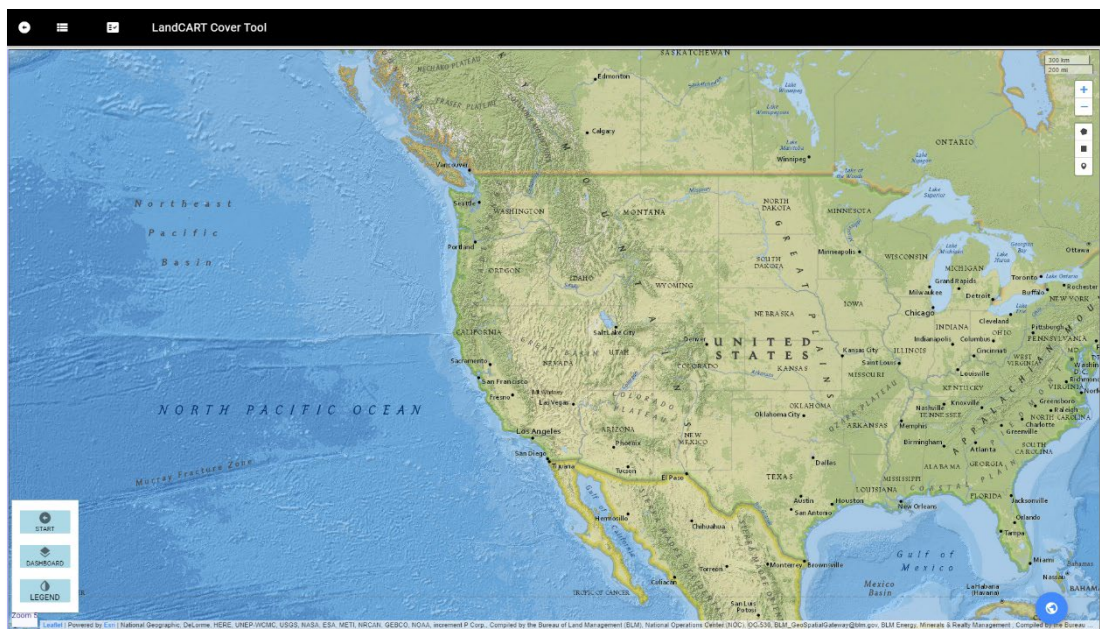
OPENING THE COVER TOOL

When you open the Cover Tool the first time, your web browser will open to this screen:



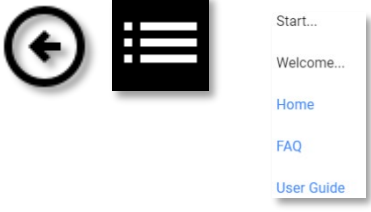



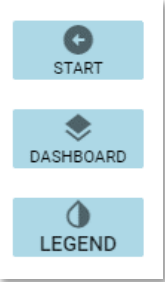
Read and close the splash screen to continue. You can choose to stop displaying the splashscreen by clicking the checkbox:

☒ Display this welcome page at startup



MAP SCREEN CONTROLS

Take a few minutes to check out the controls on the map screen:

	<p>Top Left: You can open the Start Panel with the left button on the title bar or select a choice from the Menu List to open the Start Panel and start your fractional vegetation cover analysis, show the Welcome splash screen, go back to the Home page, go to the Frequently Asked Questions page, or read the User Guide.</p>
	<p>The Checklist Menu provides links to downloadable generic Metadata and Report templates for LandCART outputs.</p>
	<p>Top Right: You can zoom in and out of the map using the Plus/Minus buttons. You can navigate/pan around the map by clicking and dragging your mouse.</p>
	<p>Bottom Right: You can change the base map type using choices from the Blue Globe Button. Click to select Topo, Streets, Imagery, Geographic, Terrain, or Trails.</p>
	<p>Bottom Left: You can use the Toolbox buttons to:</p> <ul style="list-style-type: none"> • Start your fractional vegetation cover analysis (AOI, TOI, IOI), • Show the Dashboard to make visible/invisible data layers, or • Show the Legend (when the Cover Tool has generated a prediction).

START: DEFINE YOUR AREA OF INTEREST (AOI)

Notes:

- **The minimum recommended AOI size is approximately 100 acres or 40 ha. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **GEE is optimized for very large datasets, so don't be afraid to use AOIs of 1 million acres or larger.**

First zoom in close to your AOI using the +/- buttons at top right or the roller on your mouse. Click and drag to pan around the map to a different location.



Then open the **Toolbox - Start Panel** (bottom left OR top left) if it is not already open.



Hover over  for more information about each section in the **Start Panel**.

LandCART Cover Tool

Area of Interest

Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

UPLOAD

Study Area Name

Analyze

Map an AIM indicator across an area. The Cover Tool predicts the chosen indicator and then produces a distribution histogram and simple summary statistics of the prediction.

AIM Indicator:

Timeframe

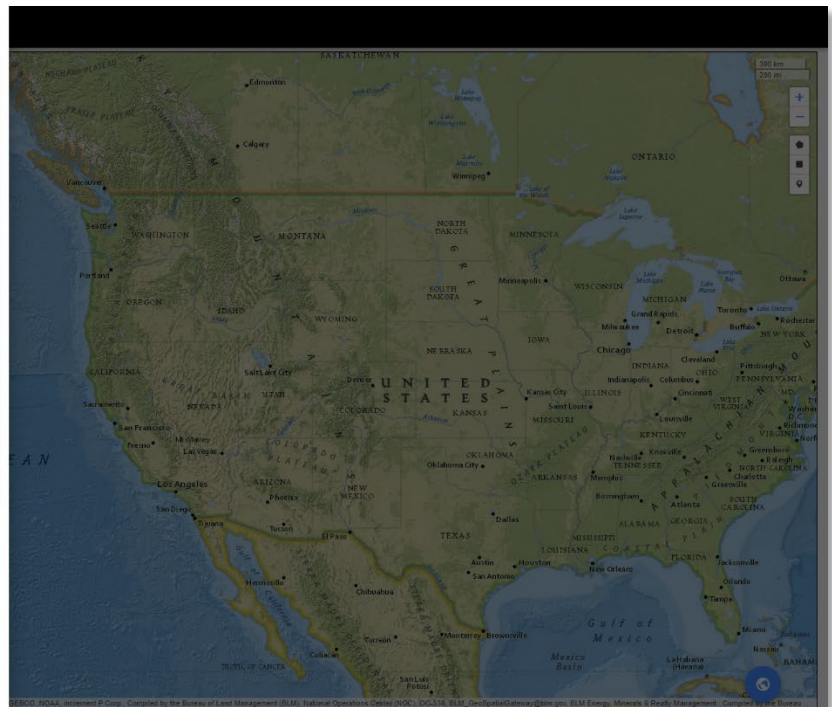
Start Date:

Duration (Months):

Generate

☐ Download
 ☒ Histogram Chart
 ☐ Combine/Compare Series

GENERATE PREDICTION



Where is your AOI and how will you define the boundary?

There are three choices to define the boundary in the Cover Tool: (1) the current map extent, (2) a drawn polygon, or (3) an uploaded shapefile.

LandCART Cover Tool

Area of Interest ?

Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

↑

UPLOAD

Study Area Name

You can (1) use the **current map extent**; the actual area will be a little (5%) inside what you see so make sure you include everything you want. You can adjust the extent using pan and zoom controls described above.

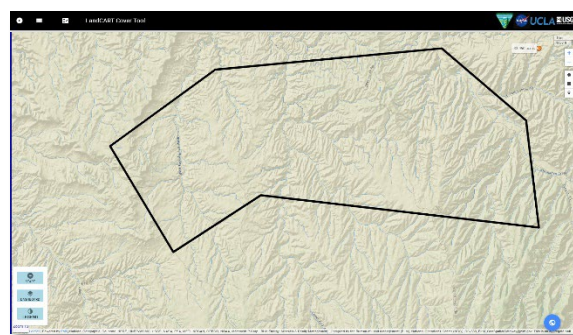
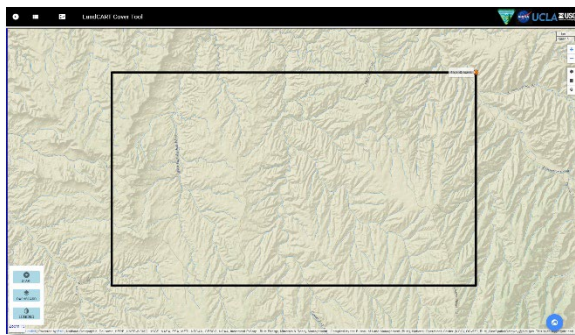
Write in a **Study Area Name**. The **Study Area Name** will be used for display and to name download files.

Study Area Name

You can (2) draw a **polygon or rectangle graphic extent** by clicking on one of the two **drawing tools** on the screen, top right.



Click on separate points to draw the polygon and click on the first point to finish it, or Click and drag to obtain a rectangle shape.

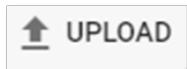


Return to the **Start Panel** and enter your **Study Area Name**, which will be used for display and to name download files. You can leave this blank if you want.

Study Area Name

You can (3) **upload** your predefined area as a **shapefile**.

- **Minimum AOI size is approximately 100 acres. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **The zipped shapefile must include the .shp, .dbf, and .prj files, but we recommend including ALL the files associated with the shapefile.**
- **The shapefile should be ONE polygon or ONE multipolygon.**
- **The polygon boundary should be fairly simple – see [Appendix A](#) in the User Guide for instructions on how to simplify a complicated polygon in ArcGIS 10.x.**



Click on Upload to upload a **zipped, polygon shapefile** with all files including the projection file (.prj). Note that this shapefile can be a single polygon or multipart polygon; if the shapefile has multiple different polygons, the application will randomly select ONE of the polygons for your AOI.

The shapefile name will automatically fill in the **Study Area Name** in the **Start Panel**.

LandCART Cover Tool

Area of Interest ⓘ

Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

UPLOAD

Study Area Name
FisherCreek

6,085 acres

RESET AOI

RESET ALL BUT AOI

A **RESET AOI** and **RESET ALL BUT AOI** button will appear in the **Generate** section below once a polygon has been drawn or uploaded so that you can clear your AOI and start over, if necessary.

Move to the **Analyze** section to select the Indicator to map.

START: DEFINE YOUR INDICATOR OF INTEREST (IOI)

What [AIM core indicator](#) do you wish to predict with the Cover Tool?

Analyze ?

Map an AIM indicator across an area. The Cover Tool predicts the chosen indicator and then produces a distribution histogram and simple summary statistics of the prediction.

AIM Indicator:

Click on the dropdown list.
An alphabetical list of the available
will appear.

AIM Indicator:

indicators

Choose an indicator from the list (Annual Grass in this example).

Analyze ?

Map an AIM indicator across an area. The Cover Tool predicts the chosen indicator and then produces a distribution histogram and simple summary statistics of the prediction.

AIM Indicator:


Annual Grass

START: DEFINE YOUR TIMEFRAME OF INTEREST (TOI)

If you wish to predict indicators for 2012, please see Appendix D, [Landsat 5 and Missing 2012 Data](#), for a cautionary tale when working with 2012 Landsat imagery.

Select the start date and duration of your predictions.

Timeframe ?



Type in a start date in the given format (yyyy-mm-dd) or click on the calendar button to select a start date. To set the year click on “2021” (upper left side) and roll the years (with the roller on your mouse or use the scroll bar) to when you want the predictions to start. Click on the year (2018 in the example). Select the month and day to start then click OK.



Start Date:

Duration (M)

2021

Fri, Apr 2

<

APRIL 2021

>

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

CANCEL OK

Start Date:

Duration

2018

Fri, Mar 2

2016

2017

2018

2019

2020

CANCEL OK

Start Date:

Duration

2018

Mon, Apr 2

2018

JANUARY

FEBRUARY

MARCH

APRIL

MAY

JUNE

JULY

AUGUST

SEPTEMBER

OCTOBER

NOVEMBER

DECEMBER

CANCEL OK

Start Date:

Duration (M)

2018

Mon, Apr 2

<

APRIL 2018

>

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

CANCEL OK

26

Duration (Months):

Select the **Duration** of time to pull satellite data to use for predictions. We recommend using between *one* and *three* months of satellite data to obtain full and good quality coverage of your AOI. If the satellite data does not provide full coverage, there will be gaps in the prediction map. The Cover Tool defaults to one month of data. Please see [Appendix E](#) for an explanation of why we need to select a duration for the TOI.

Timeframe ?

Start Date.



2018-05-05



Duration (Months):

3

CALCULATE FRACTIONAL COVER

Almost there!

Generate

☐ Download
 ☒ Histogram Chart
 ☐ Combine/Compare Series

You can choose whether to obtain raster datasets to download and whether to obtain a histogram of pixel frequency that can be exported to csv, xls, jpg, and png files.

☐ Download

Click on **Download** to be provided with a single-band image with prediction values.

☐ Histogram Chart

Click on **Histogram Chart** to produce a frequency histogram of the area of the AOI that falls in 5% bins of fractional cover. Summary statistics are also provided.

☐ Combine/Compare Series

Click on **Combine/Compare Series** to combine multiple prediction results into one histogram. This does not need to be activated for your first prediction of a session.

Click on **Generate Prediction** to begin an on-the-fly prediction of your AOI, IOI, and TOI.

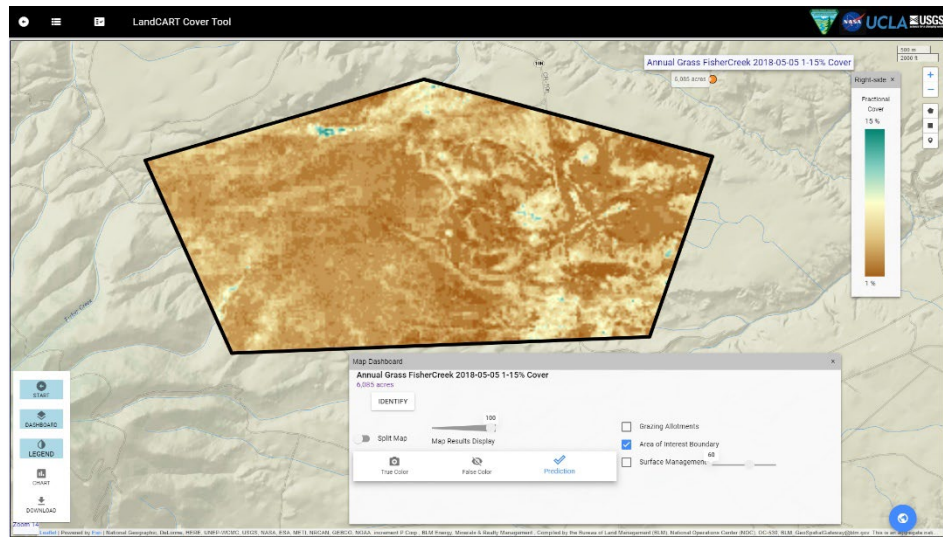
Note that you can click on **Reset AOI** to clear the currently defined AOI and choose a new AOI. This button appears only after you have defined and AOI.

Note that you can click on **Reset All but AOI** to reset all the parameters in the **Start Panel** and keep the current AOI. This button appears only after you have defined and AOI.

The **CLEAR IDENTIFY** button appears below the **Generate Prediction** box after an AOI has been defined. This button clears any **IDENTIFY** points from the map screen.

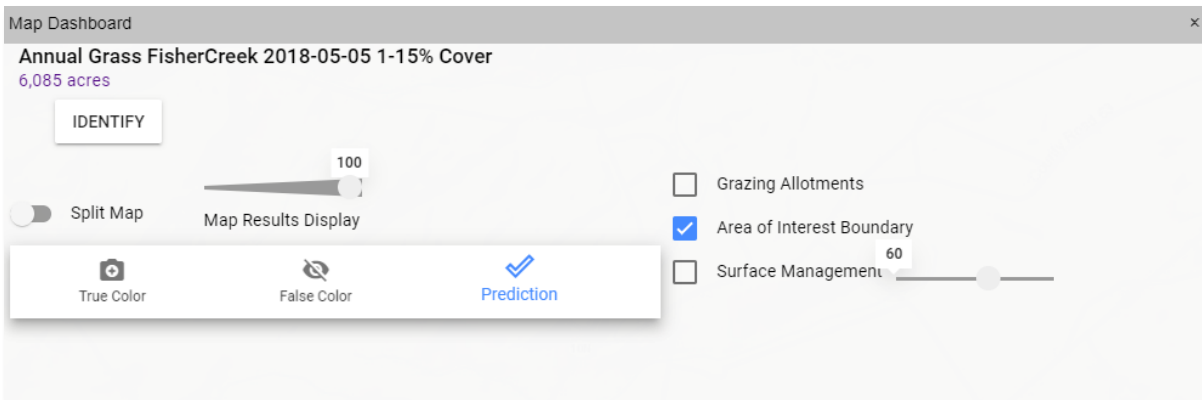
PLEASE BE PATIENT! The map drawing/calculating takes more than a few seconds and sometimes up to several minutes depending on network connectivity.

When calculations are complete, the display shows the predicted fractional cover type, the **Map Dashboard**, and color ramp **Legend** indicating percent cover. The legend color ramp is dynamic and adjusts the minimum and maximum based on the currently drawn prediction.

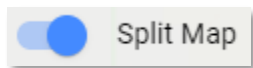


Click on **Dashboard** or **Legend** to open or close the pop-up windows, or the small “x” in the upper right corner of each window to close it.

TOOLBOX: MAP DASHBOARD



On the **Map Dashboard** you can choose to display the **Prediction** with color ramp (initially defaults to a standard stretch but can be changed to fit the predicted data exactly – see below), the **true color composite** (Red, Green, Blue bands of Landsat imagery used in the prediction) or an **infrared** view (Near InfraRed, Red, Green bands of Landsat imagery used in the prediction).



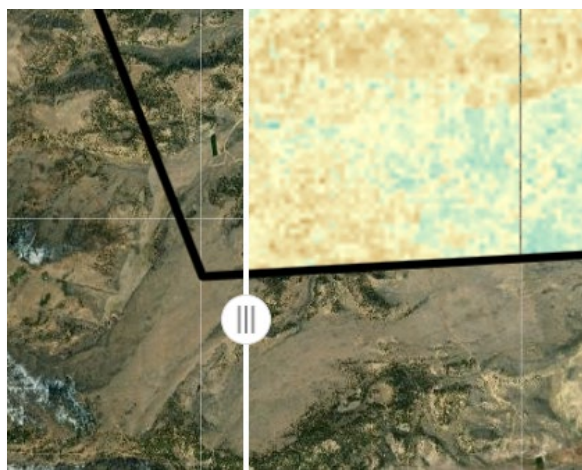
Toggle the **Split Map** button to show a vertical, moveable bar on the map screen.



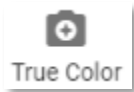
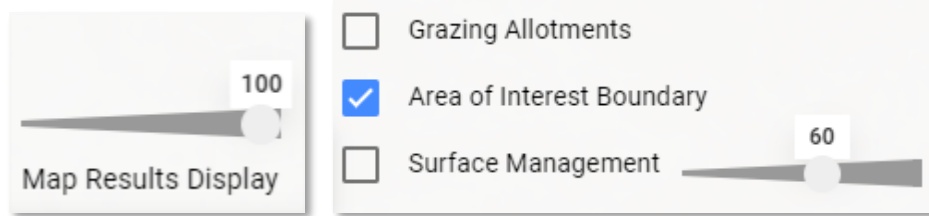
Click and drag the round slider to check out the underlying imagery or base map (left side) and compare it to the predicted data (right side).



Now might be a good time to change your base map type (click on the **Blue Globe**, bottom right).



The transparency of the predicted map can be adjusted with the **Map Results Display** slider bar if you wish to see landmarks on the base map. You can also show Vector layers: BLM grazing allotments, the AOI boundary, and Surface Management Agency (SMA). The transparency of SMA can be adjusted on the slider bar so that the underlying base map will show; the transparency defaults to 60%.



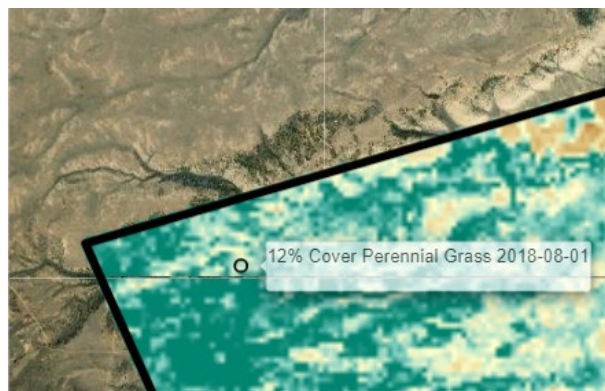
If you wish to view the Landsat composite imagery used in the calculation, click on the **True Color** button to see the red, green, and blue bands displayed for a natural color view.



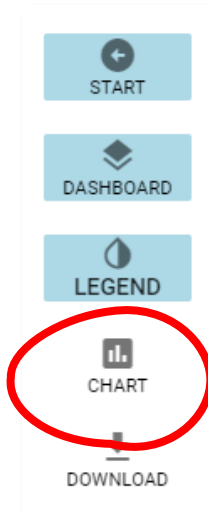
The **Infrared** button displays the Landsat composite imagery in the near-infrared, red, and green bands for a false color composite view showing green vegetation as red.



The **Identify** button – in the **Map Dashboard** and in the upper right corner of the display, below the drawing tools – allows you to click anywhere on the screen and see the fractional cover value from your prediction. These values are not from a single pixel, but rather from an average of approximately 9 pixels centered where you click.

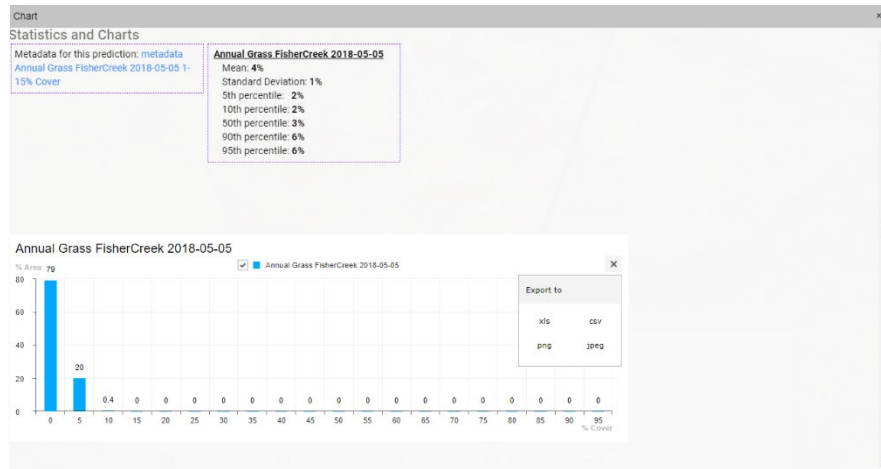


TOOLBOX: CHART

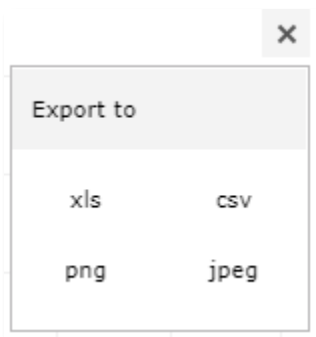


If you have not done so already, now you can look at the histogram chart by clicking on the **Chart** button that has appeared on the **Toolbox** panel.

A histogram showing the percent of the AOI area within 5% cover bins will be displayed. Basic summary statistics will be listed as well. If you selected the **Download** button in the **Generate** section in the **Start** panel, a partially filled-in metadata XML file will be available here.



Click on the ellipse button on the top right of the chart to be able to export these chart data as “.xls”, “.csv”, “.png”, or “.jpg”.

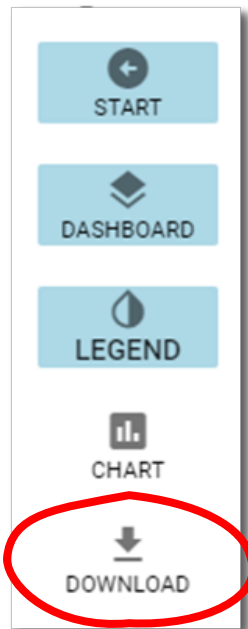


The file might automatically download to your default download location or will ask you to select a download location depending on how your browser is set up. The file name includes the **IOI**, the study area name (**AOI**), and the **TOI**. The file extension depends upon your selection.

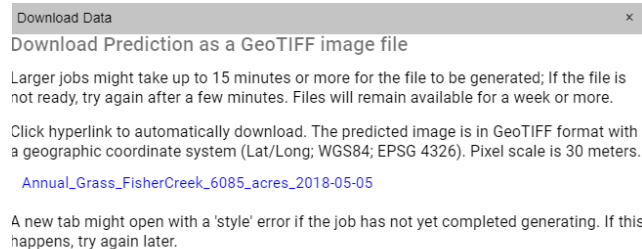
For example:

Annual Grass FisherCreek 2018-05-05.csv,.xls,.png, or .jpg.

TOOLBOX: DOWNLOAD

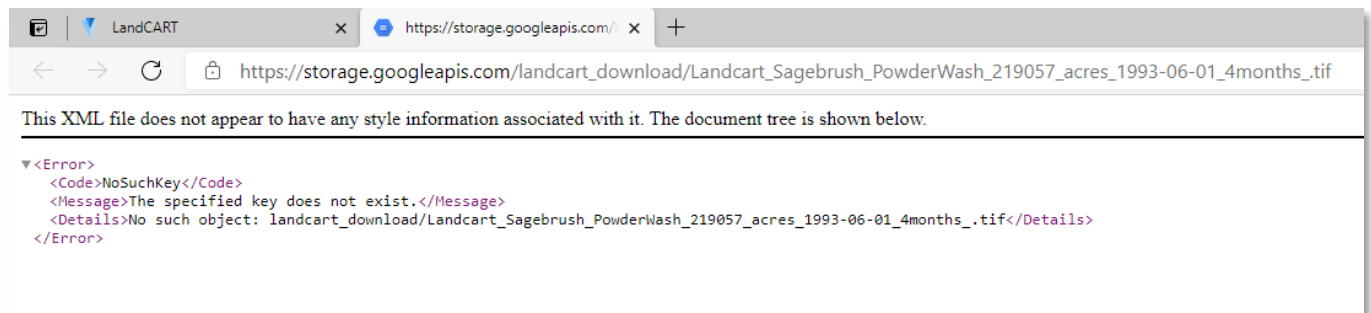


If you would like to run independent analyses of the prediction image/data, you can download the image to your local drive and work with it in your favorite geospatial software (ArcGIS, Imagine, ENVI, R, etc.). Click on the **Download** button in the **Toolbox** panel. This button will only be made available if the data have been successfully predicted. A pop-up will open that looks like this:



(This window often pops up behind the Chart window if it is open)
Click on the link to download the image.

There are two notes of importance on this pop-up: “Larger jobs might take up to 15 minutes or more for the file to be generated; If the file is not ready, try again after a few minutes.” AND “A new tab might open with a ‘style’ error if the job has not yet completed generating.” In summary, if the AOI is small (less than 100,000 acres or so), the prediction image is usually generated quickly and clicking on the link will start the download immediately. If the AOI is large (we have not determined a limit to AOI size at this point), when you click on the link a new browser tab might open with an error message. This is the typical error we have received when the prediction file has not yet been generated:



If this happens, close this tab, and wait a few minutes to try again. We have successfully downloaded areas of 4 million acres; however, the file generation for areas of this size can take half an hour or more. Please be patient.

The file is automatically downloaded into your default download location (typically, the Downloads folder in your local drive). The predicted image is an unprojected (Geographic coordinate system) TIF image made up of 30-m pixels. We suggest you reproject the image to the projection you are using for the project and define the pixel size in meters (See [Appendix B](#) to learn how to reproject images and [Appendix C](#) for a list of common BLM projections). The value of each pixel is the percent of the pixel covered by the indicator chosen.

```
Projection: Geographic (Lat/Lon)
Spheroid: WGS 84
Datum: WGS 84
EPSG Code: 4326
```

The file is automatically named from your input in the **Start Panel** (if you entered a Study Area Name):

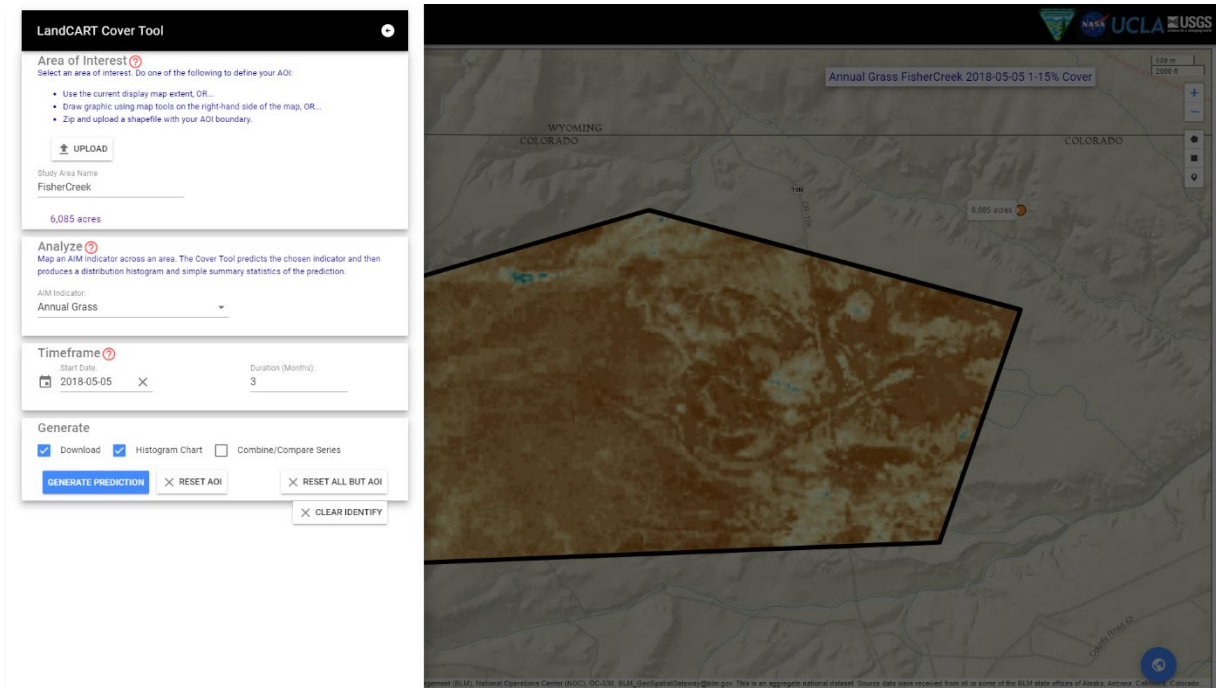
Annual_Grass_FisherCreek_6085_acres_2018-05-05.TIF

The name includes the **IOI**, the study area name (*AOI*), number of acres, and the **TOI**.

WASH, RINSE, REPEAT...



Now that you have predicted fractional cover for this AOI, IOI, and TOI, you can go back to the **Start Panel** and change any of the design features to create a new prediction. For instance, maybe you wish to determine the difference in annual grass distribution from spring to fall for this NW Colorado AOI. Simply change the timeframe parameter to start in August of 2018 for 2 or 3 months and generate a new prediction to view and/or download.



You can reload the browser page to clear your AOI and all other parameters (TOI, IOI) from previous tool runs.

✕ RESET ALL BUT AOI

✕ RESET AOI

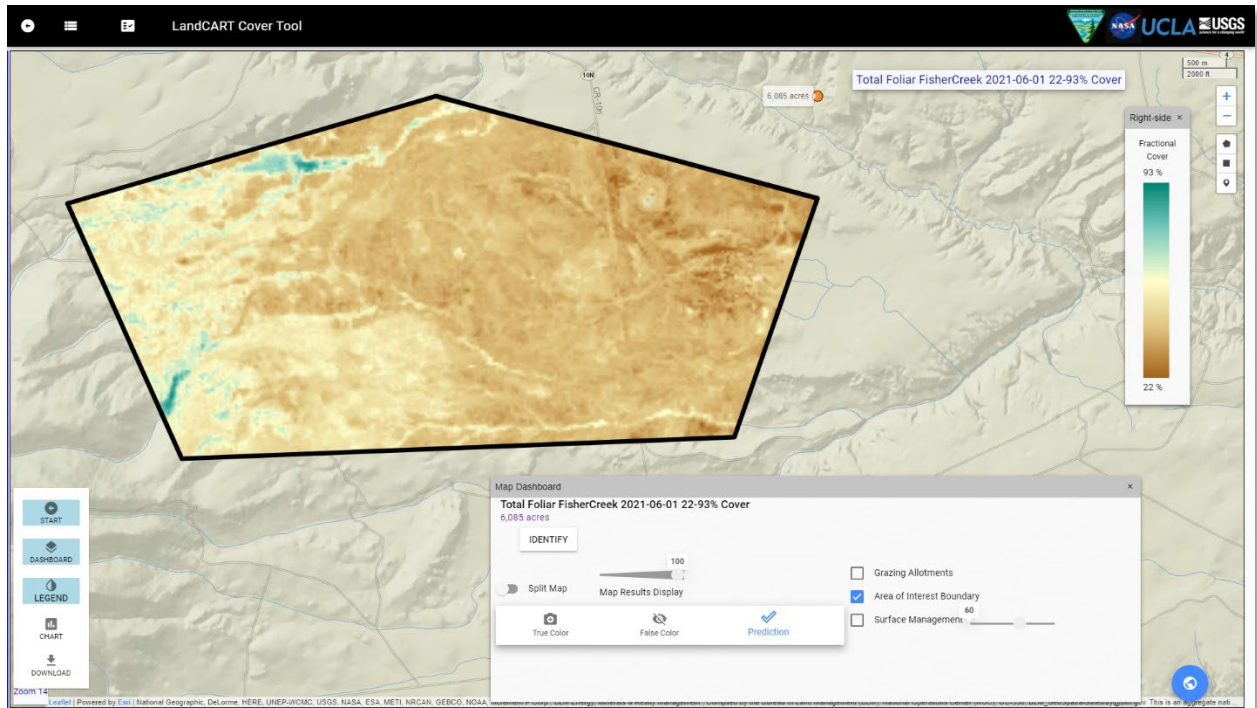
Note that you can click the **Reset All but AOI** button on the **Start Panel** to re-use your AOI but clear all other parameters for multiple runs of the tool. This button appears only after you have clicked the **Generate Prediction** button. Or you can click the **RESET AOI** button to clear the current AOI.

☐ Combine/Compare Series

At this time, you can also click on **Combine/Compare Series** to combine multiple prediction results into one histogram.

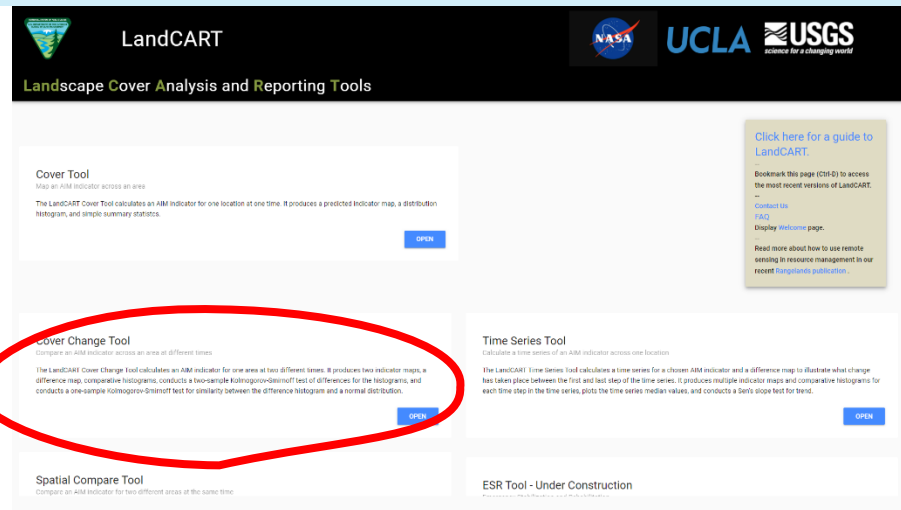
✕ CLEAR IDENTIFY

The **CLEAR IDENTIFY** button appears below the **Generate Prediction** box after an AOI has been defined. This button clears any **IDENTIFY** points from the map screen.



Or change the Indicator of Interest or change the location. The possibilities are endless!

LANDCART COVER CHANGE TOOL



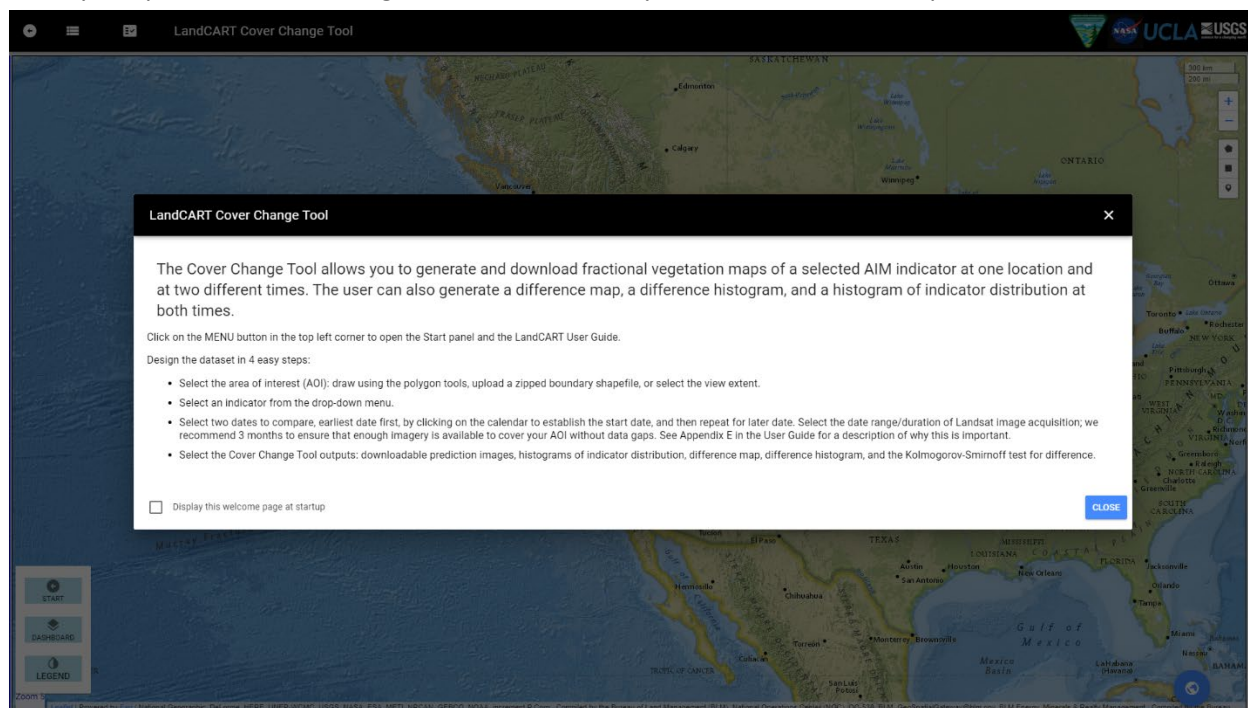
This tool allows the user to predict a continuous fractional cover map to represent AIM indicators for a selected area of interest (AOI) for two different times of interest (TOIs). It produces two indicator maps, a difference map, comparative histograms, conducts a two-sample Kolmogorov-Smirnov test of differences for the histograms, and conducts a one-sample Kolmogorov-Smirnov test for similarity between the difference histogram and a normal distribution.

List of fractional cover types available in LandCART V1.0 (see [LandCART Fractional Cover Types](#) for details of how the AIM indicators are calculated/defined).

- Annual Forb
- Annual Grass
- Annual Herbaceous
- Bare Ground
- Bare Soil
- Canopy Gaps greater than 25cm
- Canopy Gaps greater than 100 cm
- Canopy Gaps greater than 200 cm
- Herbaceous
- Perennial Forb
- Perennial Grass
- Perennial Herbaceous
- Sagebrush
- Shrubs
- Shrubsucculent
- Succulent
- Total Foliar
- Trees
- Woody

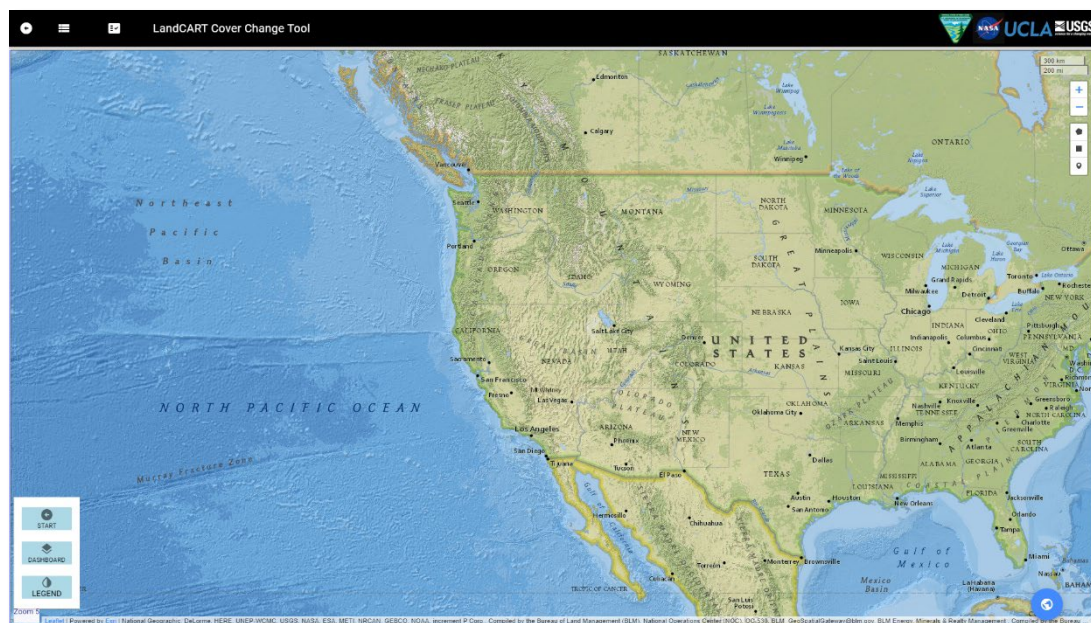
OPENING THE COVER CHANGE TOOL

When you open the Cover Change Tool the first time, your web browser will open to this screen:



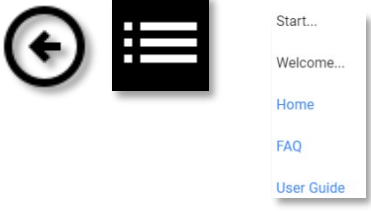



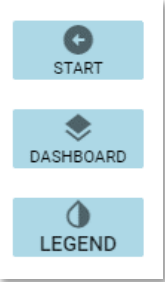
Read and close the splash screen to continue. You can choose to stop displaying the splashscreen by clicking the checkbox:

☒ Display this welcome page at startup



MAP SCREEN CONTROLS

Take a few minutes to check out the controls on the map screen:

	<p>Top Left: You can open the Start Panel with the left button on the title bar or select a choice from the Menu List to open the Start Panel and start your fractional vegetation cover analysis, show the Welcome splash screen, go back to the Home page, go to the Frequently Asked Questions page, or read the User Guide.</p>
	<p>The Checklist Menu provides links to downloadable generic Metadata and Report templates for LandCART outputs.</p>
	<p>Top Right: You can zoom in and out of the map using the Plus/Minus buttons. You can navigate/pan around the map by clicking and dragging your mouse.</p>
	<p>Bottom Right: You can change the base map type using choices from the Blue Globe Button. Click to select Topo, Streets, Imagery, Geographic, Terrain, or Trails.</p>
	<p>Bottom Left: You can use the Toolbox buttons to:</p> <ul style="list-style-type: none"> • Start your fractional vegetation cover analysis (AOI, TOI, IOI), • Show the Dashboard to make visible/invisible data layers, or • Show the Legend (when the Cover Change Tool has generated predictions).

START: DEFINE YOUR AREA OF INTEREST (AOI)

Notes:

- **The minimum recommended AOI size is approximately 100 acres or 40 ha. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **GEE is optimized for very large datasets, so don't be afraid to use AOIs of 1 million acres or larger.**

First zoom in close to your AOI using the +/- buttons at top right or the roller on your mouse. Click and drag to pan around the map to a different location.



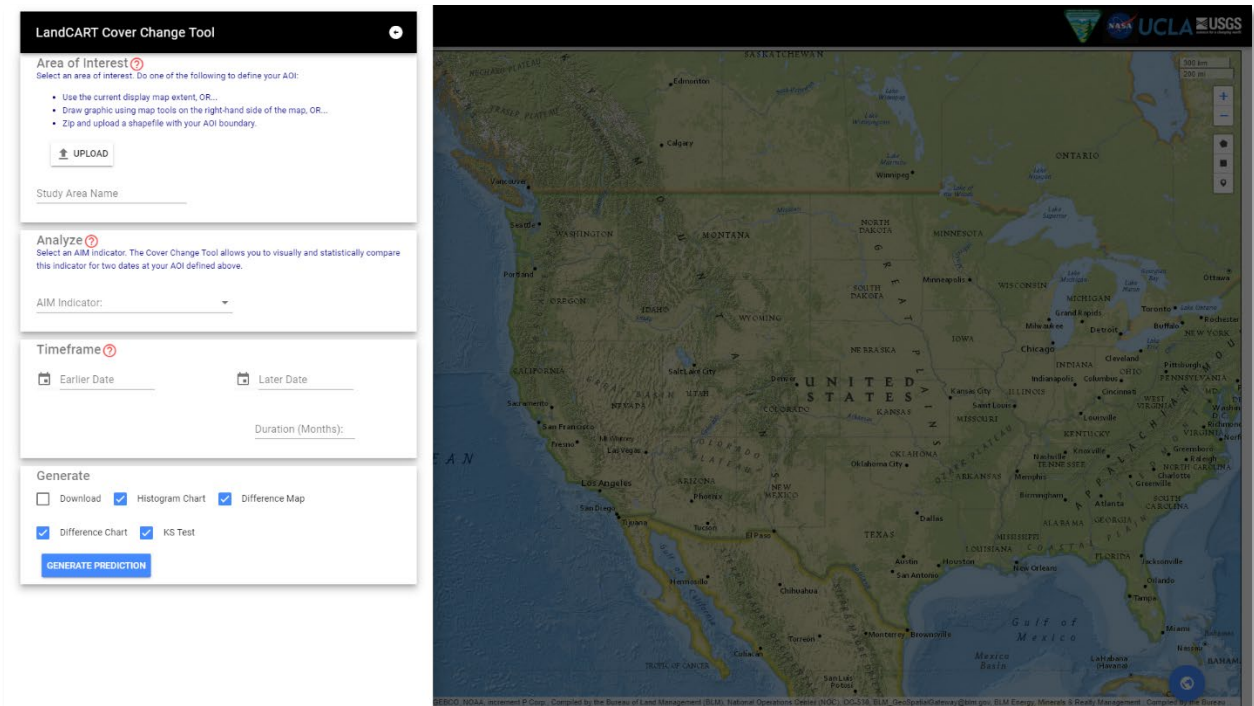
Then open the **Toolbox - Start Panel** (bottom left OR top left) if it is not already open.



Hover over



for more information about each section in the **Start Panel**.



Where is your AOI and how will you define the boundary?

There are three choices to define the boundary in the Cover Change Tool: (1) the current map extent, (2) a drawn polygon, or (3) an uploaded shapefile.

LandCART Cover Change Tool
←

Area of Interest ?

Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

UPLOAD

Study Area Name

You can (1) use the **current map extent**; the actual area will be a little (5%) inside what you see so make sure you include everything you want. You can adjust the extent using pan and zoom controls described above.

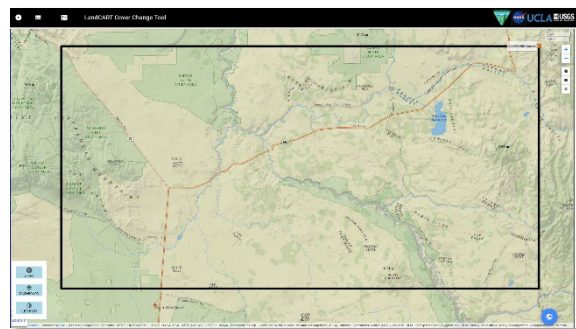
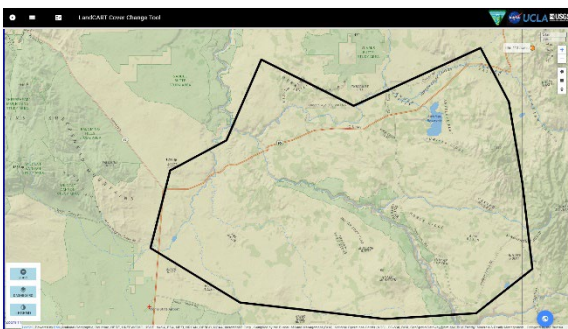
Study Area Name

Write in a **Study Area Name**. The **Study Area Name** will be used for display and to name download files.

You can (2) draw a **polygon or rectangle graphic extent** by clicking on one of the two **drawing tools** on the screen, top right.



Click on separate points to draw the polygon and click on the first point to finish it, or Click and drag to obtain a rectangle shape.



Return to the **Start Panel** and enter your **Study Area Name**. The **Study Area Name** will be used for display and to name download files. You can leave this blank if you want.

Study Area Name

You can (3) **upload** your predefined area as a **shapefile**.

- **Minimum AOI size is approximately 100 acres. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **The zipped shapefile must include the .shp, .dbf, and .prj files, but we recommend including ALL the files associated with the shapefile.**
- **The shapefile should be ONE polygon or ONE multipolygon.**
- **The polygon boundary should be fairly simple – see [Appendix A](#) in the User Guide for instructions on how to simplify a complicated polygon in ArcGIS 10.x.**



Click on Upload to upload a **zipped, polygon shapefile** with all files including the projection file (.prj). Note that this shapefile can be one polygon or one multipart polygon; if the shapefile has multiple different polygons, the application will randomly select ONE of the polygons for your AOI.

The shapefile name will automatically fill in the **Study Area Name** in the **Start Panel**.

LandCART Cover Change Tool

Area of Interest ⓘ
Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

UPLOAD

Study Area Name
LaPlata

9,513 acres

RESET AOI **RESET ALL BUT AOI**

A **RESET AOI** and **RESET ALL BUT AOI** button will appear in the **Generate** section below once a polygon has been drawn or uploaded so that you can clear your AOI and start over, if necessary.

Move to the **Analyze** section to select the Indicator to map.

START: DEFINE YOUR INDICATOR OF INTEREST (IOI)

What [AIM core indicator](#) do you wish to predict with the Cover Change Tool?

Analyze ?

Select an AIM indicator. The Cover Change Tool allows you to visually and statistically compare this indicator for two dates at your AOI defined above.

AIM Indicator:

Click on the dropdown list.

AIM Indicator:

An alphabetical list of the available indicators will appear.

Choose an indicator from the list (Annual Grass in this example).

Analyze ?

Select an AIM indicator. The Cover Change Tool allows you to visually and statistically compare this indicator for two dates at your AOI defined above.

AIM Indicator:

Annual Herbaceous

START: DEFINE YOUR TIMEFRAME OF INTEREST (TOI)

If you wish to predict indicators for 2012, please see Appendix D, [Landsat 5 and Missing 2012 Data](#), for a cautionary tale when working with 2012 Landsat imagery.

Input the first (earlier) date, second (later) date, and duration of your predictions.

Timeframe?

Calendar icon

Earlier Date

Calendar icon

Later Date

Duration (Months):

Type in a first (earlier) date in the given format (yyyy-mm-dd) or click on the calendar button to select a date. To set the year click on “2021” (upper left side) and roll the years (with the roller on your mouse or use the scroll bar) to when you want the predictions to start. Click on the year (2005 in the example). Select the month and day to start then click OK.



Repeat the process for a second (later) date.

Calendar icon

Earlier Date

Calendar icon

Later Date

2021

Tue, July 20

<

JULY 2021

>

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

CANCEL OK

Calendar icon

Earlier Date

Calendar icon

Later Date

2005

Wed, July 20

2003

2004

2005

2006

2007

CANCEL OK

Calendar icon

Earlier Date

Calendar icon

Later Date

2005

Thu, June 16

2005

JANUARY	FEBRUARY	MARCH
APRIL	MAY	JUNE
JULY	AUGUST	SEPTEMBER
OCTOBER	NOVEMBER	DECEMBER

CANCEL OK

Calendar icon

Earlier Date

Calendar icon

Later Date

2005

Wed, June 1

<

JUNE 2005

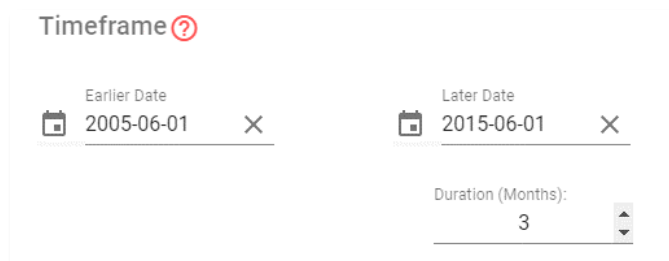
>

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

CANCEL OK

Duration (Months):

Select the **Duration** of time to include satellite data to use for predictions. We recommend using between *one* and *three* months of satellite data to obtain full and good quality coverage of your AOI. If the satellite data does not provide full coverage, there will be gaps in the prediction map. The Cover Change Tool defaults to three months duration of data. Please see [Appendix E](#) for an explanation of why we need to select a duration for the TOI.



The screenshot shows a 'Timeframe' dialog box with a red question mark icon. It contains two date selection fields: 'Earlier Date' and 'Later Date', both set to '2015-06-01'. Below these is a 'Duration (Months):' dropdown menu currently set to '3'. Each date field has a calendar icon and a clear 'X' button.

CALCULATE FRACTIONAL COVER

Almost there!

Generate

☐ Download
 ☒ Histogram Chart
 ☒ Difference Map

☒ Difference Chart
 ☒ KS Test

You can generate raster datasets to download, a histogram of cover distribution, a difference map, a difference histogram, and perform a Kolmogorov-Smirnoff test.

☐ Download

Click on **Download** to be provided with two single-band images with prediction values for your selected dates.

☐ Histogram Chart

Click on **Histogram Chart** to produce a frequency histogram of the area of the AOI that falls in 5% bins of fractional cover. Summary statistics are also provided.

☐ Difference Map

Click on **Difference Map** to create a difference image. The image is calculated by subtracting the earlier prediction from the later prediction so that positive values indicate an increase from earlier to later date and negative values indicate a decrease.

☐ Difference Chart

Click on **Difference Chart** to create a difference histogram based on subtracting one predicted image from the other, typically the later date minus the earlier date.

☐ KS Test

Click on **KS Test** to calculate the Kolmogorov-Smirnoff statistics. See the [Statistics Review](#) for a detailed explanation of interpreting p-values and results of the KS test.

Click on **Generate Prediction** to begin an on-the-fly prediction using your AOI, IOI, and TOIs.

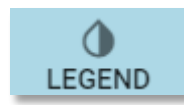
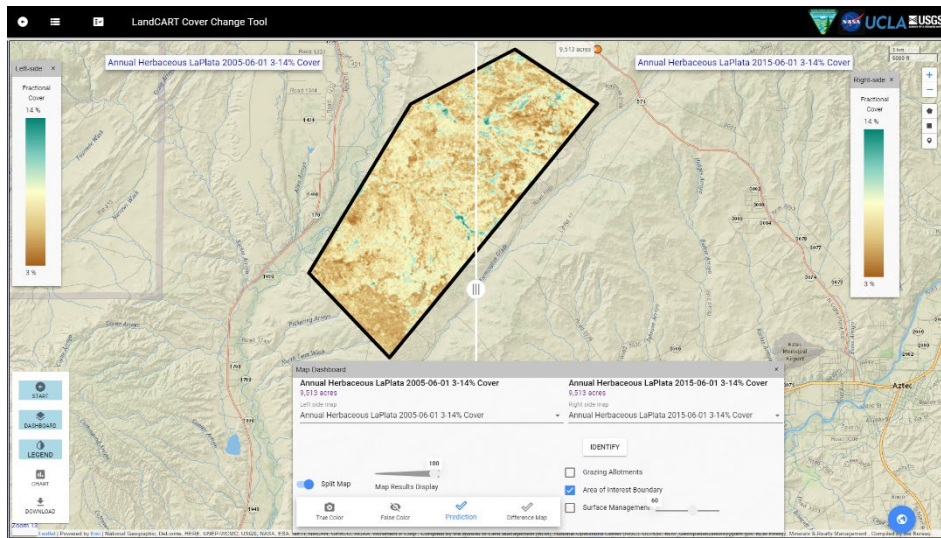
Note that you can click on **Reset AOI** to clear the currently defined AOI and choose a new AOI. This button appears only after you have defined an AOI.

Note that you can click on **Reset All but AOI** to reset all the parameters in the **Start Panel** and keep the current AOI. This button appears only after you have clicked **Generate Prediction**.

The **CLEAR IDENTIFY** button appears below the **Generate Prediction** box after an AOI has been defined. This button clears any **IDENTIFY** points from the map screen.

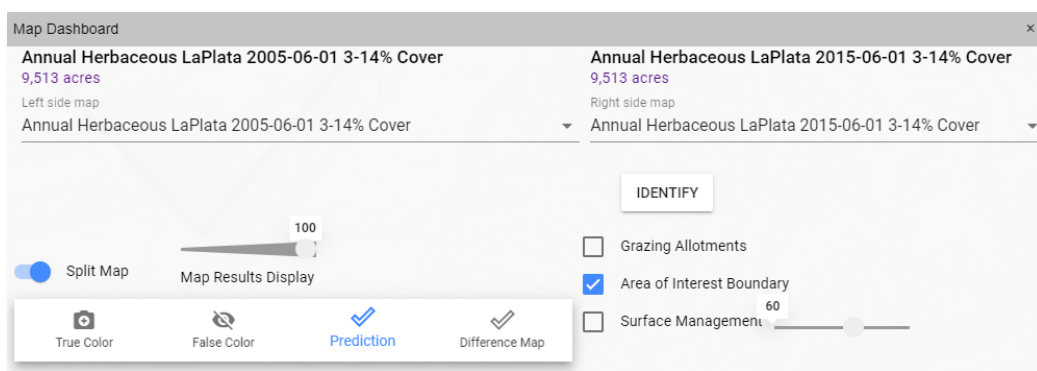
PLEASE BE PATIENT! The map drawing/calculating takes more than a few seconds and sometimes up to several minutes depending on network connectivity.

When calculations are complete, the display shows the predicted fractional cover type for two dates on a split screen, the **Map Dashboard**, the color ramp **Legends** indicating percent cover for both predictions, an identify tool (on the right, below the drawing tools), and the **Toolbox** with buttons to access charts and downloads if selected for generate.

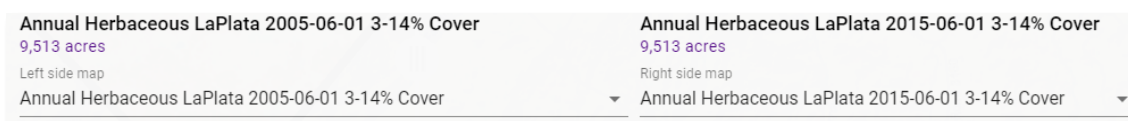


Click on **Dashboard** or **Legend** to open or close the pop-up windows, or the small "x" in the upper right corner of each window to close it.

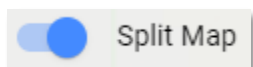
TOOLBOX: MAP DASHBOARD



On the **Map Dashboard** you can choose to display the **Predictions** with dynamic color ramp, the **true color composite** (Red, Green, Blue bands of Landsat imagery used in the prediction) or an **infrared** view (Near InfraRed, Red, Green bands of Landsat imagery used in the prediction), and if you generated a **Difference Map**, it can be displayed as well.



You can choose which map to display on which side. The Cover Change Tool defaults to a split screen view showing your first date on the left and your second date on the right. The title of the maps includes the Indicator, the date of the prediction, and the range of fractional cover that is currently displayed (these values will change in the title as you change your visualization).



Split Map

Toggle the **Split Map** button to show a vertical, moveable bar on the map screen.

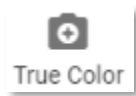
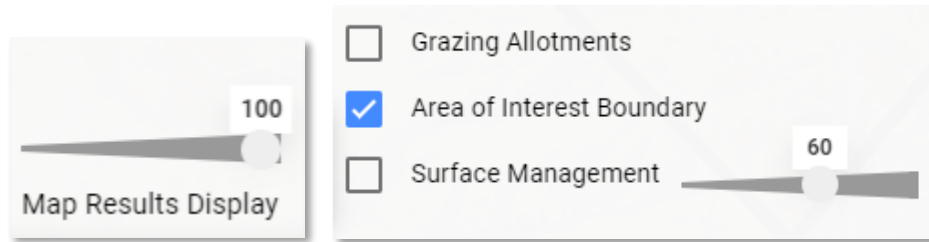


Click and drag the split map round slider to compare the two different maps. You can also choose No Map on either side and use the base map for comparison to one of your dates.



You can change your base map type (click on the **Blue Globe**, bottom right) if desired.

The transparency of the predicted map can be adjusted with the **Map Results Display** slider bar if you wish to see landmarks on the base map. You can also show Vector layers: BLM grazing allotments, the AOI boundaries, and Surface Management Agency (SMA). The transparency of SMA can be adjusted on the slider bar so that the underlying base map will show; the transparency defaults to 60%.



If you wish to view the Landsat composite imagery used in the calculation, click on the **True Color** button to see the red, green, and blue bands displayed for a natural color view.

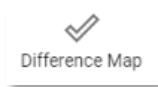


The **Infrared** button displays the Landsat composite imagery in the near-infrared, red, and green bands for a false color composite view showing green vegetation as red.

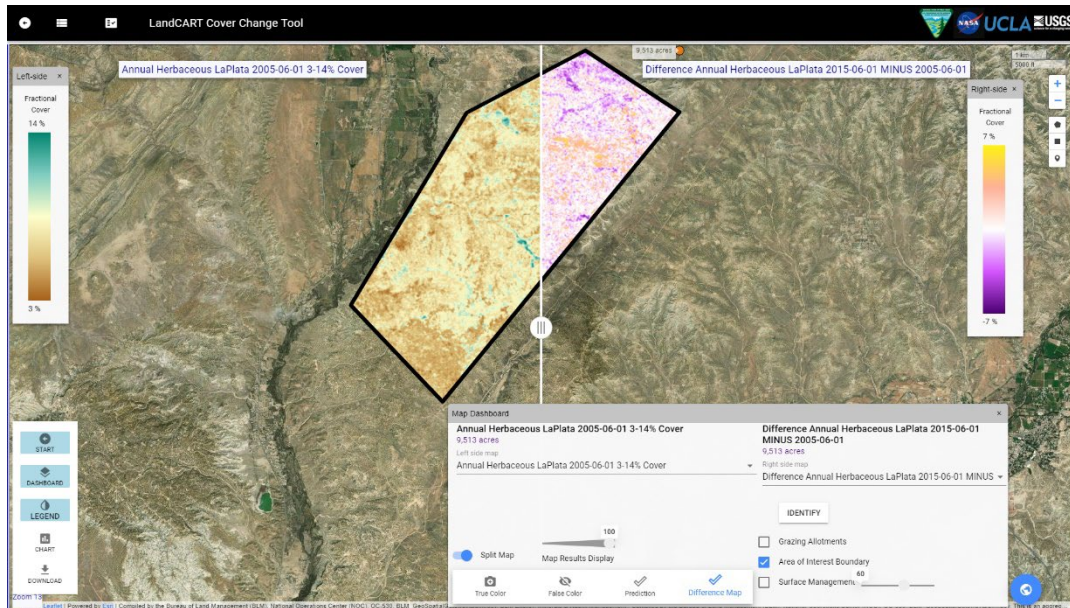


The **Identify** button allows you to click anywhere on the screen and see the fractional cover value from both predictions. These values are not from a single pixel, but rather from an average of approximately 9 pixels centered where you click.



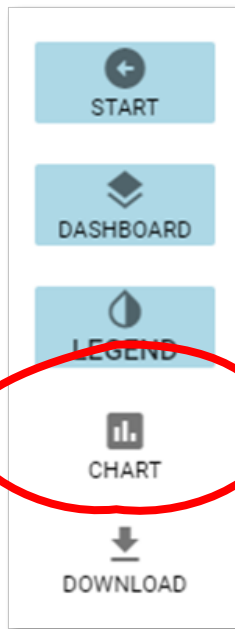


The **Difference Map** button displays the difference image created by subtracting the earlier prediction from the later prediction. In the example below, “Difference Map: Annual Grass LaPlata 2015-06-01 MINUS Annual Grass 2005-06-01,” positive values (yellow) indicate an increase from the earlier date to the later date and negative values (purple) indicate a decrease.



You can see the difference histogram by clicking on the **Chart** button.

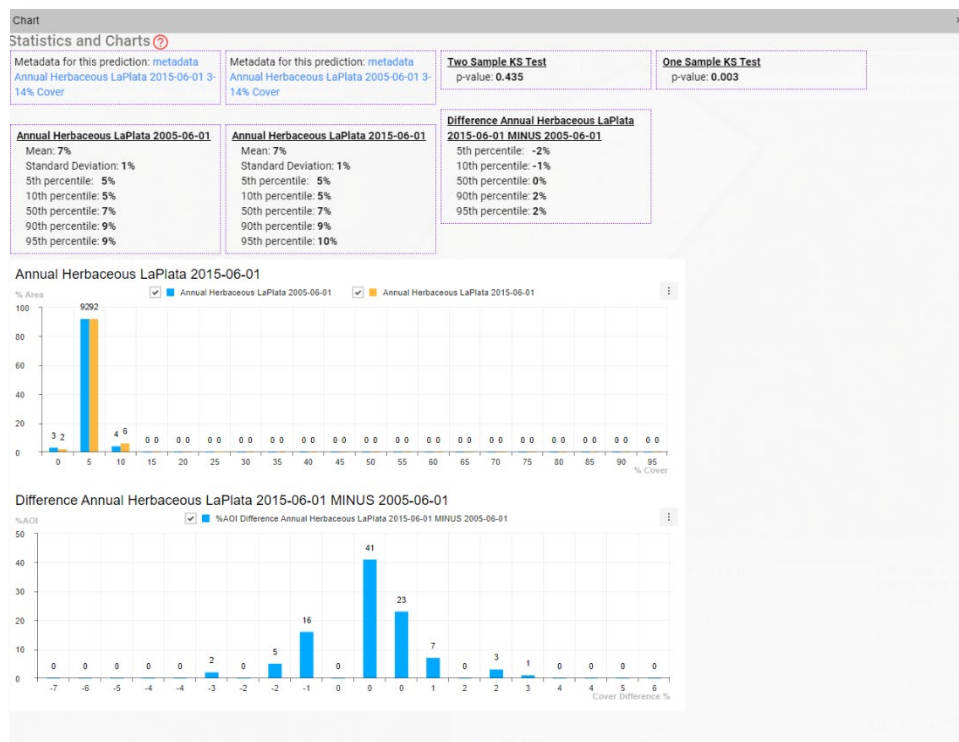
TOOLBOX: CHART



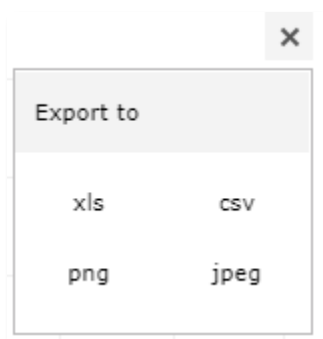
If you have not done so already, now you can look at the percent cover histogram and the difference histogram (if selected to generate) by clicking on the **Chart** button that has appeared on the **Toolbox** panel.

A histogram showing the percent of the AOI area within 5% cover bins will be displayed for both predictions. A difference histogram is also displayed. Basic summary statistics are listed at the top. If you chose to calculate the Kolmogorov-Smirnoff (KS) statistics, these will be listed as well. If you selected the **Download** button in the **Generate** section in the **Start** panel, a partially filled-in metadata XML file for each image will be available here.

See the [Statistics Review](#) for a detailed explanation of interpreting p-values and results of the KS test.



Click on the ellipse button on the top right of the charts to be able to export these chart data as ".xls", ".csv", ".png", or ".jpg".



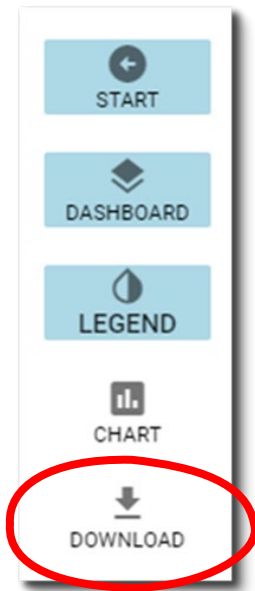
The file might automatically download to your default download location or will ask you to select a download location depending on how your browser is set up. The indicator prediction file name includes the **IOI**, the study area name (*AOI*), and the **TOI**. The difference histogram file name includes the **IOI**, the two **TOIs**, and the *AOI*. The file extension depends upon your selection.

For example:

Annual Grass LaPlata 2005-06-01.csv,.xls,.png, or .jpg. and

Annual Grass LaPlata 2015-06-01 MINUS 2005-06-01.csv,.xls,.png, or .jpg

TOOLBOX: DOWNLOAD

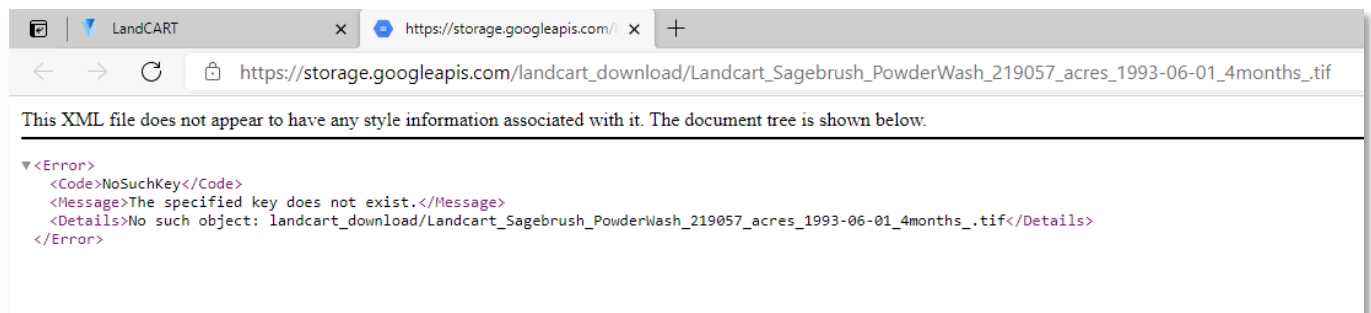


If you would like to run independent analyses of the prediction images/data, you can download the images to your local drive and work with them in your favorite geospatial software (ArcGIS, Imagine, ENVI, R, etc.). Click on the **Download** button in the **Toolbox** panel. This button will only be made available if the data have been successfully predicted. A pop-up will open that looks like this:



(This window often pops up behind the Chart window if it is open)
Click on each link to download individual images.

There are two notes of importance on this pop-up: “Larger jobs might take up to 15 minutes or more for the file to be generated; If the file is not ready, try again after a few minutes.” AND “A new tab might open with a ‘style’ error if the job has not yet completed generating.” In summary, if the AOI is small (less than 100,000 acres or so), the prediction image is usually generated quickly and clicking on the link will start the download immediately. If the AOI is large (we have not determined a limit to AOI size at this point), when you click on the link a new browser tab might open with an error message. This is the typical error we have received when the prediction file has not yet been generated:



If this happens, close this tab, and wait a few minutes to try again. We have successfully downloaded areas of 4 million acres; however, the file generation for areas of this size can take half an hour or more. Please be patient.

The files are automatically downloaded into your default download location (typically, the Downloads folder in your local drive). The predicted images are unprojected (Geographic coordinate system) TIF images made up of 30-m pixels. We suggest you reproject the images to the projection you are using for the project and define the pixel size in meters (See [Appendix B](#) to learn how to reproject images and [Appendix C](#) for a list of common BLM projections). The value of each pixel is the percent of the pixel covered by the indicator chosen.

```
Projection: Geographic (Lat/Lon)
Spheroid: WGS 84
Datum: WGS 84
EPSG Code: 4326
```

The files are automatically named from your input in the **Start Panel** (if you entered a Study Area Name):

Annual_Grass_LaPlata_9513_acres_2005-06-01.TIF

Annual_Grass_LaPlata_9513_acres_2015-06-01.TIF

The name includes the **IOI**, the study area name (*AOI*), number of acres, and the **TOI**.

WASH, RINSE, REPEAT...



Now that you have predicted fractional cover for this AOI, IOI, and TOI, you can go back to the **Start Panel** and change any of the design features to create a new prediction. For instance, maybe you wish to look at change for several indicators in the same location over the same time period.



You can reload the browser page to clear your AOI and all other parameters (TOI, IOI) from previous tool runs.



Alternatively, you can click on the **RESET ALL BUT AOI** button and everything, including the charts and statistics, will be cleared, except for your AOI (this is particularly useful when you have hand-drawn the AOI). Or you can click the **RESET** button to start the tool from the beginning.

LandCART Cover Change Tool

Area of Interest
Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent. OR...
- Draw graphic using map tools on the right hand side of the map. OR...
- Zip and upload a shapefile with your AOI boundary.

UPLOAD

Study Area Name:
LaPlata

9,513 acres

Analyze
Select an AIM indicator. The Cover Change Tool allows you to visually and statistically compare this indicator for two dates at your AOI defined above.

AIM Indicator:
Annual Herbaceous

Timeframe

Earlier Date: 2005-06-01

Later Date: 2015-06-01

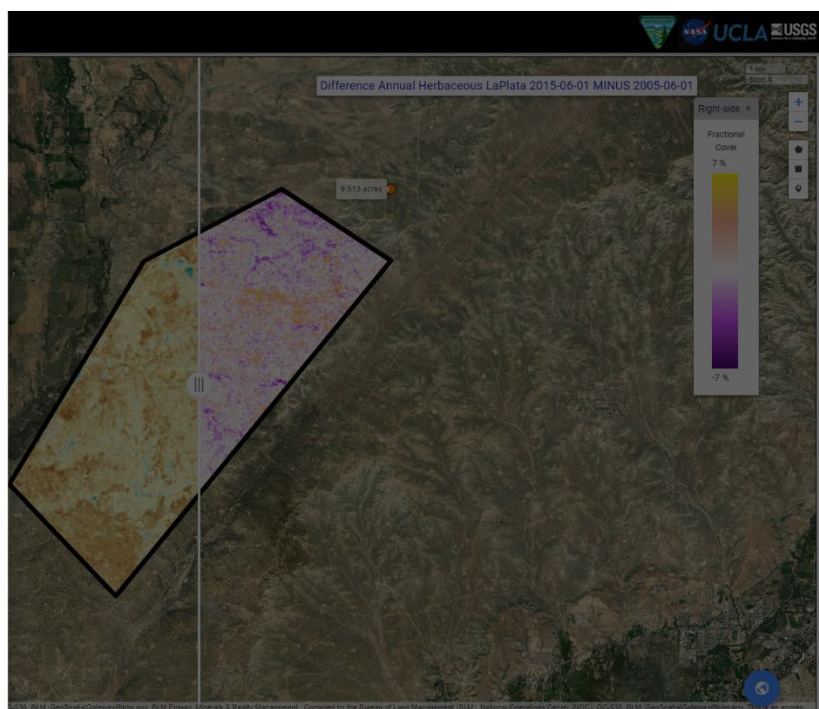
Duration (Months): 3

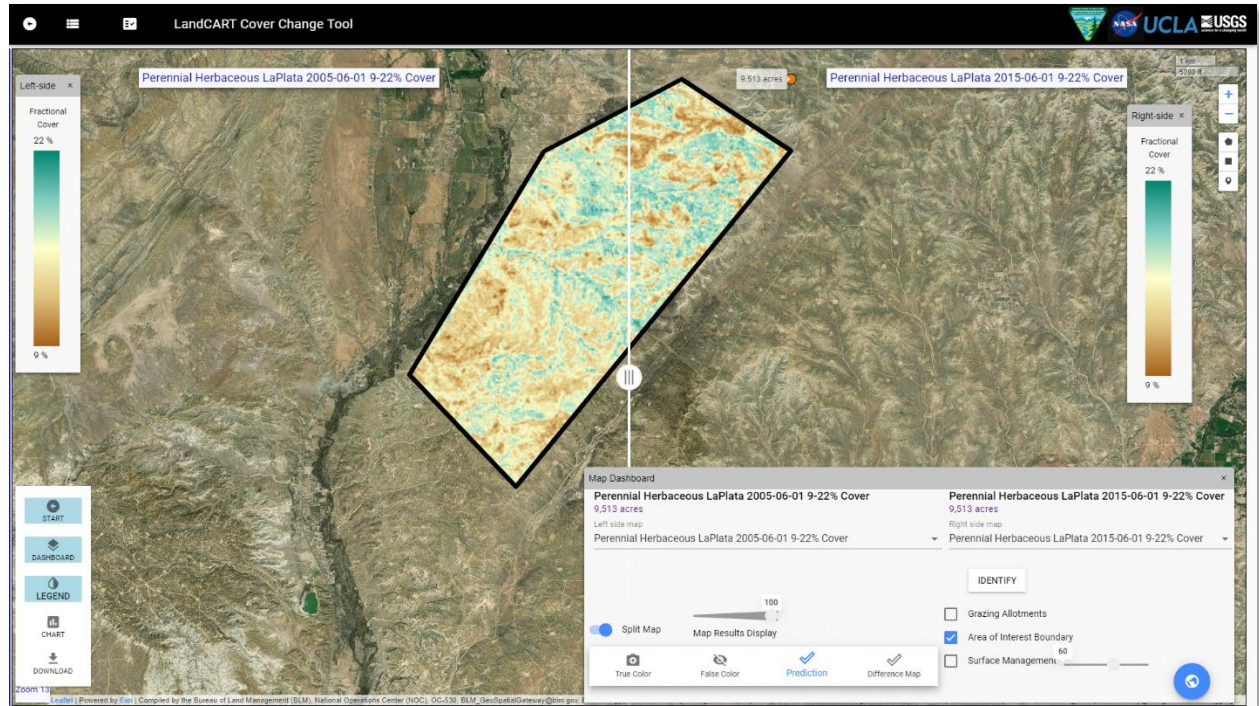
Generate

☒ Download ☒ Histogram Chart ☒ Difference Map

☒ Difference Chart ☒ KS Test

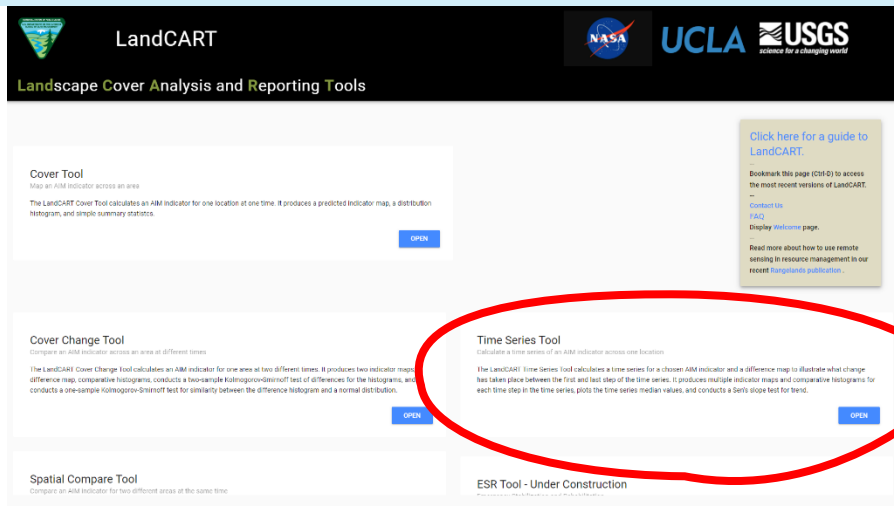
GENERATE PREDICTION **RESET AOI** **RESET ALL BUT AOI** **CLEAR IDENTIFY**





Or change the time range or change the location or all of the above. The possibilities are endless!

LANDCART TIME SERIES TOOL



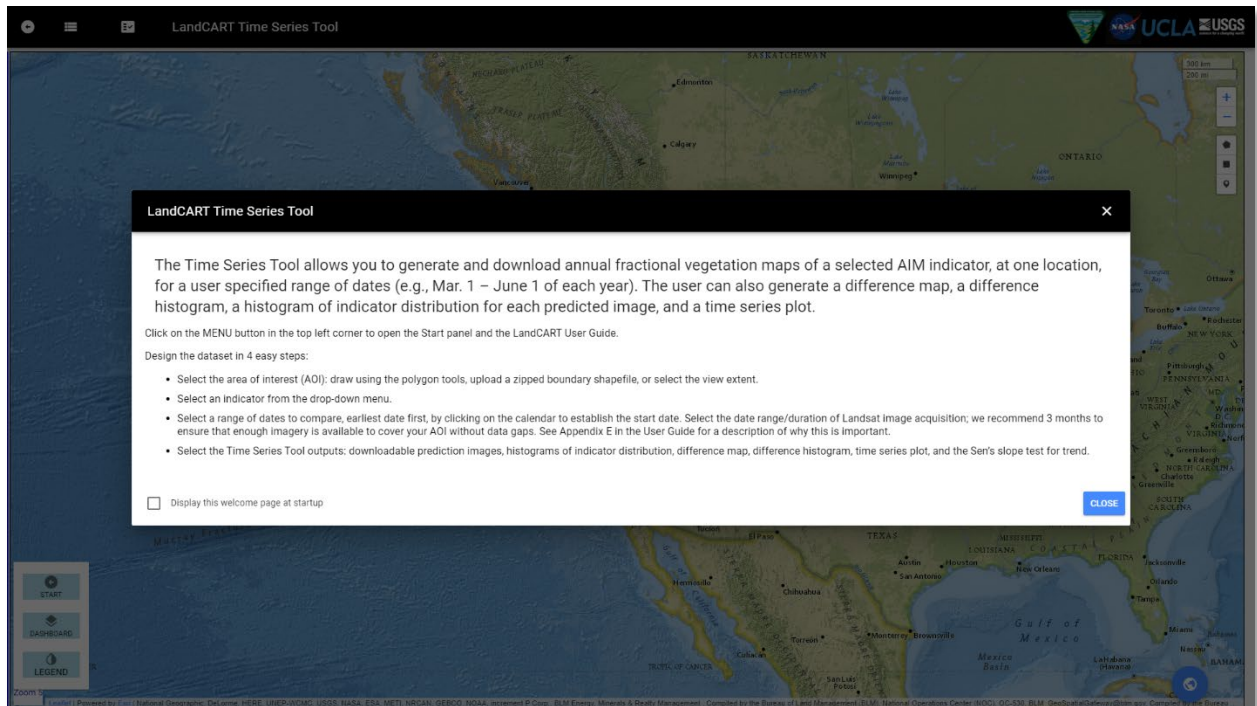
This tool allows the user to predict a continuous fractional cover map to represent AIM indicators for a selected area of interest (AOI) for a range of times of interest (TOIs) (currently annually, seasonally in the future). It produces multiple indicator maps depending on the time range you choose, a difference map of the first and last dates you choose, comparative histograms, and conducts a Sen's Slope test for trend.

List of fractional cover types available in LandCART V1.0 (see [LandCART Fractional Cover Types](#) for details of how the AIM indicators are calculated/defined).

- Annual Forb
- Annual Grass
- Annual Herbaceous
- Bare Ground
- Bare Soil
- Canopy Gaps greater than 25cm
- Canopy Gaps greater than 100 cm
- Canopy Gaps greater than 200 cm
- Herbaceous
- Perennial Forb
- Perennial Grass
- Perennial Herbaceous
- Sagebrush
- Shrubs
- Shrubsucculent
- Succulent
- Total Foliar
- Trees
- Woody

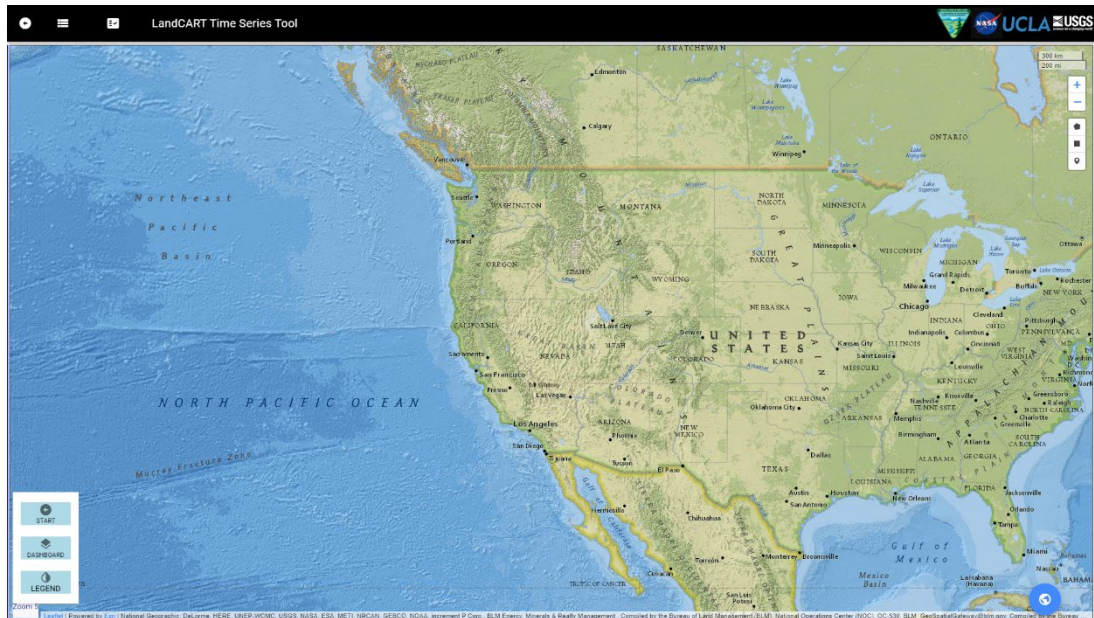
OPENING THE TIME SERIES TOOL

When you open the Time Series Tool the first time, your web browser will open to this screen:



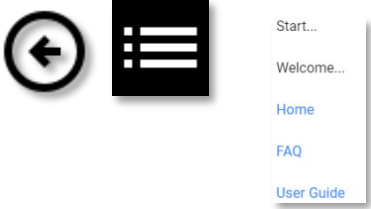



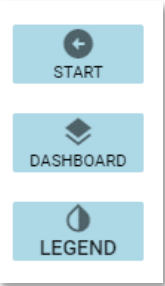
Read and close the splash screen to continue. You can choose to stop displaying the splashscreen by clicking the checkbox:

☒ Display this welcome page at startup



MAP SCREEN CONTROLS

Take a few minutes to check out the controls on the map screen:

	<p>Top Left: You can open the Start Panel with the left button on the title bar or select a choice from the Menu List to open the Start Panel and start your fractional vegetation cover analysis, show the Welcome splash screen, go back to the Home page, go to the Frequently Asked Questions page, or read the User Guide.</p>
	<p>The Checklist Menu provides links to downloadable generic Metadata and Report templates for LandCART outputs.</p>
	<p>Top Right: You can zoom in and out of the map using the Plus/Minus buttons. You can navigate/pan around the map by clicking and dragging your mouse.</p>
	<p>Bottom Right: You can change the base map type using choices from the Blue Globe Button. Click to select Topo, Streets, Imagery, Geographic, Terrain, or Trails.</p>
	<p>Bottom Left: You can use the Toolbox buttons to:</p> <ul style="list-style-type: none"> • Start your fractional vegetation cover analysis (AOI, TOI, IOI), • Show the Dashboard to make visible/invisible data layers, or • Show the Legend (when the Cover Tool has generated a prediction).

START: DEFINE YOUR AREA OF INTEREST (AOI)

Notes:

- **The minimum recommended AOI size is approximately 100 acres or 40 ha. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **GEE is optimized for very large datasets, so don't be afraid to use AOIs of 1 million acres or larger.**

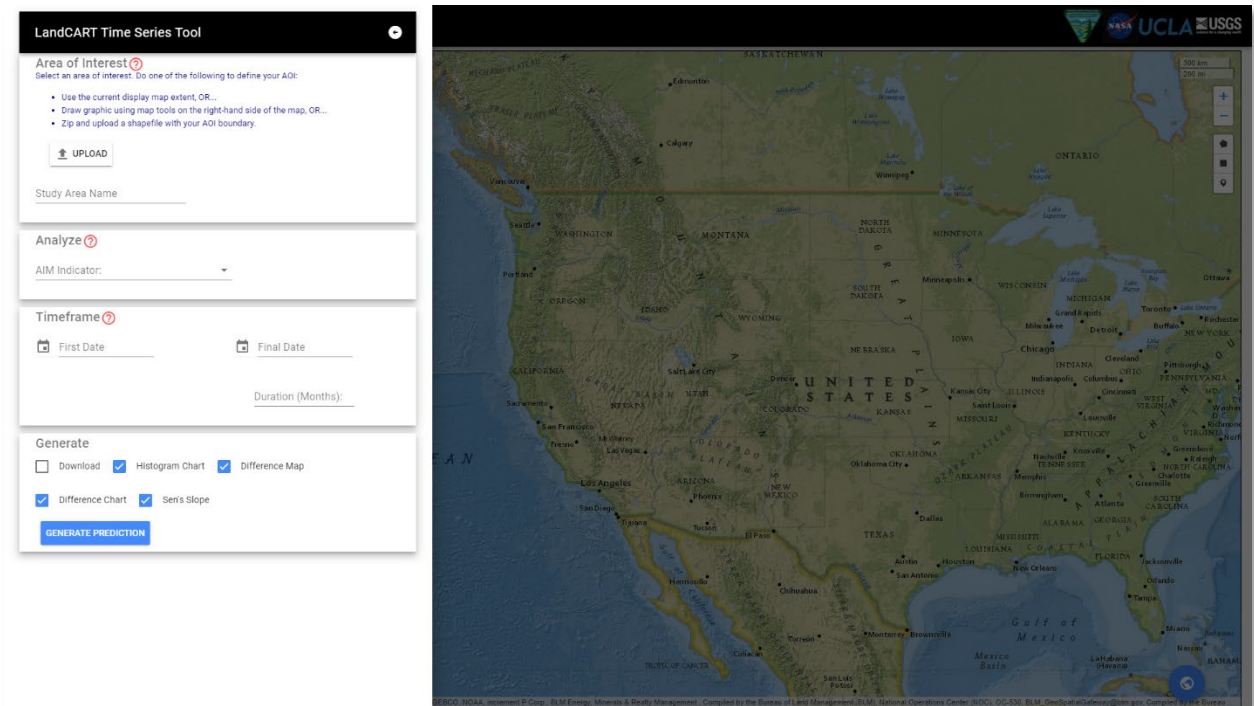
First zoom in close to your AOI using the +/- buttons at top right or the roller on your mouse. Click and drag to pan around the map to a different location.



Then open the **Toolbox - Start Panel** (bottom left OR top left) if it is not already open.



Hover over for  more information about each section in the **Start Panel**.



Where is your AOI and how will you define the boundary?

There are three choices to define the boundary in the Time Series Tool: (1) the current map extent, (2) a drawn polygon, or (3) an uploaded shapefile.

LandCART Time Series Tool

Area of Interest ?

Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

↑

UPLOAD

Study Area Name

You can (1) use the **current map extent**; the actual area will be a little (5%) inside what you see so make sure you include everything you want. You can adjust the extent using pan and zoom controls described above.

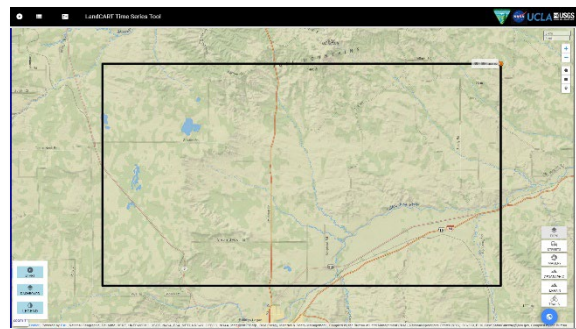
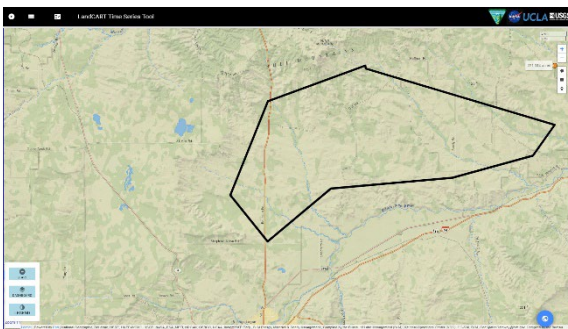
Write in a **Study Area Name**. The **Study Area Name** will be used for display and to name download files.

Study Area Name

You can (2) draw a **polygon or rectangle graphic extent** by clicking on one of the two **drawing tools** on the screen, top right.



Click on separate points to draw the polygon and click on the first point to finish it, or Click and drag to obtain a rectangle shape.



Return to the **Start Panel** and enter your **Study Area Name**. The **Study Area Name** will be used for display and to name download files. You can leave this blank if you want.

Study Area Name

You can (3) **upload** your predefined area as a **shapefile**.

- **Minimum AOI size is approximately 100 acres. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **The zipped shapefile must include the .shp, .dbf, and .prj files, but we recommend including ALL the files associated with the shapefile.**
- **The shapefile should be ONE polygon or ONE multipolygon.**
- **The polygon boundary should be fairly simple – see [Appendix A](#) in the User Guide for instructions on how to simplify a complicated polygon in ArcGIS 10.x.**



Click on Upload to upload a **zipped, polygon shapefile** with all files including the projection file (.prj). Note that this shapefile can be one polygon or one multipart polygon; if the shapefile has multiple different polygons, the application will randomly select ONE of the polygons for your AOI.

The shapefile name will automatically fill in the **Study Area Name** in the **Start Panel**.

LandCART Time Series Tool

Area of Interest ?

Select an area of interest. Do one of the following to define your AOI:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

UPLOAD

Study Area Name

LemhiRiverCentral

249,945 acres

✕ RESET AOI

✕ RESET ALL BUT AOI

A **RESET AOI** and **RESET ALL BUT AOI** button will appear in the **Generate** section below once a polygon has been drawn or uploaded so that you can clear your AOI and start over, if necessary.

Move to the **Analyze** section to select the Indicator to map.

START: DEFINE YOUR INDICATOR OF INTEREST (IOI)

What [AIM core indicator](#) do you wish to predict with the Time Series Tool?

Analyze ?
AIM Indicator:

Click on the dropdown list.

AIM Indicator:

An alphabetical list of the available indicators will appear.

Choose an indicator from the list (Shrubs in this example).

Analyze ?
AIM Indicator:
Shrubs

START: DEFINE YOUR TIMEFRAME OF INTEREST (TOI)

If you wish to predict indicators for 2012, please see Appendix D, [Landsat 5 and Missing 2012 Data](#), for a cautionary tale when working with 2012 Landsat imagery.

Input the first (earlier) date, second (later) date, and duration of your predictions.

Timeframe?

First Date

Final Date

Duration (Months):

Type in a first (earlier) date in the given format (yyyy-mm-dd) or click on the calendar button to select a date. To set the year click on “2021” (upper left side) and roll the years (with the roller on your mouse or use the scroll bar) to when you want the predictions to start. Click on the year (2005 in the example). Select the month and day to start then click OK.



Repeat the process for a second (later) date. Be sure to use the same Month and Day – just change the year. For instance, in the example below, the earlier date is 2005-06-01 and the later date is 2015-06-01.

First Date

Final Date

2022

Wed, Feb 16

<

FEBRUARY 2022

>

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

CANCEL OK

First Date

Final Date

2005

Wed, Feb 16

2003

2004

2005

2006

2007

CANCEL OK

First Date

Final Date

2005

Thu, June 16

2005

JANUARY	FEBRUARY	MARCH
APRIL	MAY	JUNE
JULY	AUGUST	SEPTEMBER
OCTOBER	NOVEMBER	DECEMBER

CANCEL OK

First Date

Final Date

2005

Wed, June 1

<

JUNE 2005

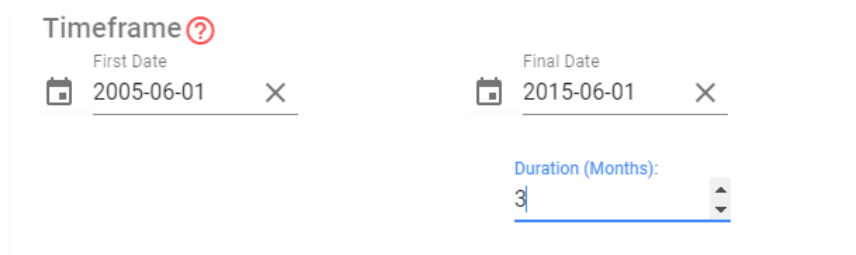
>

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

CANCEL OK

Duration (Months):

Select the **Duration** of time to include satellite data to use for predictions. We recommend using between *one* and *three* months of satellite data to obtain full and good quality coverage of your AOI. If the satellite data does not provide full coverage, there will be gaps in the prediction map. The Time Series Tool defaults to three months duration of data. This duration is applied to every prediction in the time series. Please see [Appendix E](#) for an explanation of why we need to select a duration for the TOI.



The screenshot shows a 'Timeframe' panel with a red question mark icon. It contains two date selection fields: 'First Date' with a calendar icon and a close button, showing '2005-06-01'; and 'Final Date' with a calendar icon and a close button, showing '2015-06-01'. Below these is a 'Duration (Months):' label and a numeric input field containing the value '3'.

CALCULATE FRACTIONAL COVER

Almost there!

Generate

☐ Download
 ☒ Histogram Chart
 ☒ Difference Map

☒ Difference Chart
 ☒ Sen's Slope

You can generate raster datasets to download, histograms of cover distribution, a difference map (latest year minus earliest year), a difference histogram (latest year minus earliest year), plot the time series, and perform the Sen's Slope test for trend.

☐ Download

Click on **Download** to be provided with two single-band images with prediction values for your selected dates.

☐ Histogram Chart

Click on **Histogram Chart** to produce a frequency histogram of the area of the AOI that falls in 5% bins of fractional cover. Summary statistics are also provided.

☐ Difference Map

Click on **Difference Map** to create a difference image. The image is calculated by subtracting the earlier prediction from the later prediction so that positive values indicate an increase from earlier to later date and negative values indicate a decrease.

☐ Difference Chart

Click on **Difference Chart** to create a difference histogram based on subtracting one predicted image from the other, typically the later date minus the earlier date.

☐ Sen's Slope

Click on **Sen's Slope** to calculate the Sen's Slope test for trend statistics. See the [Statistics Review](#) for a detailed explanation of interpreting p-values and results of the Sen's Slope test.

Click on **Generate Prediction** to begin an on-the-fly prediction using your AOI, IOI, and TOIs.

Note that you can click on **Reset AOI** to clear the currently defined AOI and choose a new AOI. This button appears only after you have defined an AOI.

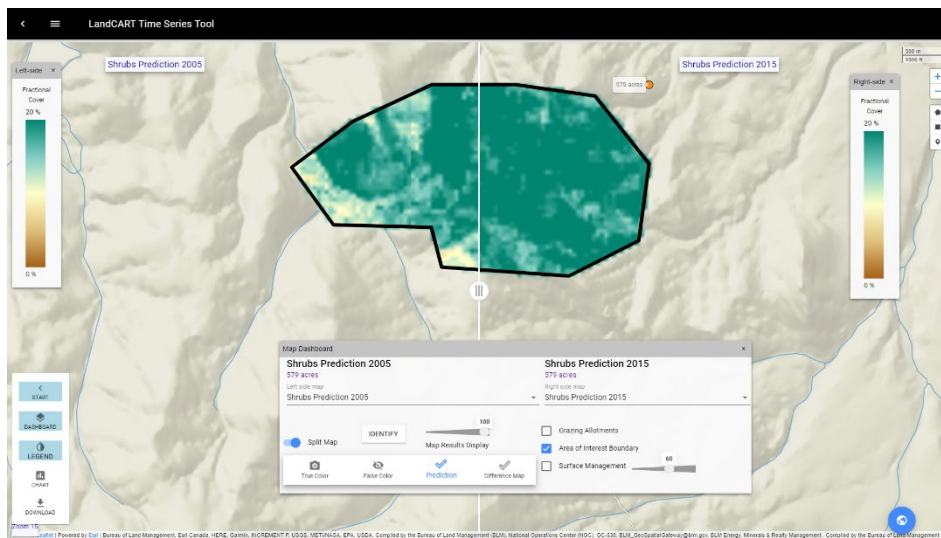
Note that you can click on **Reset All but AOI** to reset all the parameters in the **Start Panel** and keep the current AOI. This button appears only after you have clicked **Generate Prediction**.



The **CLEAR IDENTIFY** button appears below the **Generate Prediction** box after an AOI has been defined. This button clears any **IDENTIFY** points from the map screen.

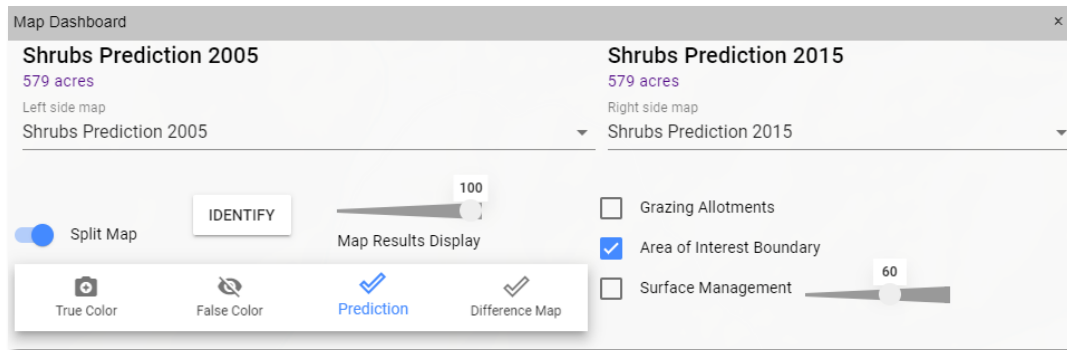
PLEASE BE PATIENT! The map drawing/calculating takes more than a few seconds and sometimes up to several minutes depending on network connectivity.

When calculations are complete, the display shows the predicted fractional cover type for two dates on a split screen, the **Map Dashboard**, the color ramp **Legends** indicating percent cover for both predictions, an identify tool (on the right, below the drawing tools), and the **Toolbox** with buttons to access charts and downloads if selected for generate.

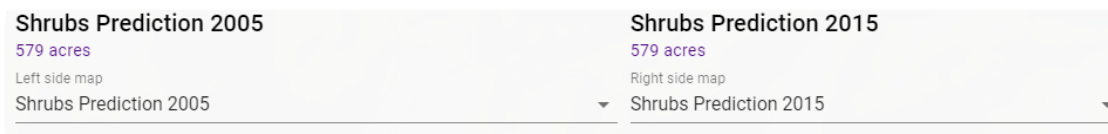


Click on **Dashboard** or **Legend** to open or close the pop-up windows, or the small "x" in the upper right corner of each window to close it.

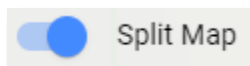
TOOLBOX: MAP DASHBOARD



On the **Map Dashboard** you can choose to display the **Predictions** with dynamic color ramp, the **true color composite** (Red, Green, Blue bands of Landsat imagery used in the prediction) or an **infrared** view (Near InfraRed, Red, Green bands of Landsat imagery used in the prediction), and if you generated a **Difference Map**, it can be displayed as well.



You can choose which map to display on which side. The Time Series Tool defaults to a split screen view showing your first date on the left and your second date on the right. The title of the maps includes the Indicator, the date of the prediction, and the range of fractional cover that is currently displayed (these values will change in the title as you change your visualization).



Toggle the **Split Map** button to show a vertical, moveable bar on the map screen.

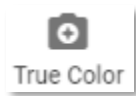
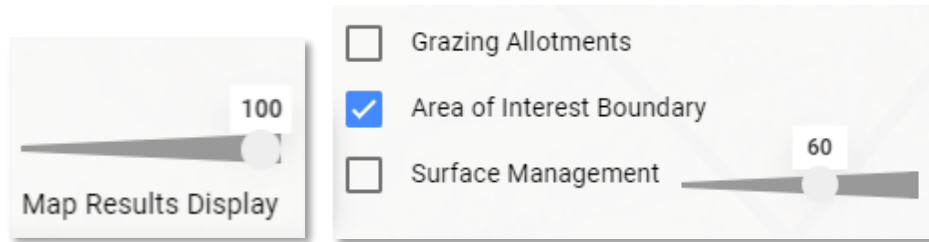


Click and drag the split map round slider to compare the two different maps. You can also choose No Map on either side and use the base map for comparison to one of your dates.



You can change your base map type (click on the **Blue Globe**, bottom right) if desired.

The transparency of the predicted map can be adjusted with the **Map Results Display** slider bar if you wish to see landmarks on the base map. You can also show Vector layers: BLM grazing allotments, the AOI boundary, and Surface Management Agency (SMA). The transparency of SMA can be adjusted on the slider bar so that the underlying base map will show; the transparency defaults to 60%.



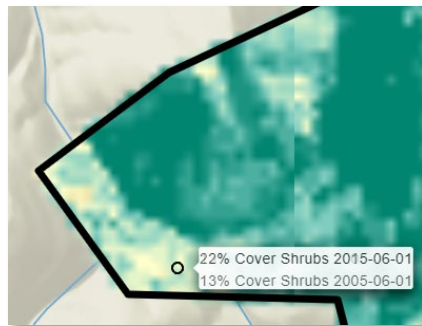
If you wish to view the Landsat composite imagery used in the calculation, click on the **True Color** button to see the red, green, and blue bands displayed for a natural color view.



The **Infrared** button displays the Landsat composite imagery in the near-infrared, red, and green bands for a false color composite view showing green vegetation as red.

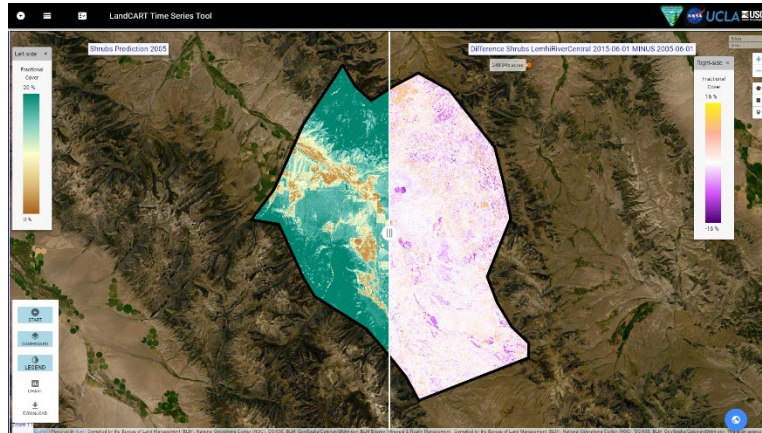


The **Identify** button allows you to click anywhere on the screen and see the fractional cover value from both predictions. These values are not from a single pixel, but rather from an average of approximately 9 pixels centered where you click.



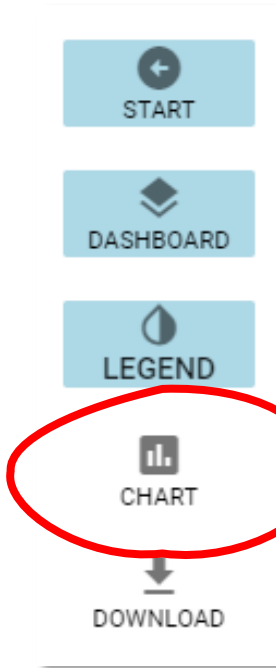


The **Difference Map** button displays the difference image created by subtracting the earlier prediction from the later prediction. In the example below, “Difference Map: Shrubs 2015-06-01 MINUS Shrubs 2005-06-01,” positive values (yellow) indicate an increase from the earlier date to the later date and negative values (purple) indicate a decrease.



You can see the difference histogram by clicking on the **Chart** button.

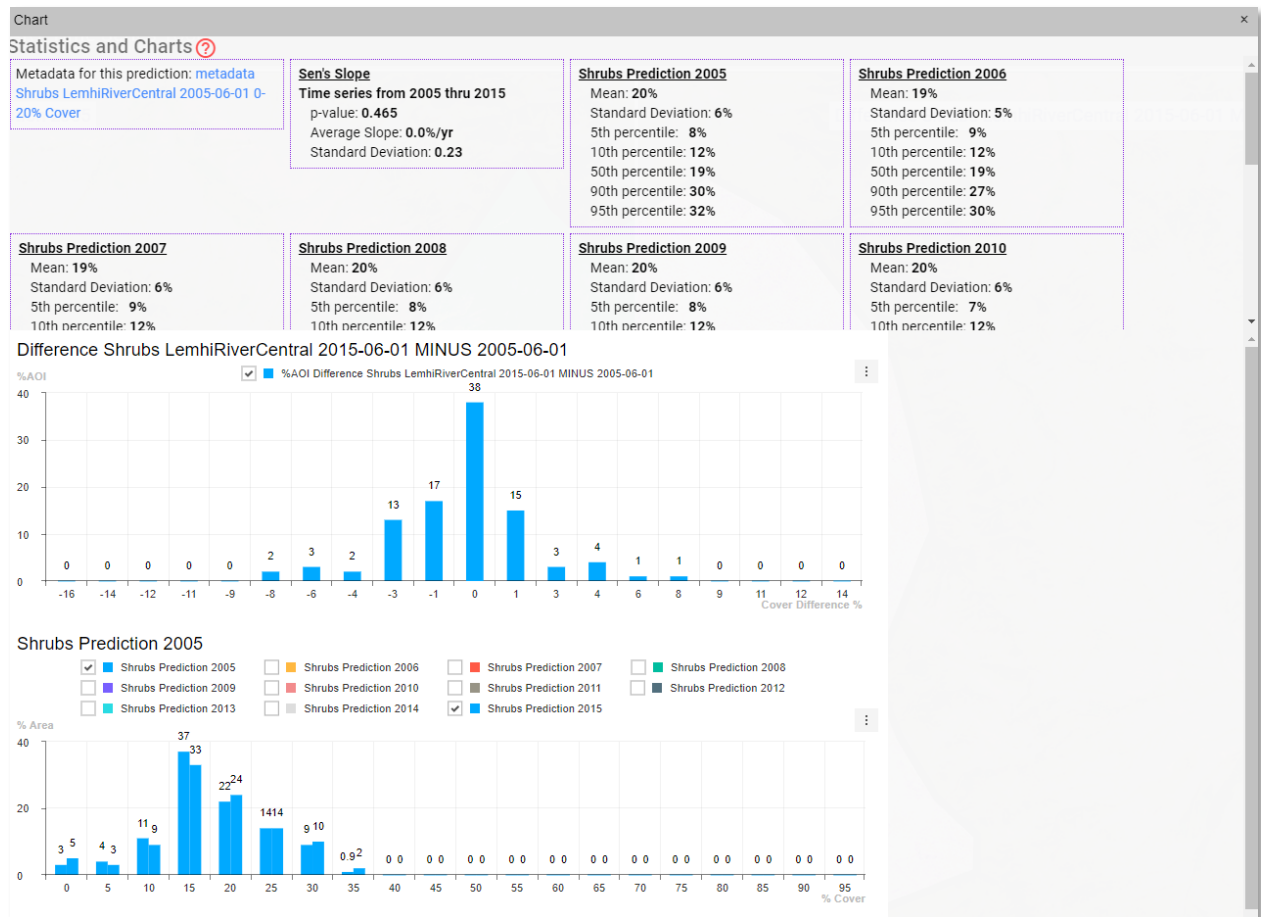
TOOLBOX: CHART

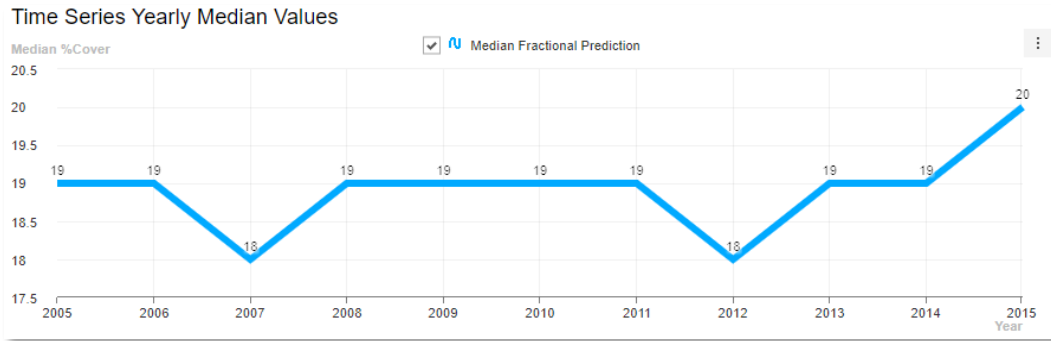


If you have not done so already, now you can look at the percent cover histogram, the time series plot and the difference histogram (if selected to generate) by clicking on the **Chart** button that has appeared on the **Toolbox** panel.

A histogram showing the percent of the AOI area within 5% cover bins will be displayed, defaulting to only the first and last prediction. You can click on the different dates to observe their distributions. Basic summary statistics are listed at the top. If you chose to calculate the Sen's Slope test for trend, these statistics will be listed as well. You might have to scroll down to see all of the statistics. If you selected the **Download** button in the **Generate** section in the **Start** panel, a partially filled-in metadata XML file for the first date of the time series will be available here. You can copy that metadata XML and change the date for the rest of the images in your time series.

See the [Statistics Review](#) for a detailed explanation of interpreting p-values and results of the Sen's Slope test.

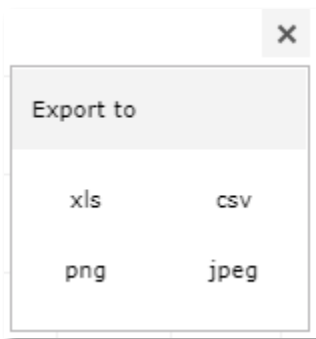




The Time Series Plot that is displayed here can be somewhat misleading. When the y-axis is not set to zero to 100, the change/differences between years might look exaggerated even if the Sen's Slope test for trend statistics indicate there is no trend or very little trend. If you would like a different perspective of this trend line, you can export the values as described below and bring the data into Excel or R and produce a new plot with the y-axis defined differently.



Click on the ellipse button on the top right of the charts to be able to export these chart data as ".xls", ".csv", ".png", or ".jpg". Only the predictions that are checked on will be exported for the distribution histogram.



The files might automatically download to your default download location or will ask you to select a download location depending on how your browser is set up. The indicator prediction file name includes the **IOI**, the study area name (*AOI*), and the year of the **TOI**. The time series plot file name includes the **IOI**, the *AOI*, and the range of years of the **TOI**. The difference histogram file name includes the **IOI**, the last and first **TOIs**, and the *AOI*. The file extension depends upon your selection.

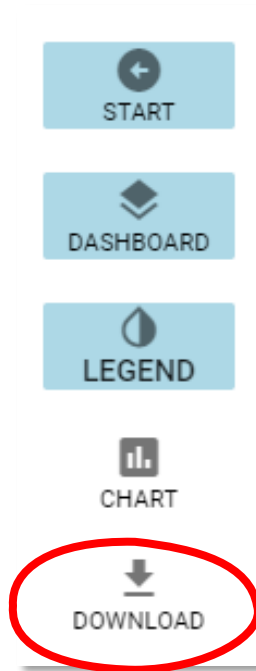
For example:

Shrubs *LemhiRiverCentral* 2005.csv,.xls,.png, or .jpg and

Time Series Median **Shrubs** *LemhiRiverCentral* 2005 to 2015.csv,.xls,.png., or .jpg and

Difference **Shrubs** *LemhiRiverCentral* 2015-06-01 MINUS 2005-06-01.csv,.xls,.png, or .jpg

TOOLBOX: DOWNLOAD

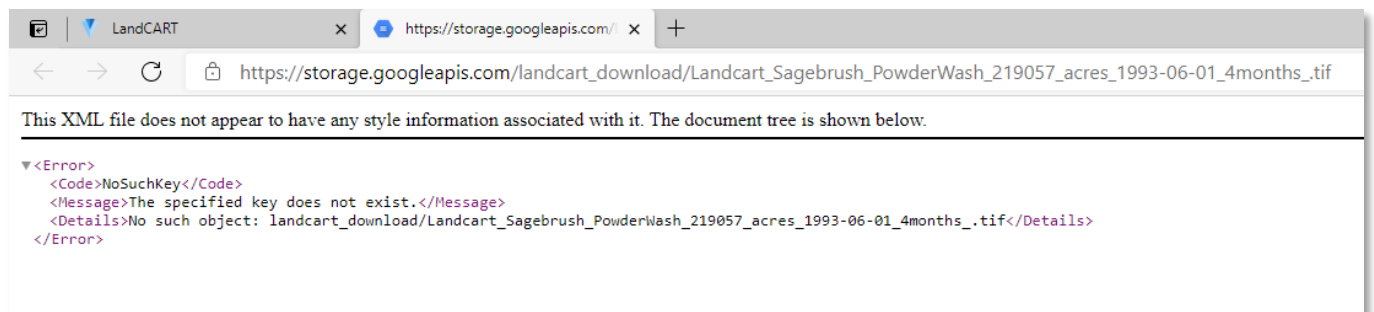


If you would like to run independent analyses of the prediction images/data, you can download the images to your local drive and work with them in your favorite geospatial software (ArcGIS, Imagine, ENVI, R, etc.). Click on the **Download** button in the **Toolbox** panel. This button will only be made available if the data have been successfully predicted. A pop-up will open that looks like this:



(This window often pops up behind the Chart window if it is open)
Click on each link to download individual images.

There are two notes of importance on this pop-up: “Larger jobs might take up to 15 minutes or more for the file to be generated; If the file is not ready, try again after a few minutes.” AND “A new tab might open with a ‘style’ error if the job has not yet completed generating.” In summary, if the AOI is small (less than 100,000 acres or so), the prediction image is usually generated quickly and clicking on the link will start the download immediately. If the AOI is large (we have not determined a limit to AOI size at this point), when you click on the link a new browser tab might open with an error message. This is the typical error we have received when the prediction file has not yet been generated:



If this happens, close this tab, and wait a few minutes to try again. We have successfully downloaded areas of 4 million acres; however, the file generation for areas of this size can take half an hour or more. Please be patient.

The files are automatically downloaded into your default download location (typically, the Downloads folder in your local drive). The predicted images are unprojected (Geographic coordinate system) TIF images made up of 30-m pixels. We suggest you reproject the images to the projection you are using for the project and define the pixel size in meters (See [Appendix B](#) to learn how to reproject images and [Appendix C](#) for a list of common BLM projections). The value of each pixel is the percent of the pixel covered by the indicator chosen.

```
Projection: Geographic (Lat/Lon)
Spheroid: WGS 84
Datum: WGS 84
EPSG Code: 4326
```

The files are automatically named from your input in the **Start Panel** (if you entered a Study Area Name):

Shrubs_LemhiRiverCentral_594_acres_**2005**.TIF

Shrubs_LemhiRiverCentral_594_acres_**2006**.TIF

...

Shrubs_LemhiRiverCentral_594_acres_**2014**.TIF

Shrubs_LemhiRiverCentral_594_acres_**2015**.TIF

The name includes the **IOI**, the study area name (*AOI*), number of acres, and the **TOI**.

WASH, RINSE, REPEAT...



Now that you have predicted fractional cover for this AOI, IOI, and TOI, you can go back to the **Start Panel** and change any of the design features to create a new prediction. For instance, maybe you wish to look at change for several indicators in the same location over the same time period.

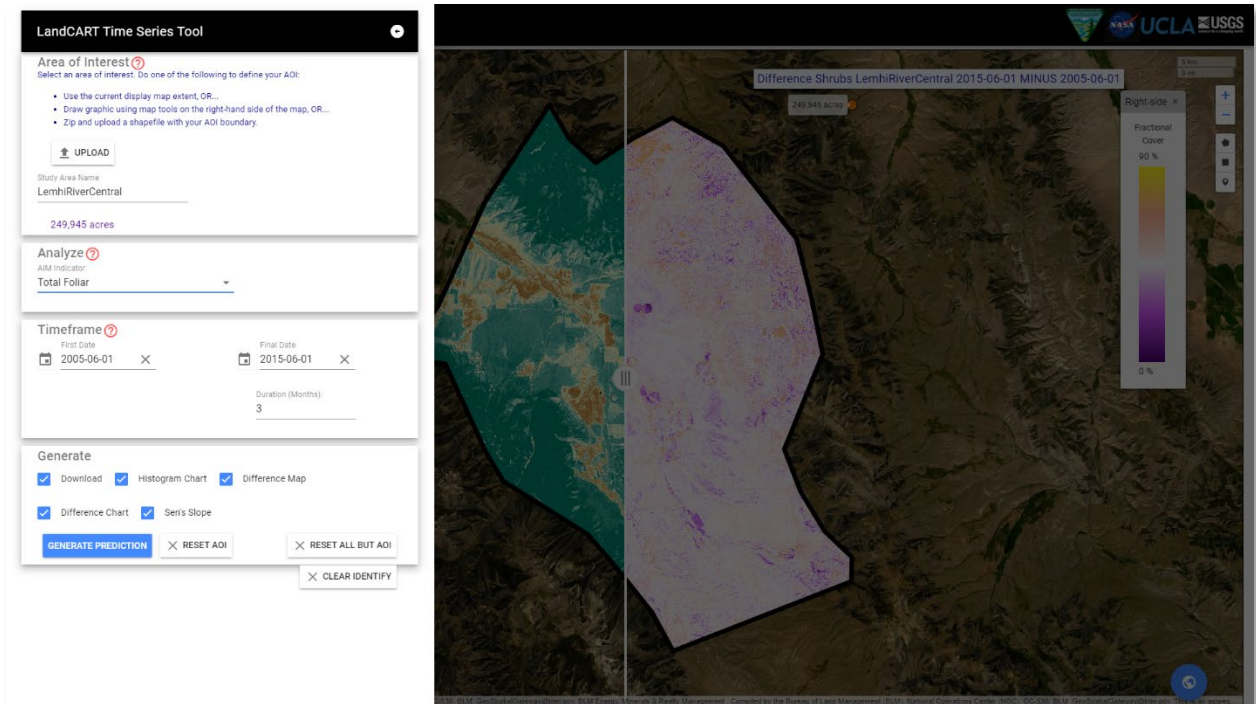


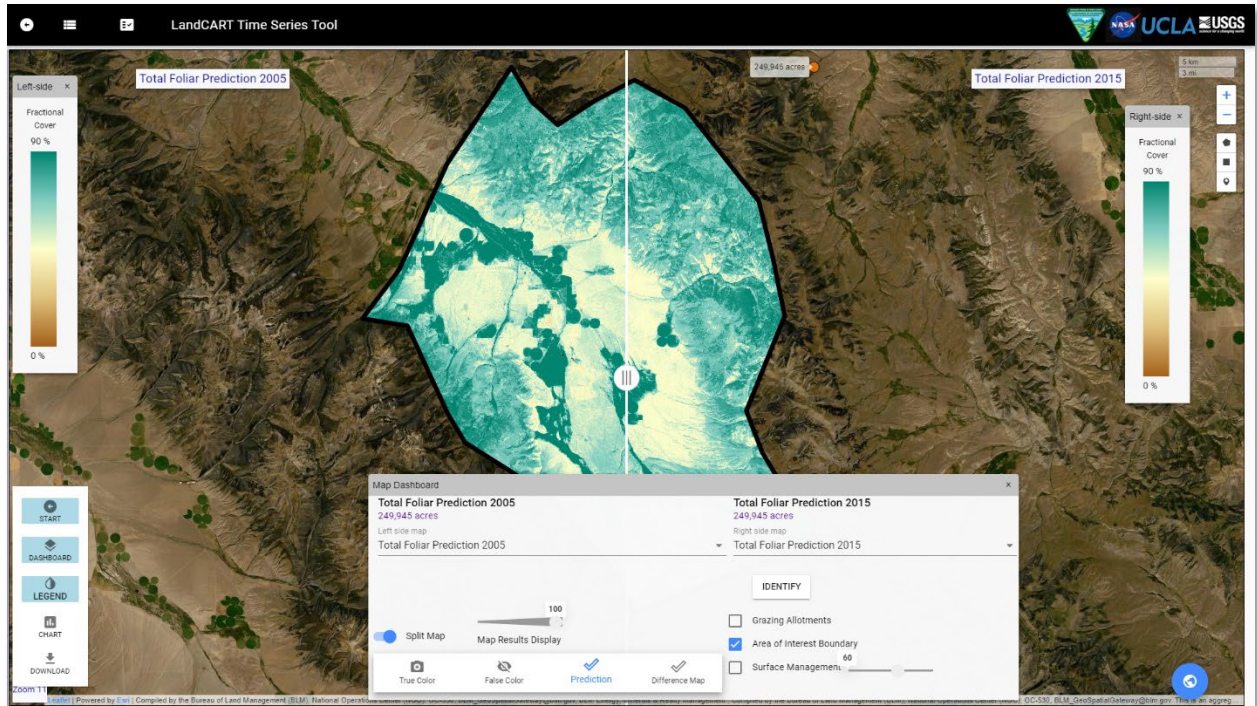
You can reload the browser page to clear your AOI and all other parameters (TOI, IOI) from previous tool runs.

✕ RESET ALL BUT AOI

✕ RESET AOI

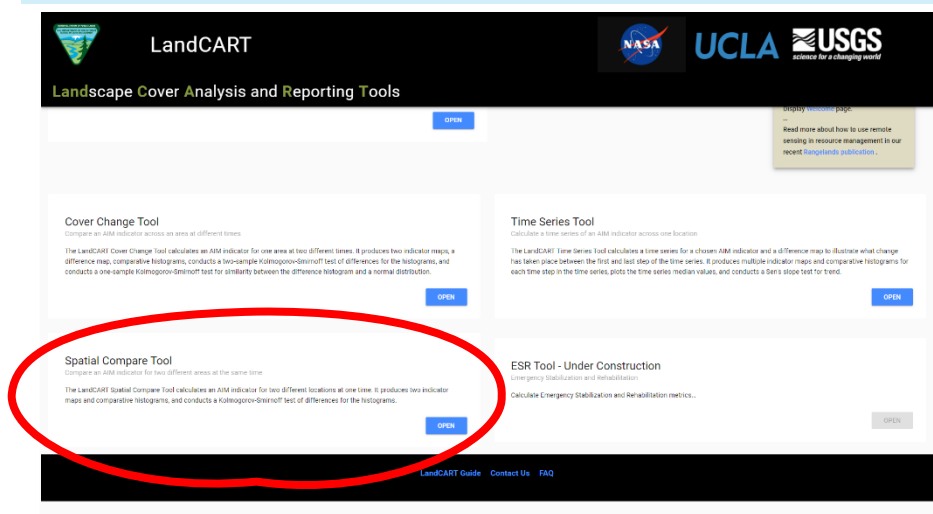
Alternatively, you can click on the **RESET ALL BUT AOI** button and everything, including the charts and statistics, will be cleared, except for your AOI (this is particularly useful when you have hand-drawn the AOI). Or you can click the **RESET** button to start the tool from the beginning.





Or change the time range or change the location or all of the above. The possibilities are endless!

LANDCART SPATIAL COMPARE TOOL



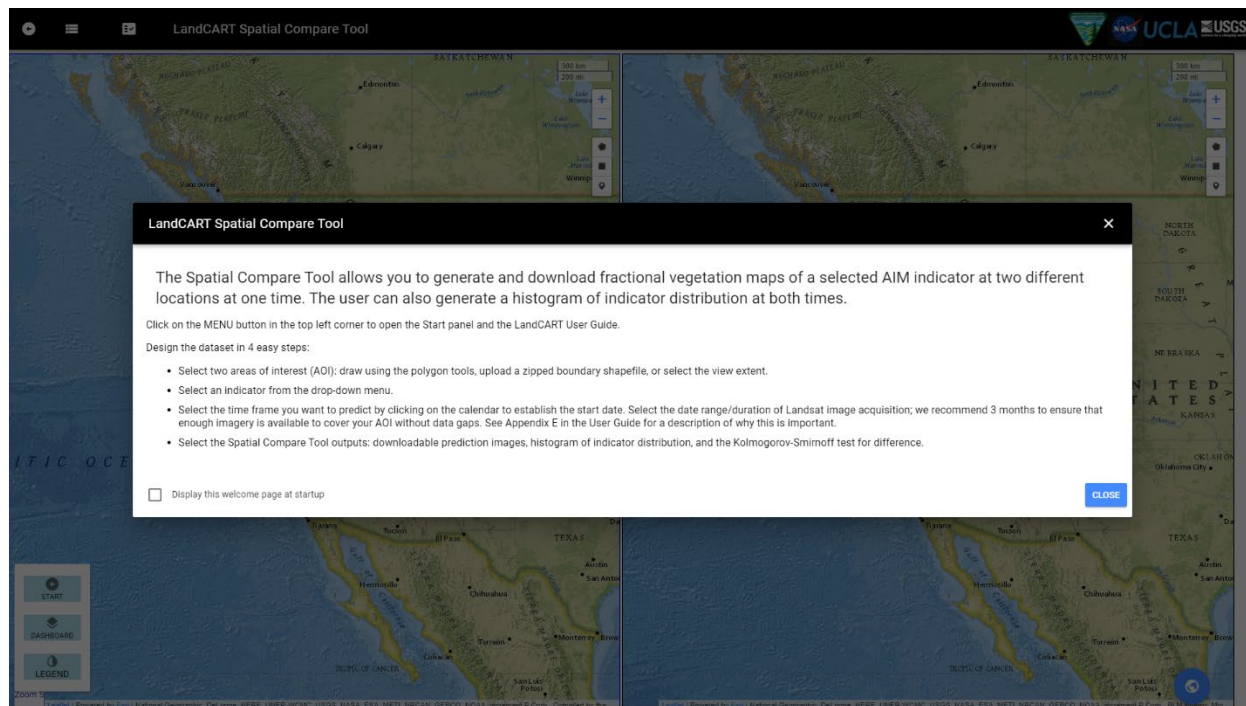
This app allows the user to predict a continuous fractional cover map to represent AIM indicators for a selected time of interest (TOI) and two different locations (AOIs). It produces two indicator maps, comparative histograms, and conducts a two-sample Kolmogorov-Smirnoff test of differences for the histograms.

List of fractional cover types available in LandCART V1.0 (see [LandCART Fractional Cover Types](#) for details of how the AIM indicators are calculated/defined).

- | | |
|-----------------------------------|------------------------|
| • Annual Forb | • Perennial Grass |
| • Annual Grass | • Perennial Herbaceous |
| • Annual Herbaceous | • Sagebrush |
| • Bare Ground | • Shrubs |
| • Bare Soil | • Shrubsucculent |
| • Canopy Gaps greater than 25cm | • Succulent |
| • Canopy Gaps greater than 100 cm | • Total Foliar |
| • Canopy Gaps greater than 200 cm | • Trees |
| • Herbaceous | • Woody |
| • Perennial Forb | |

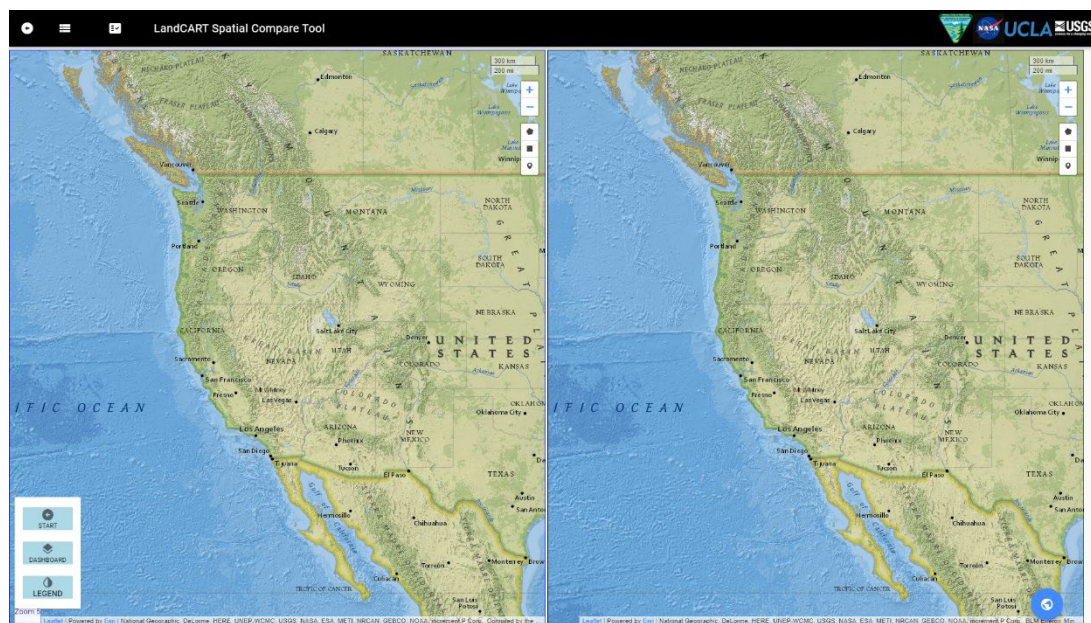
OPENING THE SPATIAL COMPARE TOOL

When you open the Cover Change Tool the first time, your web browser will open to this screen:



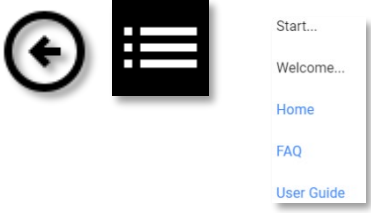



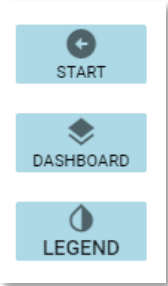
Read and close the splash screen to continue. You can choose to stop displaying the splashscreen by clicking the checkbox:

☒ Display this welcome page at startup



MAP SCREEN CONTROLS

Take a few minutes to check out the controls on the map screen:

	<p>Top Left: You can open the Start Panel with the left button on the title bar or select a choice from the Menu List to open the Start Panel and start your fractional vegetation cover analysis, show the Welcome splash screen, go back to the Home page, go to the Frequently Asked Questions page, or read the User Guide.</p>
	<p>The Checklist Menu provides links to downloadable generic Metadata and Report templates for LandCART outputs.</p>
	<p>Top Right: You can zoom in and out of the map using the Plus/Minus buttons. You can navigate/pan around the map by clicking and dragging your mouse.</p>
	<p>Bottom Right: You can change the base map type using choices from the Blue Globe Button. Click to select Topo, Streets, Imagery, Geographic, Terrain, or Trails.</p>
	<p>Bottom Left: You can use the Toolbox buttons to:</p> <ul style="list-style-type: none"> • Start your fractional vegetation cover analysis (AOI, TOI, IOI), • Show the Dashboard to make visible/invisible data layers, or • Show the Legend (when the Cover Tool has generated a prediction).

START: DEFINE YOUR AREAS OF INTEREST (AOI)

Notes:

- **The minimum recommended AOI size is approximately 100 acres or 40 ha. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **GEE is optimized for very large datasets, so don't be afraid to use AOIs of 1 million acres or larger.**

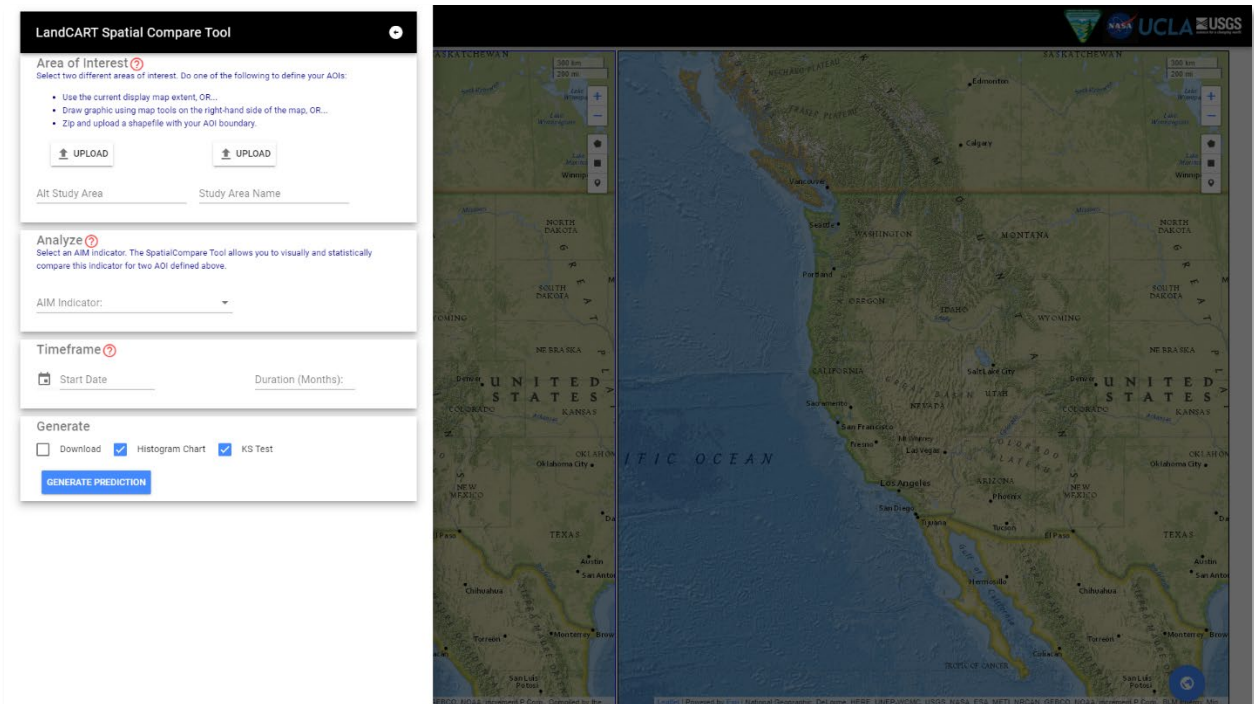


Open the **Toolbox - Start Panel** (bottom left) if it is not already open.

Hover over for



more information about each section in the **Start Panel**.



Where are your AOIs and how will you define the boundaries?

There are three choices to define the boundaries in the Spatial Compare Tool – applied to each map independently: (1) the current map extent, (2) a drawn polygon, or (3) an uploaded shapefile.

LandCART Spatial Compare Tool

Area of Interest ?

Select two different areas of interest. Do one of the following to define your AOIs:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

↑ UPLOAD

↑ UPLOAD

Alt Study Area

Study Area Name

You can (1) use the **current map extent**; the actual area will be a little (5%) inside what you see so make sure you include everything you want. You can adjust the extent using pan and zoom controls described above.

Alt Study Area

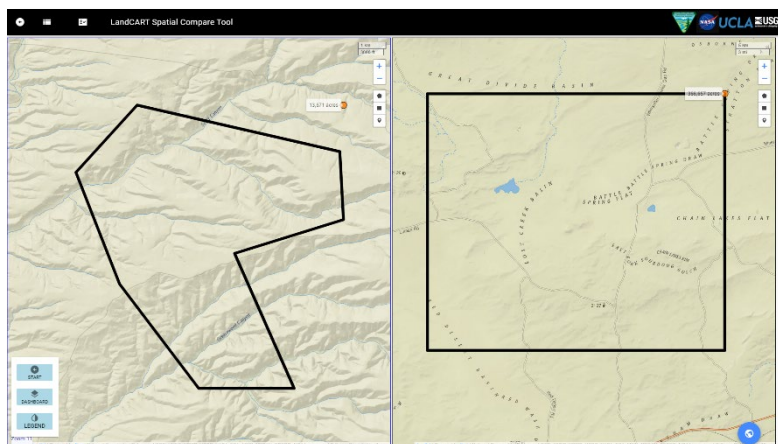
Study Area Name

Write in a name for the left-side map (**Alt Study Area**) and a name for the right-side map (**Study Area Name**). These names will be used for display and to name download files. You can leave these blank if you want, but we strongly suggest you give each side a distinct name to more easily label what you are looking at.

You can (2) draw a **polygon or rectangle graphic extent** by clicking on one of the two **drawing tools** on each map screen, top right.



Click on separate points to draw the polygon and click on the first point to finish it, or Click and drag to obtain a rectangle shape.



Return to the **Start Panel** and write in a name for the left-side map (**Alt Study Area**) and a name for the right-side map (**Study Area Name**). These names will be used for display and to name download files. You can leave these blank if you want, but we strongly suggest you give each side a distinct name to more easily label what you are looking at.

Alt Study Area	Study Area Name
----------------	-----------------

You can (3) **upload** a predefined area as a **shapefile** to either map.

- **Minimum AOI size is approximately 100 acres. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results.**
- **The zipped shapefile must include the .shp, .dbf, and .prj files, but we recommend including ALL the files associated with the shapefile.**
- **The shapefile should be ONE polygon or ONE multipolygon.**
- **The polygon boundary should be fairly simple – see [Appendix A](#) in the User Guide for instructions on how to simplify a complicated polygon in ArcGIS 10.x.**

 **UPLOAD**
 **UPLOAD**

Click on the **Upload** button on the left to upload a shapefile into the left-side map and the **Upload** button on the right to upload a shapefile into the right-side map. The upload file must be a **zipped, polygon shapefile** with all files including the projection file (.prj). Note that this shapefile can be one polygon or one multipart polygon; if the shapefile has multiple different polygons, the application will randomly select ONE of the polygons for your AOI.


The shapefile name will automatically fill in the **Alt Study Area** and **Study Area Name** in the **Start Panel**.


LandCART Spatial Compare Tool

Area of Interest ?

Select two different areas of interest. Do one of the following to define your AOIs:

- Use the current display map extent, OR...
- Draw graphic using map tools on the right-hand side of the map, OR...
- Zip and upload a shapefile with your AOI boundary.

 **UPLOAD**

 **UPLOAD**

Alt Study Area

AllotmentBoundary

7,167 acres

Study Area Name

SW_Pasture

1,702 acres

A rectangular button with a light gray background and a thin border. It contains a small 'X' icon followed by the text 'RESET AOI'.A rectangular button with a light gray background and a thin border. It contains a small 'X' icon followed by the text 'RESET ALL BUT AOI'.

A **RESET AOI** and **RESET ALL BUT AOI** button will appear in the **Generate** section below once a polygon has been drawn or uploaded so that you can clear your AOI and start over, if necessary.

You can use any of these methods to define your AOI in either map. For instance, you can upload a shapefile to the left-side map and draw a polygon in the right-side map. You don't have to use the same method for both.

Move to the **Analyze** section to select the Indicator to map.

START: DEFINE YOUR INDICATOR OF INTEREST (IOI)

What [AIM core indicator](#) do you wish to predict with the Spatial Compare Tool?

Analyze ?

Select an AIM indicator. The SpatialCompare Tool allows you to visually and statistically compare this indicator for two AOI defined above.

AIM Indicator:

Click on the dropdown list.

AIM Indicator:

An alphabetical list of the available indicators will appear.

Choose an indicator from the list (Total Foliar in this example).

Analyze ?

Select an AIM indicator. The SpatialCompare Tool allows you to visually and statistically compare this indicator for two AOI defined above.

AIM Indicator:


Herbaceous

START: DEFINE YOUR TIMEFRAME OF INTEREST (TOI)

If you wish to predict indicators for 2012, please see Appendix D, [Landsat 5 and Missing 2012 Data](#), for a cautionary tale when working with 2012 Landsat imagery.

Select the start date and duration of your predictions.

Timeframe ?



Type in a start date in the given format (yyyy-mm-dd) or click on the calendar button to select a start date. To set the year click on “2021” (upper left side) and roll the years (with the roller on your mouse or use the scroll bar) to when you want the predictions to start. Click on the year (2018 in the example). Select the month and day to start then click OK.



Start Date:

Duration (M)

2021

Fri, Apr 2

<

APRIL 2021

>

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

CANCEL OK

Start Date:

Duration

2018

Fri, Mar 2

2016

2017

2018

2019

2020

CANCEL OK

Start Date:

Duration

2018

Mon, Apr 2

2018

JANUARY

FEBRUARY

MARCH

APRIL

MAY

JUNE

JULY

AUGUST

SEPTEMBER

OCTOBER

NOVEMBER

DECEMBER

CANCEL OK

Start Date:

Duration (M)

2018

Mon, Apr 2

<

APRIL 2018

>



S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

CANCEL OK

Duration (Months):

Select the **Duration** of time to pull satellite data to use for predictions. We recommend using between *one* and *three* months of satellite data to obtain full and good quality coverage of your AOI. If the satellite data does not provide full coverage, there will be gaps in the prediction map. The Cover Tool defaults to three months duration of data. Please see [Appendix F](#) for an explanation of why we need to select a duration for the TOI.

Timeframe ?

Start Date.
 2018-04-04 

Duration (Months):

3

CALCULATE FRACTIONAL COVER

Almost there!

Generate

☐ Download
 ☒ Histogram Chart
 ☒ KS Test

You can generate raster datasets to download, histograms of cover distribution, and perform a Kolmogorov-Smirnoff test.

☐ Download

Click on **Download** to be provided with two single-band images with prediction values for your selected dates.

☐ Histogram Chart

Click on **Histogram Chart** to produce a frequency histogram of the area of the AOI that falls in 5% bins of fractional cover. Summary statistics are also provided.

☐ KS Test

Click on **KS Test** to calculate the Kolmogorov-Smirnoff statistics. See the [Statistics Review](#) for a detailed explanation of interpreting p-values and results of the KS test.

GENERATE PREDICTION

Click on **Generate Prediction** to begin an on-the-fly prediction using your AOI, IOI, and TOIs.

X RESET AOI

Note that you can click on **Reset AOI** to reset only the AOIs on the maps and in the **Start Panel** while keeping all other parameters. This button appears only after you have added an AOI to a map.

X RESET ALL BUT AOI

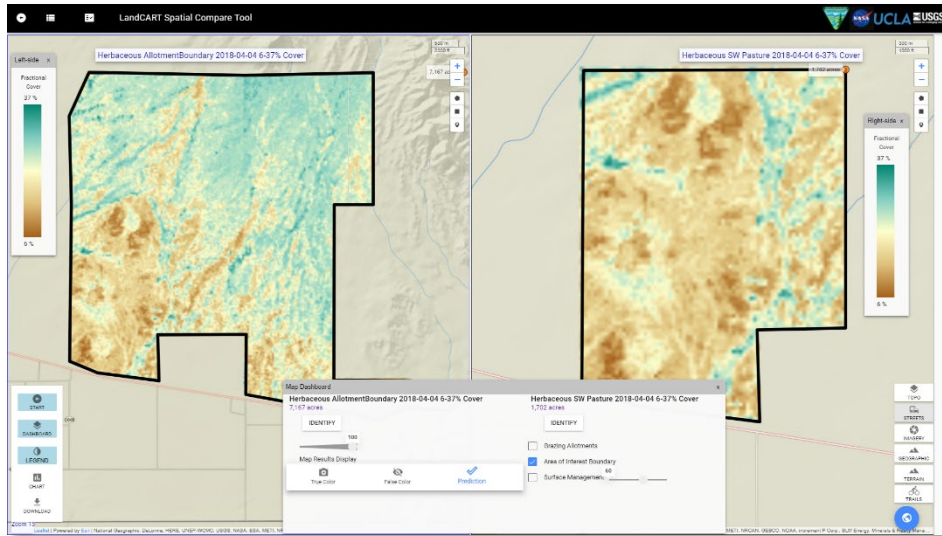
Note that you can click on **Reset All but AOI** to reset all the parameters in the **Start Panel** and keep the current AOI. This button appears only after you have clicked **Generate Prediction**.

X CLEAR IDENTIFY

The **CLEAR IDENTIFY** button appears below the **Generate Prediction** box after an AOI has been defined. This button clears any **IDENTIFY** points from the map screen.

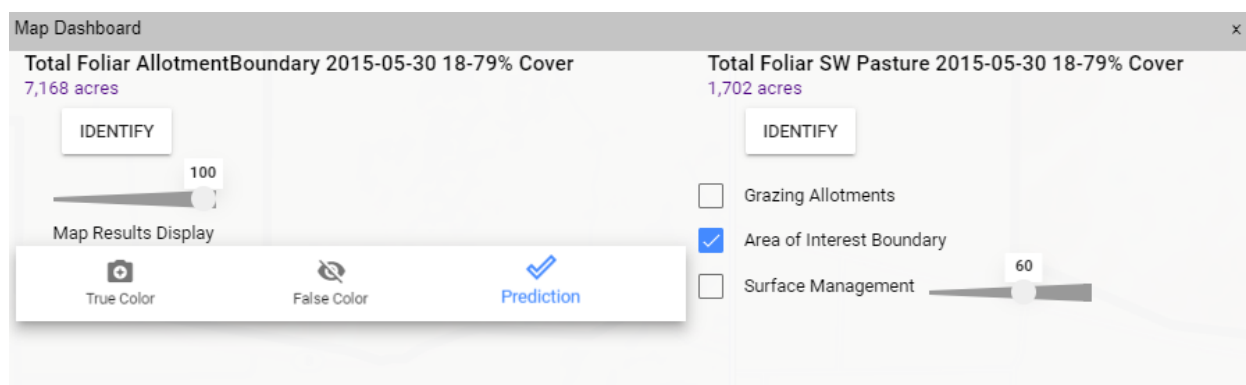
PLEASE BE PATIENT! The map drawing/calculating takes more than a few seconds and sometimes up to several minutes depending on network connectivity.

When calculations are complete, the display shows the predicted fractional cover type on two maps for the same time range, the **Map Dashboard**, the color ramp **Legends** indicating percent cover for both predictions, an identify tool (on the right of each map, below the drawing tools), and the **Toolbox** with buttons to access charts and downloads if selected for generate.



Click on **Dashboard** or **Legend** to open or close the pop-up windows, or the small “x” in the upper right corner of each window to close it.

TOOLBOX: MAP DASHBOARD



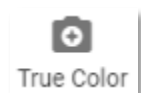
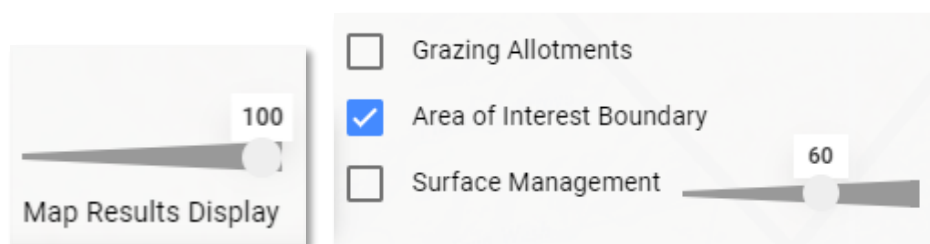
On the **Map Dashboard** you can choose to display the **Predictions** with dynamic color ramp, the **true color composite** (Red, Green, Blue bands of Landsat imagery used in the prediction), or an **infrared** view (Near InfraRed, Red, Green bands of Landsat imagery used in the prediction).

The Spatial Compare Tool displays two maps of different locations and the same indicator and time frame. The title of the maps includes the Indicator, the AOI, the date of the prediction, and the range of fractional cover that is currently displayed.



You can change your base map type (click on the **Blue Globe**, bottom right) if desired.

The transparency of the predicted map can be adjusted with the **Map Results Display** slider bar if you wish to see landmarks on the base map. You can also show Vector layers: BLM grazing allotments, the AOI boundaries, and Surface Management Agency (SMA). The transparency of SMA can be adjusted on the slider bar so that the underlying base map will show; the transparency defaults to 60%.



If you wish to view the Landsat composite imagery used in the calculation, click on the **True Color** button to see the red, green, and blue bands displayed for a natural color view. *(As of 11-17-2021, this function only applies to the right-side map; this will be updated to show both images.)*

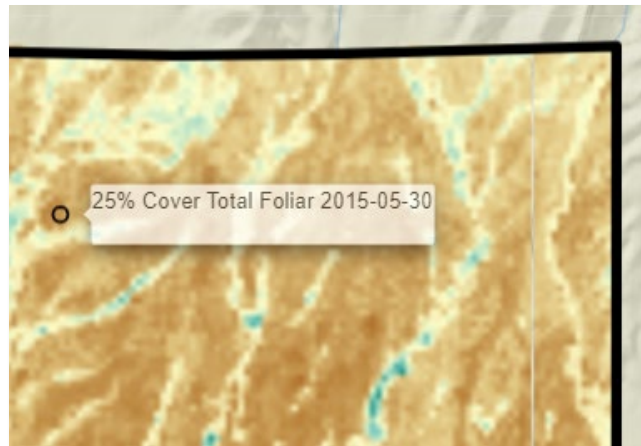


The **Infrared** button displays the Landsat composite imagery in the near-infrared, red, and green bands for a false color composite view showing green vegetation as red. (As of 11-17-2021, this function only applies to the right-side map; this will be updated to show both images.)

IDENTIFY

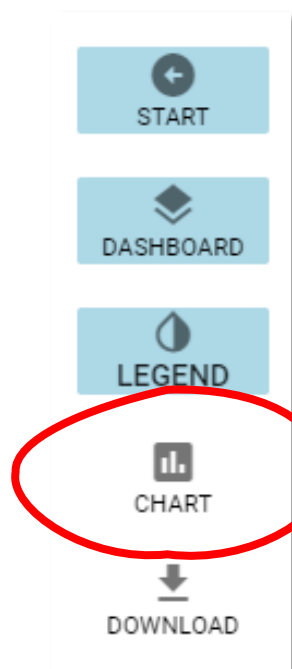


The **Identify** button allows you to click anywhere on the screen and see the fractional cover value from both predictions. These values are not from a single pixel, but rather from an average of approximately 9 pixels centered where you click. Buttons on the left apply to the left-side map; buttons on the right apply to the right-side map.



You can see the difference histogram by clicking on the **Chart** button.

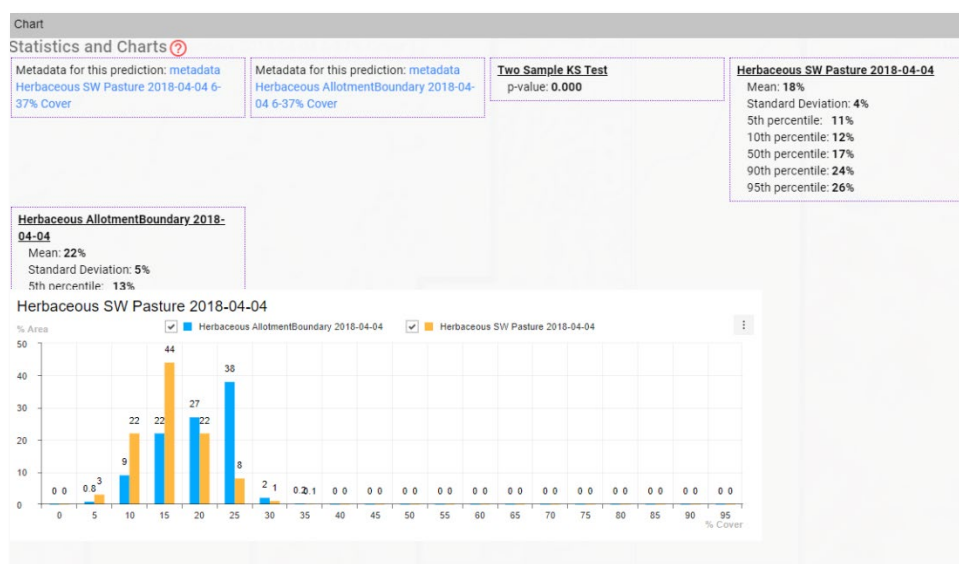
TOOLBOX: CHART



If you have not done so already, now you can look at the percent cover histogram by clicking on the **Chart** button that has appeared on the **Toolbox** panel.

A histogram showing the percent of the AOI area within 5% cover bins will be displayed for both predictions. Basic summary statistics are listed at the top. If you chose to calculate the Kolmogorov-Smirnoff (KS) statistics, the two-sample KS test will be performed. If you selected the **Download** button in the **Generate** section in the **Start** panel, a partially filled-in metadata XML file for each image will be available here.

See the [Statistics Review](#) for a detailed explanation of interpreting p-values and results of the KS test.



Click on the ellipse button on the top right of the charts to be able to export these chart data as ".xls", ".csv", ".png", or ".jpg".



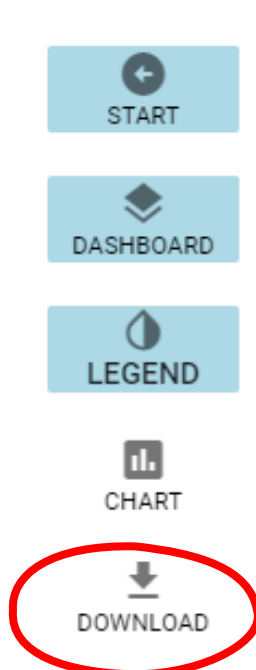
The file might automatically download to your default download location or will ask you to select a download location depending on how your browser is set up. The indicator prediction file name includes the **IOI**, the study area name (*AOI*), and the **TOI**. The file extension depends upon your selection.

For example:

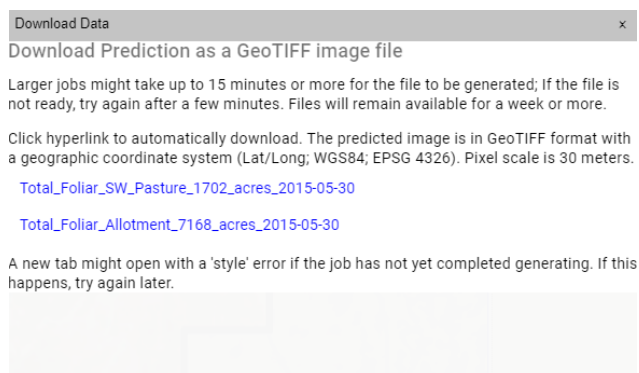
Total Foliar Allotment 2015-05-30.csv,.xls,.png, or .jpg. and

Total Foliar SW_Pasture 2015-05-30.csv,.xls,.png, or .jpg

TOOLBOX: DOWNLOAD

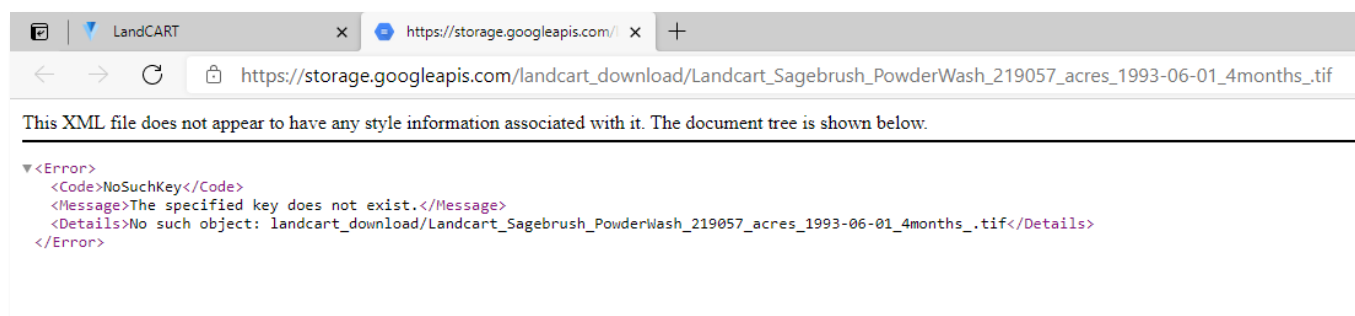


If you would like to run independent analyses of the prediction images/data, you can download the images to your local drive and work with them in your favorite geospatial software (ArcGIS, Imagine, ENVI, R, etc.). Click on the **Download** button in the **Toolbox** panel. This button will only be made available if the data have been successfully predicted. A pop-up will open that looks like this:



(This window often pops up behind the Chart window if it is open)
Click on each link to download individual images.

There are two notes of importance on this pop-up: “Larger jobs might take up to 15 minutes or more for the file to be generated; If the file is not ready, try again after a few minutes.” AND “A new tab might open with a ‘style’ error if the job has not yet completed generating.” In summary, if the AOI is small (less than 100,000 acres or so), the prediction image is usually generated quickly and clicking on the link will start the download immediately. If the AOI is large (we have not determined a limit to AOI size at this point), when you click on the link a new browser tab might open with an error message. This is the typical error we have received when the prediction file has not yet been generated:



If this happens, close this tab, and wait a few minutes to try again. We have successfully downloaded areas of 4 million acres; however, the file generation for areas of this size can take half an hour or more. Please be patient.

The files are automatically downloaded into your default download location (typically, the Downloads folder in your local drive). The predicted images are unprojected (Geographic coordinate system) TIF images made up of 30-m pixels. We suggest you reproject the images to the projection you are using for the project and define the pixel size in meters (See [Appendix B](#) to learn how to reproject images and [Appendix C](#) for a list of common BLM projections). The value of each pixel is the percent of the pixel covered by the indicator chosen.

```
Projection: Geographic (Lat/Lon)
Spheroid: WGS 84
Datum: WGS 84
EPSG Code: 4326
```

The files are automatically named from your input in the **Start Panel** (if you entered a Study Area Name):

Total_Foliar_Allotment_7168_acres_2015-05-30.TIF

Total_Foliar_SW_Pasture_1702_acres_2015-05-30.TIF

The name includes the **IOI**, the study area name (*AOI*), number of acres, and the **TOI**.

WASH, RINSE, REPEAT...



Now that you have predicted fractional cover for these AOIs, IOI, and TOI, you can go back to the **Start Panel** and change any of the design features to create new predictions. For instance, perhaps after looking at the pasture compared to the entire allotment you would like to compare two pastures within the allotment.

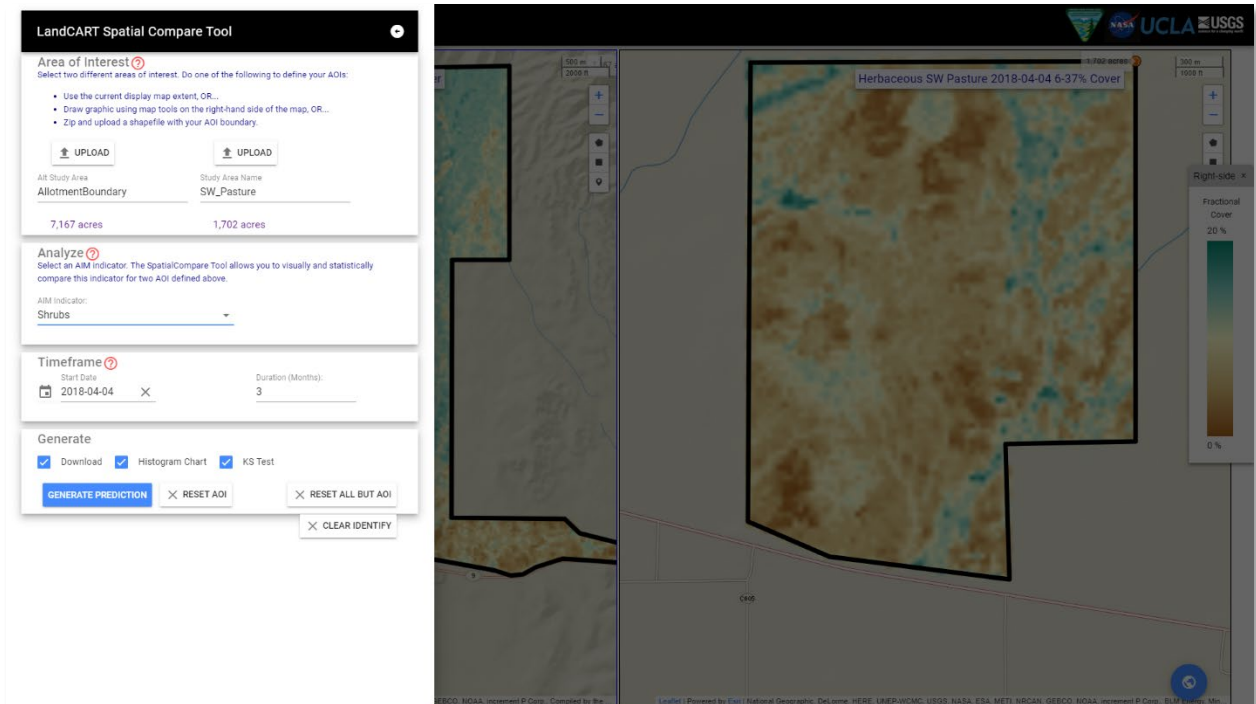


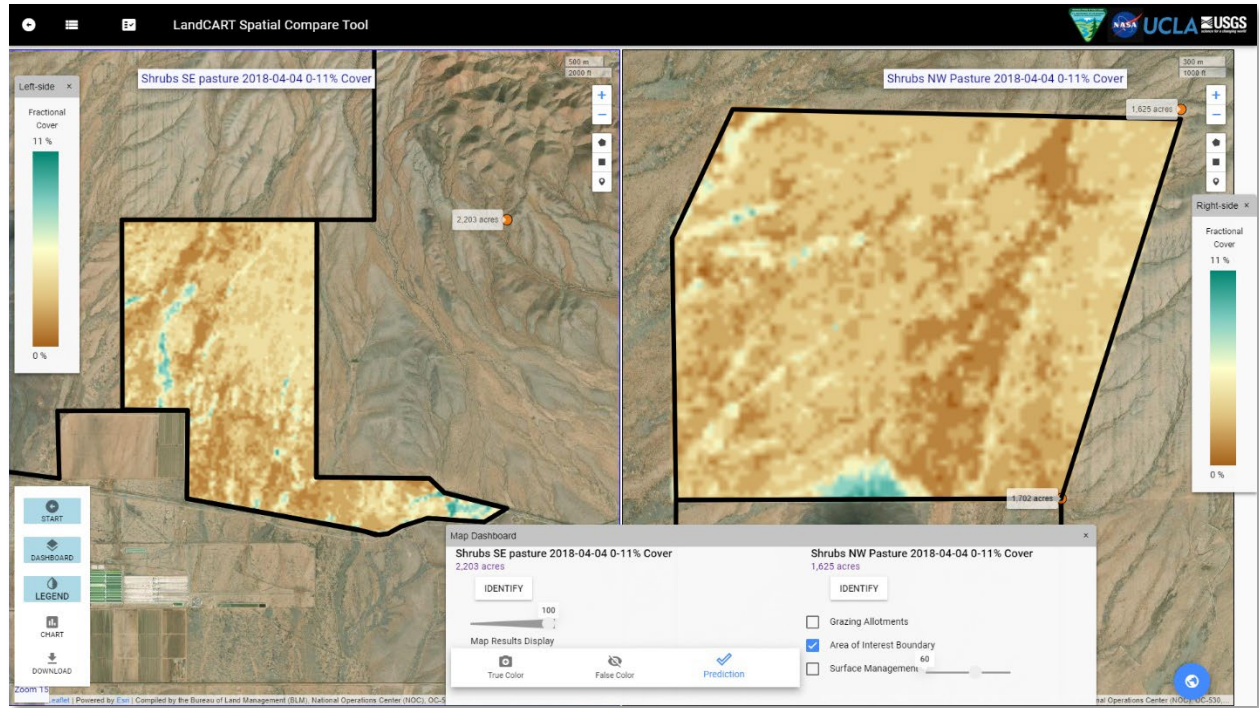
You can reload the browser page to clear your AOI and all other parameters (TOI, IOI) from previous tool runs.

✕ RESET ALL BUT AOI

✕ RESET AOI

Alternatively, you can click on the **RESET ALL BUT AOI** button and everything, including the charts and statistics, will be cleared, except for your AOIs (this is particularly useful when you have hand-drawn the AOI). Or you can click the **RESET AOI** button to change your AOIs while keeping the same parameters elsewhere.






Or change the time or change the indicator or all of the above. The possibilities are endless!

APPENDIX A – HOW TO SIMPLIFY POLYGON SHAPEFILES IN ARCGIS 10.X FOR UPLOADING INTO LANDCART

PURPOSE

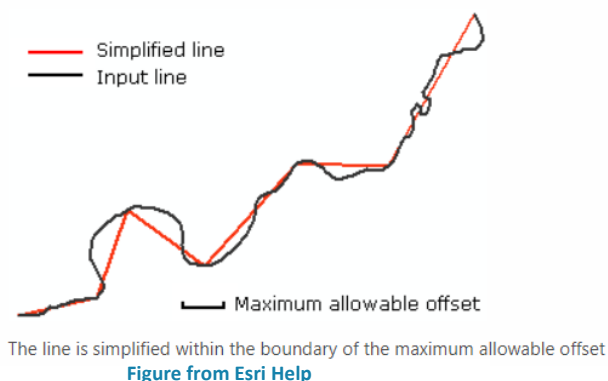
When running LandCART, overly complex shapefile boundaries might result in slow performance or fail to run. This section describes how to simplify the shapefile. The simplified shapefile can then be uploaded to LandCART and run as the Area of Interest. It will be up to the user to determine how these changes affect their calculation and what changes they will tolerate.

METHODS

Open ArcGIS 10.x and use Add Data  to insert your shapefile into the Table of Contents (TOC). If you want to count the existing number of vertices in the polygon using ArcMap you can use this [Esri article](https://support.esri.com/en/technical-article/000011230) (<https://support.esri.com/en/technical-article/000011230>); this is helpful to compare the vertices count after processing. Remember to save your map document.

We tested shapefiles in ArcGIS 10.7. Earlier versions are generally the same although some will have fewer options in the Simplify Tool.

GENERALIZE OR SIMPLIFY THE SHAPEFILE BOUNDARY



The Simplify or Generalize tools straighten the polygon boundary by removing some vertices (left). When the simplified shapefile is input to LandCART it reduces the number of calculations and increases performance.

Should I use Generalize or Simplify?

The Simplify and Generalize tools can use the same algorithm and produce the same results when using the default options for Simplify and the same Tolerance Distance.


The differences follow:

- Simplify writes a new shapefile while Generalize changes the existing shapefile (so make a copy!).
- Simplify allows to user to make more modifications including using other algorithms, adjusting the minimum area, handling topological errors, and including barrier layers (e.g., roads, mountains). We did not systematically test Simplify beyond the default options described here; let us know if you do!

HOW TO USE GENERALIZE

NOTE: The Generalize tool edits the input features; make a copy to edit before you use the tool!

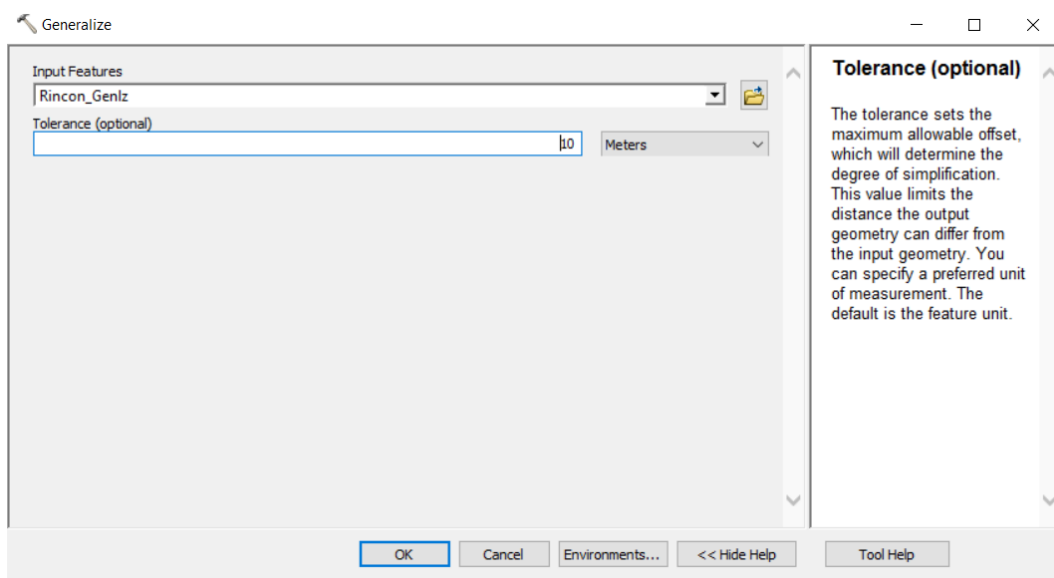
Toolbox location: Editing Tools\Generalize Tool.

Open Arc Toolbox from the menu bar . In Arc Toolbox, click the plus sign next to **Editing Tools** to expand. Double Click to open the **Generalize** Tool.

Use the dropdown arrow to fill in the **Input Features** with the name of your polygon shapefile. This shapefile will be altered; the **Generalize** tool does not create a new shapefile. This is the shapefile that will be used as input to LandCART.


Enter the tolerance distance. A smaller distance will keep the new polygon closer to the original; a longer distance will alter the original polygon more, but it will have fewer vertices. See below for example tests.

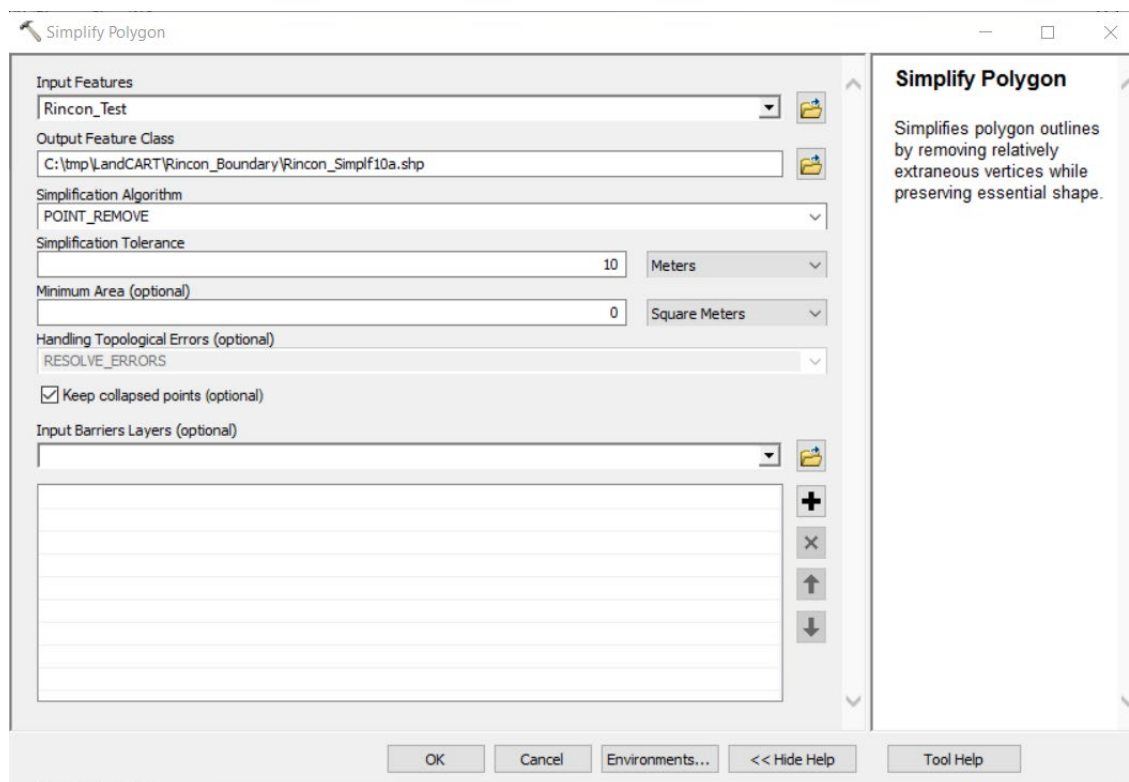
Click **OK** to run Generalize. Compare your new shapefile to the original – does it pass the Smell Test? Do you need to alter the Tolerance?



HOW TO USE SIMPLIFY

Toolbox location: Cartography\Generalization\Simplify Polygon

Open Arc Toolbox from the menu bar . In Arc Toolbox, click the plus sign next to **Cartography Tools** and then **Generalization** to expand the lists. Double Click to open the **Simplify Polygon** Tool.



Use the dropdown arrow to fill in the **Input Features** with the name of your polygon features. Browse to and name your choice for the output shapefile.

There are four **Simplification Algorithms**; Point Remove (the default) is used by the Generalize Tool. We have not tested the other algorithms.

Enter the **Simplification Tolerance distance**. A smaller distance will keep the new polygon more similar to the original; a longer distance will alter the original polygon more, but it will have fewer vertices which is preferable for LandCART.

We left the remaining options at the default values and did not enter any barrier layers.

Click **OK** to run Simplify. Compare your new shapefile to the original – does it pass the Smell Test? Do you need to alter the Simplification Tolerance?

Table showing results from tests on Rincon HUC10 and Cougar Fire with area and vertices changes from the original

Data Location	Method and Tolerance Distance Used	Area (acres / ha)	Change in Area from Original Data (ha)	Count of Vertices (change)
Rincon HUC10	Original Data	85,770 / 34,710.0	--	1919
Rincon HUC10	Simplify 10 m	85,769 / 34,709.6	-0.4	664 (1255)
Rincon HUC10	Simplify 50 m	85,773 / 34,711.2	+1.2	219 (1700)
Cougar Fire	Original Data	466.7 / 188.9	--	660
Cougar Fire	Simplify 10 m	466.6 / 188.8	-0.1	94 (566)
Cougar Fire	Simplify 50 m	468.7 / 189.7	+0.8	34 (626)


APPENDIX B – HOW TO PROJECT RASTERS IN ARCGIS 10.X

PURPOSE

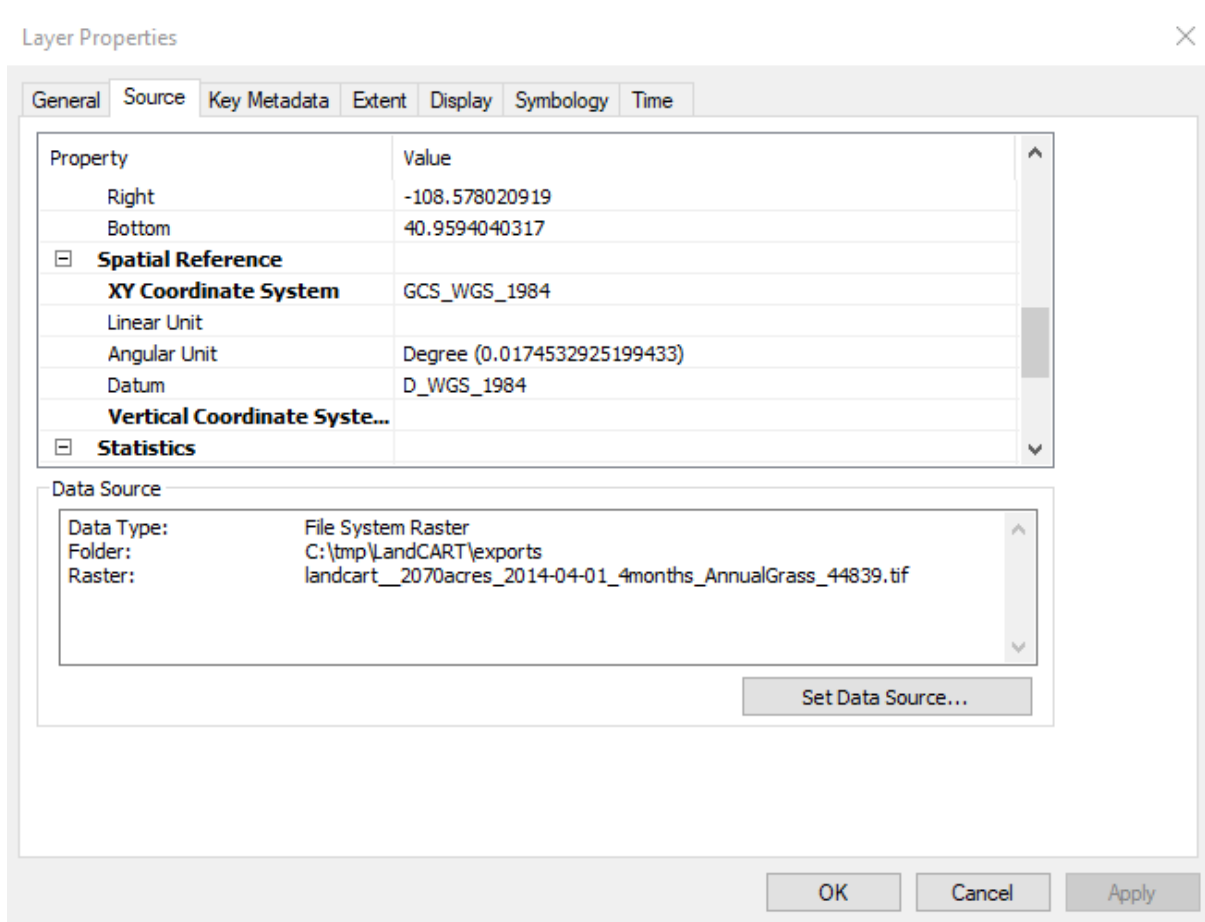
LandCART currently exports geotiffs in Geographic Coordinate System (GCS; latitude and longitude) specifically GCS_WGS_1984. Users may want to change this projection to match their standard projection and this appendix explains how to do that.

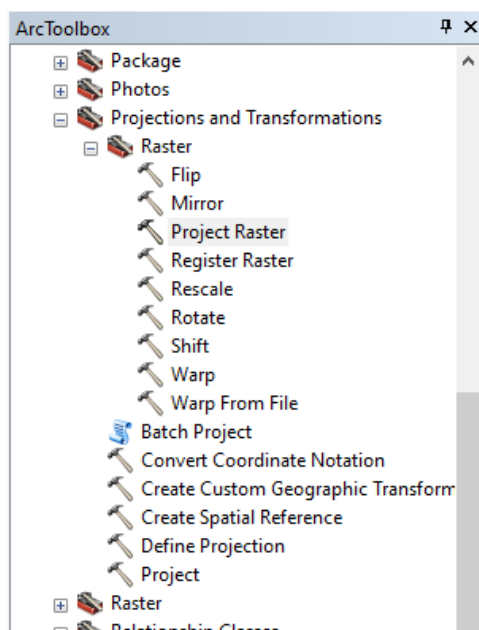
Note that any changes to the data including re-projections, changes to cell size, resampling choices will alter the data and LandCART predicted accuracy in ways that we cannot foresee. For more details see the Esri provided Help for Project Raster (Data Management) by clicking on Help in the Tool Window.

METHODS

Open ArcGIS 10.x and use Add Data  to insert your LandCART output tif file into the Table of Contents (TOC).

To determine the current projection, double click on the tif in the TOC. In the Layer Properties Window, click on the **Source Tab**, and scroll down to the **Spatial Reference Section**. Check the **XY Coordinate System** – in the example below it is GCS_WGS_1984. Click OK to close the window.





Open Arc Toolbox from the menu bar . In Arc Toolbox, click the plus sign next to **Data Management Tools** to expand. Expand **Projections and Transformations**; Expand **Raster**. Double Click to open the **Project Raster** Tool.

In the **Project Raster** Window (see below), click the down arrow beside **Input Raster** and select the raster needs to be re-projected. If the raster is not loaded into the TOC, it will not appear in the list. In this case you can click on the folder and browse to it instead. Note that when you click in each box to fill it, input-specific help appears on the right side of the window.

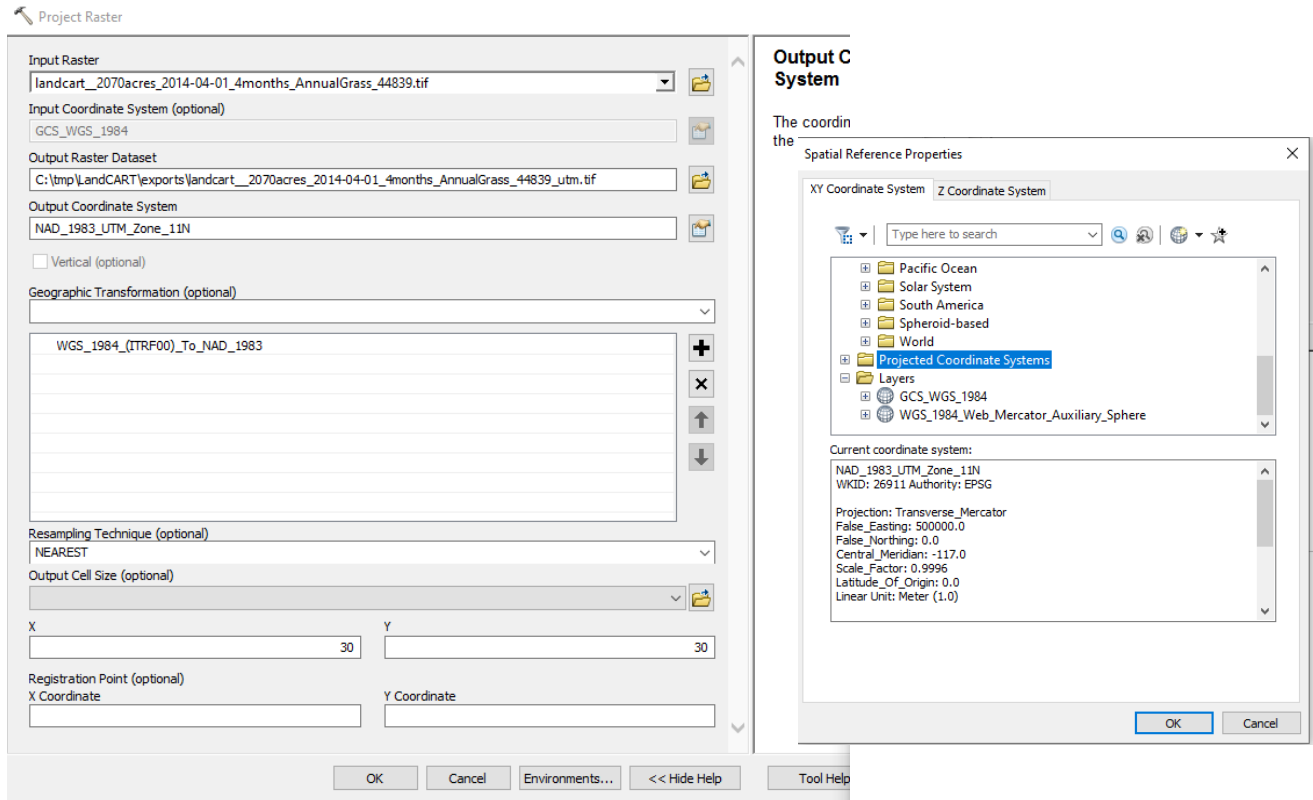
Click the browse folder button next to **Output Raster Data** and navigate to the location where you want to store the re-projected raster. Change the name so that you do not overwrite the original download if you are saving to the same folder. It is useful to include the new projection in the name so that the new raster can be immediately identified. We suggest that you maintain the tif raster format by maintaining the file extension. We recommend against saving the raster as an Esri grid (without the file extension) so that you can keep the long but explanatory file name and maintain more flexibility in moving the file around – bad things can happen to Esri grids!

Open the **Spatial References Properties** window (see below) to select the **Output Coordinate System**. The easiest way to do this is to pre-load a layer into the TOC that is the projection that you need and then select it from **Layers**. Otherwise select the projection you need from the other options and click **OK**.

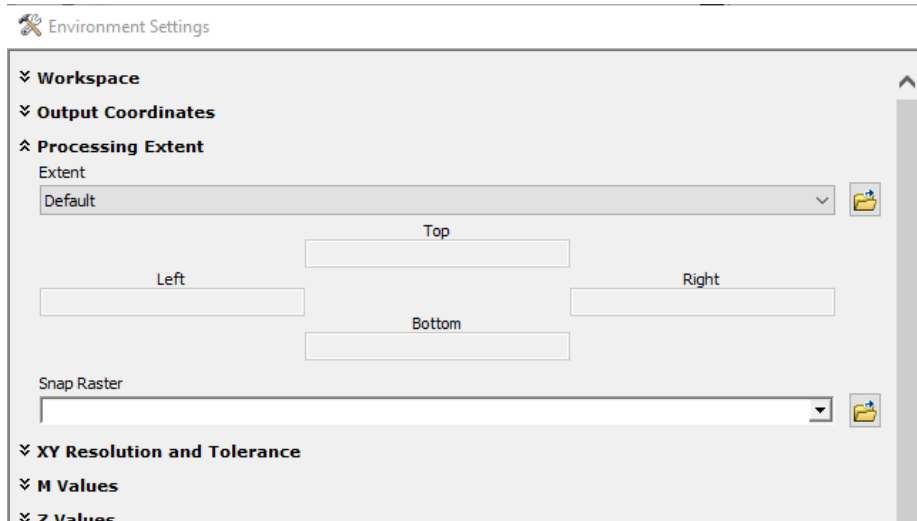
If a **Geographic Transformation** is needed, it will generally be selected for you. Most standard BLM projections will not need anything unusual.

Select **Cubic Convolution** as the **Resampling Technique** because you are projecting continuous data, i.e., percent cover.

For the **Output Cell Size** or **X and Y** boxes, you will need to add something specific to your data. If a suggestion is made for **X, Y**, you might choose to round it. In my example, X and Y suggestions (by Esri) were 28.23546 etc. I chose to round them to 30 m which will match several other data sets, is easy to use in calculations, and is close to the original. Any changes will alter the accuracy of the LandCART predictions. The output raster cells will be square.



Select the **Environments** button if you would like to clip the raster to a smaller **extent** or **snap** it to another raster in your new projection.



Under **Processing Extent**, you can select a pre-loaded dataset, browse to a dataset, or enter coordinates. Under **Snap Raster**, you can select a raster to align the cells of your input raster. Click **OK**.

Below is an example of what the change in projection might look like; check out the underlying terrain to orient yourself on each map. The UTM re-projected raster is green (above) and the original GCS (below) is in blue. A random sample of about 10 raster cells indicated that values of the UTM projected raster altered by about 0 to 3%. The legend for the UTM raster indicated a range of values from 1 to 23% while the original GCS raster displayed a range of 1 to 27%.



UTM Raster



GCS Raster

APPENDIX C – COMMON BLM PROJECTIONS

These are projections that BLMers frequently use as returned to a question on Geonet. There is no BLM national standard; each state has their own variant. Notes and details below in case there are more questions.

State	Projection Name	EPSG number
Lower 48	GCS_North_American_1983	4269
Lower 48	Albers Equal Area Conic USGS	5070
OR, WA	NAD_1983_UTM_Zone_10N	26910
NV	NAD83 / UTM zone 11N	26911
AZ, UT, WY	NAD_1983_UTM_Zone_12N	26912
CO, WY	NAD_1983_UTM_Zone_13N	26913
CA	NAD_1983_California_Teale_Albers (Meters)	3310
ID	NAD_1983_Idaho_TM	8826

National data requests:

ALBERS EQUAL AREA USGS version. The difference between most Albers projections is the Latitude of Origin.

The Implementation Guidelines for the BLM's national datasets states, "The data stored on the National Operations Center (NOC) EGIS server in Denver shall be stored in geographic coordinates for national layers using the Bureau standard NAD 83 datum rather than in a specific projection. (Brooks Wilson, Alisa Froistad)"

GCS_North_American_1983 WKID/ EPSG: 4269.

```
GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433],METADATA["North America - NAD83",167.65,14.93,-47.74,86.45,0.0,0.0174532925199433,0.0,1350]]
```

UTM north zones 10-19 for W.US, NAD 1983

AZ: EPSG 26912

```
PROJCS["NAD_1983_UTM_Zone_12N",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-111.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",26912]]
```

CA: NAD_1983_California_Teale_Albers (Meters), WKID: 3310 Authority: EPSG

CO: EPSG 26913

```
PROJCS["NAD_1983_UTM_Zone_13N",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-105.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",26913]]
```


ID (Transverse Mercator):

```
PROJCS["NAD_1983_Idaho_TM",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",2500000.0],PARAMETER["False_Northing",1200000.0],PARAMETER["Central_Meridian",-114.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",42.0],UNIT["Meter",1.0]]
```

NV:

```
PROJCS["NAD83 / UTM zone 11N",GEOGCS["NAD83",DATUM["North_American_Datum_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["false_easting",500000.0],PARAMETER["false_northing",0.0],PARAMETER["central_meridian",-117.0],PARAMETER["scale_factor",0.9996],PARAMETER["latitude_of_origin",0.0],UNIT["Metre",1.0]]
```

UT:

```
PROJCS["NAD_1983_UTM_Zone_12N",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-111.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0]]
```

WY:

```
PROJCS["NAD_1983_UTM_Zone_12N",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-111.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0]]
```

```
PROJCS["NAD_1927_UTM_Zone_13N",GEOGCS["GCS_North_American_1927",DATUM["D_North_American_1927",SPHEROID["Clarke_1866",6378206.4,294.9786982]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-105.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0]]
```

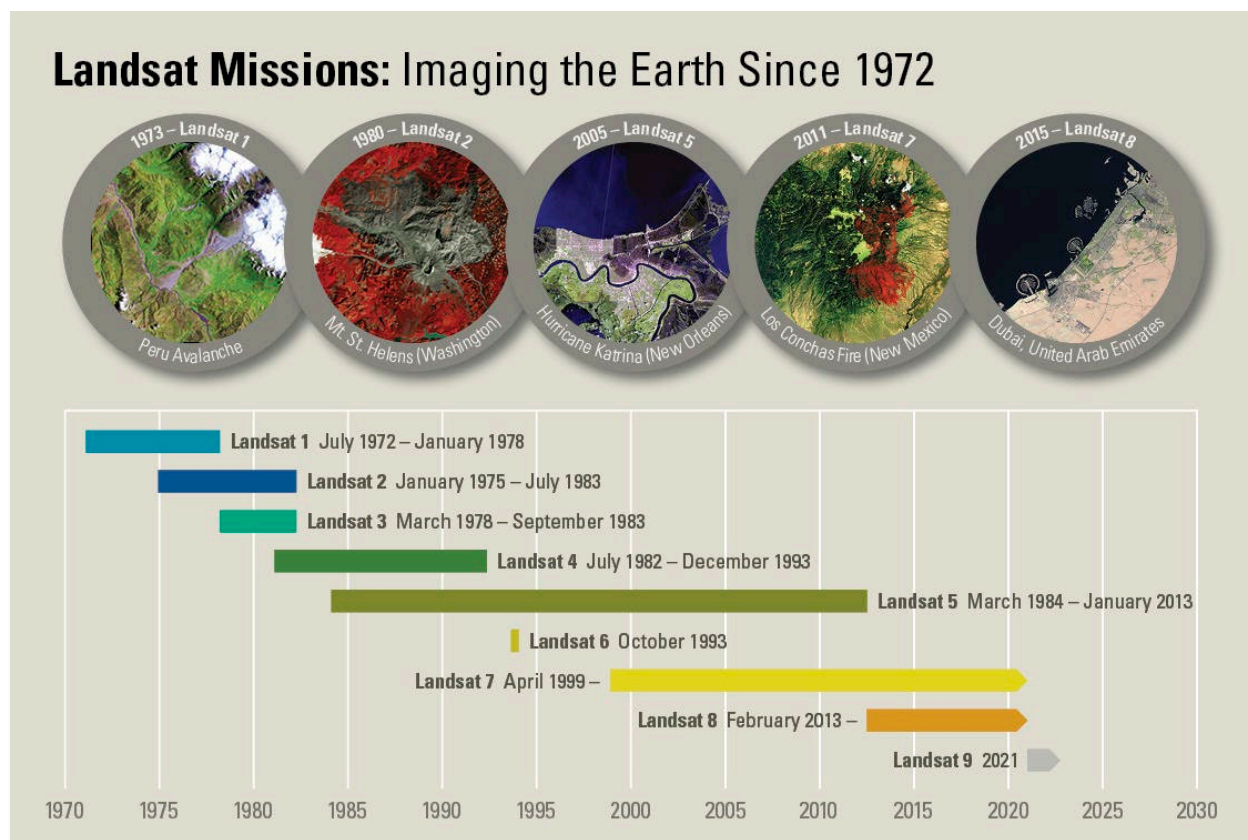
```
GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]]
```

Web Mercator:

```
PROJCS["WGS_1984_Web_Mercator_Auxiliary_Sphere",GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Mercator_Auxiliary_Sphere"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",0.0],PARAMETER["Standard_Parallel_1",0.0],PARAMETER["Auxiliary_Sphere_Type",0.0],UNIT["Meter",1.0]]
```

(AK: NAD_1983_Alaska_Albers; WKID/EPG: 3338)

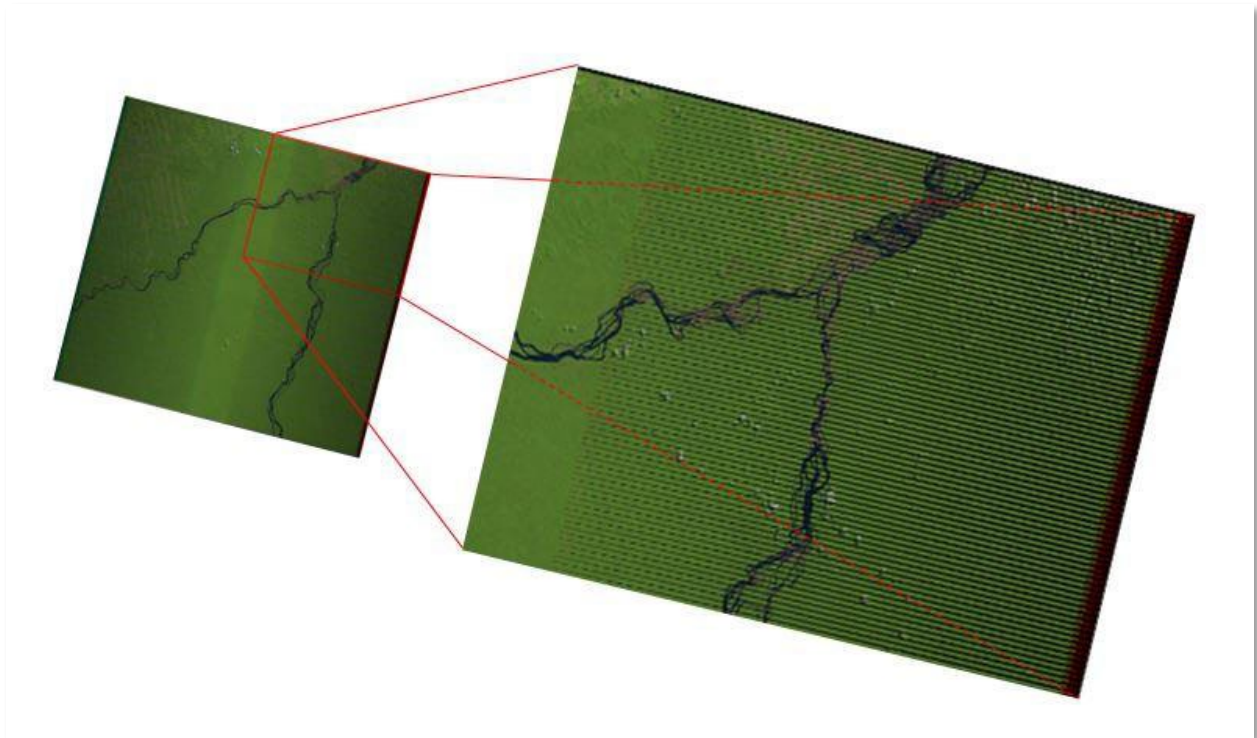
APPENDIX D – LANDSAT 5 AND MISSING 2012 DATA

Landsat Satellite MissionsAging Landsat 5 Changes Glasses at 28USGS Completes Decommissioning of Landsat 5

(source: <https://www.usgs.gov/media/images/landsat-missions-timeline>)

The Landsat Program began collecting satellite imagery of the Earth's landmasses on July 23, 1972, with the launch of what became known as Landsat 1. Since that time, a total of 8 more Landsat satellites have been launched – only Landsat 6 failed to achieve orbit – and an enormous archive of Landsat images has been made available for scientists to observe and study the Earth's surface. The most recent launch occurred on September 27, 2021, with Landsat 9, a carbon copy of Landsat 8, as part of the Landsat Data Continuity Mission.

There have been two notable breaks in data availability during the nearly 50 years of the Landsat program. First, on May 31, 2003, the Landsat 7 Scan Line Corrector (SLC) failed with a result that all Landsat 7 images from that point forward had SLC gaps or striping (example below). Landsat 7 is still collecting data, but users must be aware of these data gaps.



(source: <https://www.usgs.gov/media/images/a-landsat-7-slc-scene-example>)

The second break in data availability occurred when the Landsat 5 satellite had an electronic malfunction in the transmitter in November of 2011. Although USGS was forced to suspend routine Landsat 5 imaging at that time and Landsat 5 was decommissioned in June of 2013, it is worth noting that this satellite/sensor outlasted its expected 5-year lifespan by 24 years! Meanwhile, the Landsat Data Continuity Mission successfully launched Landsat 8 into orbit and Operational Land Imager (OLI) data became available starting April 10, 2013.

The Landsat 7 SLC gaps, the loss of Landsat 5 in late 2011, and the availability of Landsat 8 data by April 2013, spells out a significant break in full coverage of Earth's landmasses for 2012 and early 2013.

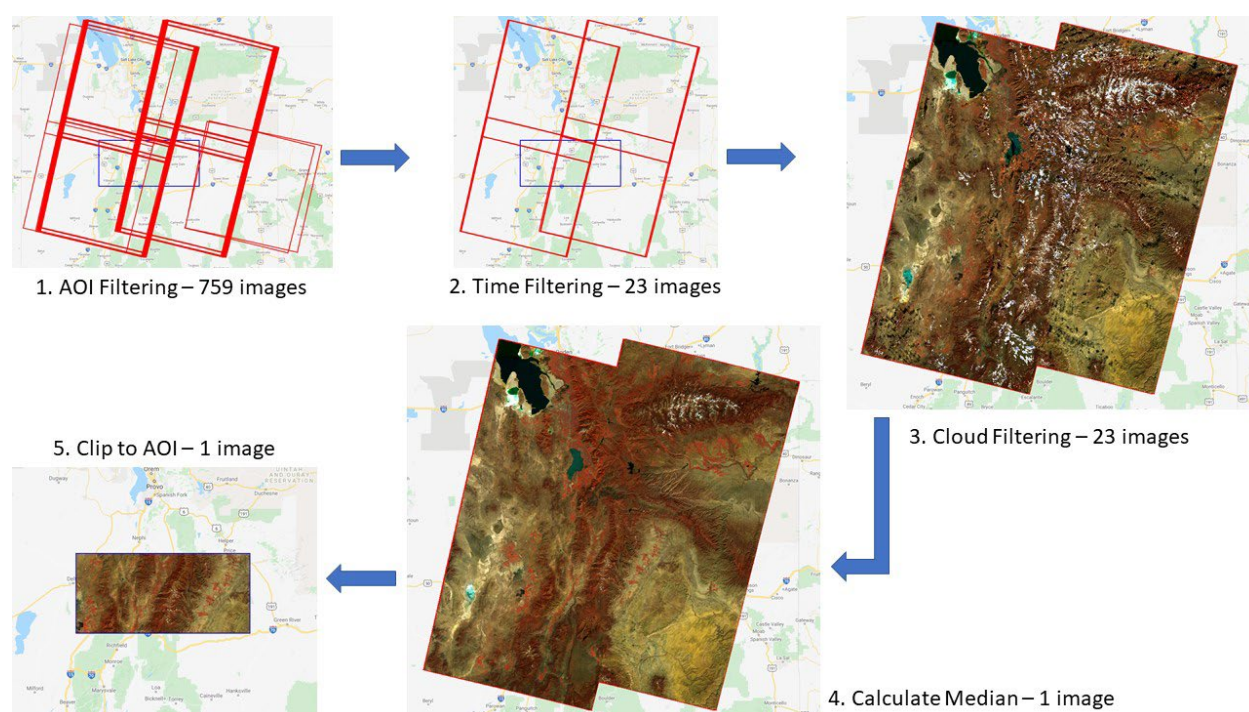
What does this mean for LandCART? And for you as a LandCART user?

Simply that this is a cautionary tale for all of us to consider 2012 predictions carefully. There are no Landsat 5 or Landsat 8 images available for 2012; only Landsat 7 images are available. For the most part, temporally adjacent Landsat 7 images will fill in the SLC gaps, but in some cases, there might be SLC gaps/stripping, resulting in incomplete predicted datasets. If you are lucky enough to have an AOI in the very center of a Landsat 7 scene, the gaps will not be a problem for you.

In summary, be aware that any 2012 predictions might be incomplete due to SLC gaps in the Landsat 7 imagery. Please review the data for any missing pixels and consider these gaps in your statistical analyses.

APPENDIX E – WHY DO WE NEED A TIME DURATION FOR THE TOI?

Each tool in LandCART asks for a duration of time in which to acquire images for predictions. Landsat satellites image the same location on Earth every 8 to 16 days. This means that trying to find a clear, complete image for a specified area of interest for one day of the year is nearly impossible. Even if you happen to randomly select a date when an image was acquired, you can't be certain that that image is free of clouds/smoke or data gaps (see information on the Landsat 7 Scan Line Corrector failure: <https://www.usgs.gov/landsat-missions/landsat-7> and <https://www.usgs.gov/media/images/a-landsat-7-slc-scene-example>). We suggest a 3-month duration so that multiple images can be composited to create one Landsat image for your area of interest that has no missing data. You can certainly try a 1-month duration, but we strongly recommend nothing shorter. Below are the steps the LandCART program takes to generate the final composite image on which the indicators can be predicted:



1. Filter image collection by area of interest (AOI) – 759 Landsat 8 OLI images intersect the defined AOI
2. Filter image collection by time range of interest (TOI) (We need multiple pixels (think layers of images stacked on top of one another) at any location in case of cloud/smoke/snow/SLC-off holes) – 23 images fall within the defined time duration of 9/1/2018 through 12/1/2018:

(Landsat8_pathrow_yyyymmdd)

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LC08_037032_20181022
LC08_037032_20181107
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LC08_038032_20180927
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LC08_038033_20181029
LC08_038033_20181114
LC08_038033_20181130

3. On an image-by-image basis mask out all the pixels covered by cloud, cloud shadow, smoke, smoke shadow, snow, or SLC-off gaps – all 23 images are masked for holes
4. Calculate the median value for every pixel in the image stack (We don't use mean because we want actual vs derived reflectance values. Other aggregation methods like max could also be used for certain applications, *e.g.*, to detect peak greenness) – the median value of overlapping pixels of the 23 images is calculated and saved to 1 new composite image
5. Clip to the user defined region of interest – 1 composite image of the defined AOI and TOI is now ready to run indicator prediction models

APPENDIX F – METADATA TEMPLATE

In order to update the metadata associated with your data predictions, you can use the *.XML file that comes with the downloaded GeoTIFF. Or you can copy and paste everything below starting from `<? xml version="1.0" encoding="UTF-8"?>` through `</metadata>` into a TXT file. Save the TXT file.

The XML file or the TXT file can be imported into the BLM Basic XML Creator (https://webmaps.blm.doi.net/program_apps/BasicXMLCreator/) or the USGS Metadata Wizard (<https://usgs.github.io/fort-pymdwizard/>) to add the required information. It is strongly recommended that you use one of these programs rather than just editing a text file manually. When you save the metadata file in these programs, it will be exported as an XML file.

All items **highlighted in yellow** are for you to fill in at the time the data are created/downloaded.

All items **CAPATALIZED, BOLDDED, AND HIGHLIGHTED IN AQUA** are dynamically filled in by LandCART in the downloaded XML file. If you copy and paste below, these items need to be filled in by you.

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<acconst>None, these data are considered public domain.</acconst>

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AIM Indicator	R ²	MAE	RMSE
Annual Forb	0.37	6.61	9.75
Annual Grass	0.43	9.74	14.5
Annual Herbaceous	0.47	12.69	16.31
Bare Ground	0.65	10.07	13.02
Bare Soil	0.56	8.85	11.98
Canopy Gaps greater than 25cm	0.57	14.1	17.87
Canopy Gaps greater than 100 cm	0.58	12.55	16.84
Canopy Gaps greater than 200 cm	0.57	9.95	14.58
Herbaceous	0.65	11.58	14.77
Perennial Forb	0.31	10.32	14.07
Perennial Grass	0.31	10.22	13.99
Perennial Herbaceous	0.37	8.96	12.43
Sagebrush	0.38	6.77	8.87
Shrubs	0.33	8.08	10.38
Shrubsucculent	0.33	7.97	10.26
Succulent	0.11	0.3	0.95
Total Foliar	0.66	10.42	13.19
Trees	0.5	3.53	7.74
Woody	0.45	8.59	11.22

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<attracce>5-fold cross validation was used to generate the validation results. The entire dataset was initially divided into 5 folds of similar sizes. Then each fold of data is used as independent testing data while the remaining 4 folds are combined as training. Thus, all the available field measurements are subject to independent testing to provide the most unbiased validation result. </attracce>

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<logic>The appropriate indicator calculation was used in prediction and validation processes. The output values for percent cover range from 0 to 100%, with a value of -1 representing no data.

Choices available for fractional cover types with the AIM indicator definitions used to define them. All indicator calculations are derived from the Line Point Intercept method (typically 150 points on three transects per plot).

Annual Forb = AH_AnnForbCover The cover of annual forbs in the plot/pixel.

Annual Grass = AH_AnnGrassCover The cover of annual grasses in the plot/pixel.

Annual Herbaceous = AH_AnnForbGrassCover The cover of annual forbs and grasses in the plot/pixel.

Bare Ground = BareSoilCover + FH_DepSoilCover + FH_RockCover The basal cover of soil, rocks, and deposited soil (all first hit) in the plot/pixel, not including ground with cover above it. For example, points with sagebrush over bare ground are not counted in the indicator.

Bare Soil = BareSoilCover The basal cover of soil in the plot/pixel, not including soil that has cover above it. For example, points with sagebrush over bare soil are not counted in this indicator, also points with rock as the soil surface code are not counted in this indicator.

Canopy Gaps greater than 25cm = GapCover_25_plus The percentage of the plot/pixel's soil surface covered by gaps between plant canopies that are greater than 25 cm in size.

Canopy Gaps greater than 100 cm = GapCover_101_200 + GapCover_200_plus The percentage of the plot/pixel's soil surface covered by gaps between plant canopies that are greater than 100 cm in size.

Canopy Gaps greater than 200 cm = GapCover_200_plus The percentage of the plot/pixel's soil surface covered by gaps between plant canopies that are greater than 200 cm in size.

Herbaceous = AH_ForbGrassCover The cover of forbs and grasses (annual, perennial, and biennial) in the plot/pixel.

Perennial Forb = AH_PerenForbCover The cover of perennial forbs in the plot/pixel.

Perennial Grass = AH_PerenGrassCover The cover of perennial grasses in the plot/pixel.

Perennial Herbaceous = AH_PerenForbGrassCover The cover of perennial forbs and grasses in the plot/pixel.

Sagebrush = AH_SagebrushCover The cover of sagebrush in the plot/pixel.

Shrubs = AH_ShrubCover The cover of shrubs in the pixel, including sub shrubs.

Shrubsucculent = AH_ShrubSucCover The cover of shrubs in the pixel, including sub shrubs and succulents.

Succulent = AH_SucculentCover The cover of succulents in the plot/pixel.

Total Foliar = TotalFoliarCover The foliar cover of plants in the plot/pixel.

Trees = AH_TreeCover The cover of trees in the plot/pixel. Woody = AH_

WoodyCover The cover of woody vegetation in the plot, including trees, shrubs, sub shrubs, and succulents in the plot/pixel.</logic>

<complete>Data set is considered complete for the information presented, as described in the abstract. Users are advised to read the rest of the metadata record carefully for additional details.</complete>

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cloud or cloud shadow; (4) Calculate the median value for every pixel (We don't use mean because we want actual vs derived reflectance values. Other
aggregation methods like max could also be used for certain applications e.g. to detect peak greenness); (5) Clip to the user defined region of interest; (6)
Extract training data table to obtain the predictor and response variable (IOI); (7) Load random forest (RF) hyperparameter based on the IOI from the
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APPENDIX G – REPORT TEMPLATES

LANDCART COVER TOOL REPORT TEMPLATE

(<<tagged>> and yellow-highlighted items in the template below are dynamic variables that the user must fill in based on their selections within the LandCART Tool. Variables are Case Dependent! Variables to find and replace multiple times are: <<Location>>, <<ioi>>, <<yyyy-mm-dd1a>>, and <<yyyy-mm-dd1b>>. The rest will need to be manually inserted from your LandCART session. Screen captures can be inserted for figures and tables.)

<<Location>> <<ioi>> Cover Prediction, <<yyyy-mm-dd1a>>

<<User should write a summary of the project and management question(s) here.>>

LandCART Cover Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation indicators. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM indicators where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) indicators (IOI) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM indicators, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Cover Tool allows a user to select one indicator at a time (IOI) at one location of interest (AOI) for one timeframe (TOI). The user can decide to map an indicator during one season, multiple seasons separately, and annually based on the local growing season. The Cover Tool provides the user with true color and infrared images of the area of interest. It predicts a continuous fractional cover map of the selected indicator, calculates simple summary statistics, and produces a histogram for the selected indicator. This tool can be used to determine distribution of an indicator in an area of interest at one point in time, perhaps to determine where weed treatment needs to be applied, for example.

Inputs and Outputs:

- **LandCART version:** <<V.B.#>> **and run date:** <<yyyy-mm-dd>>
- **AIM Indicator:** <<ioi>>
- **<<ioi>> Definition:** <<LandCART Indicator Definition (from page 15 of this User Guide)>>
- **Date predicted:** <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1a>>
- **Landsat images used:** <<Landsat image IDs>>
- **Shapefile Name:** <<Location>>.shp
(if the user uploaded a shapefile for the AOI)
OR
Bounding box rectangular extent coordinates: <<LL>> and <<UR>>
(if the user used map extent or drew a rectangular polygon for the AOI)
OR

Bounding Polygon coordinates: <<P1: x, y>> <<P2: x, y>> <<P3: x, y>> <<P4: x, y>> <<P5: x, y>> <<...>> <<Pn: x, y>>

(if the user drew a non-rectangular polygon for the AOI)

- **Vector Acreage:** <<# acres>>
- **Output Predicted Image:**
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.xml

Results

Figure 1. [LandCART Cover Tool](#) <<Location>> boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default imagery base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

Figure 2. [LandCART Cover Tool](#) <<Location>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default imagery base map. Percent <<ioi>> cover ranges from <<##min1%>> to <<##max1%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Cover Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 3. [LandCART Cover Tool](#) <<Location>> boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite displayed over the default imagery base map. The LandCART Cover Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs>>.

Figure 4. [LandCART Cover Tool](#) <<Location>> boundary (black line) with grazing allotments (green lines) and false color Landsat imagery composite displayed over the default imagery base map. The LandCART Cover Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs>>.

Figure 5. Histogram of [LandCART Cover Tool](#) <<Location>> <<ioi>> percent cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ...,90-95%, 95-100%.

Table 1. Histogram values of LandCART Cover Tool <<Location>> <<ioi>> percent cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> by percent area. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

%Cover	%Area
0	#
5	#
10	#
15	#
20	#
25	#
30	#
35	#
40	#
45	#
50	#
55	#
60	#
65	#
70	#
75	#
80	#
85	#
90	#
95	#

Table 2. LandCART Cover Tool <<Location>> summary statistics for <<ioi>> percent cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.

Mean: <<##>>%

Standard Deviation: <<#>>%

5th Percentile: <<##>>%

10th Percentile: <<##>>%

50th Percentile: <<##>>%

90th Percentile: <<##>>%

95th Percentile: <<##>>%

References

- Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ####. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.
- Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.
- Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.
- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

Thank you for using LandCART!

Landscape Cover Analysis and Reporting Tools (LandCART) is a NASA-funded collaboration between the BLM, UCLA, and the USGS (see grant information, below). LandCART tools generate continuous fractional cover maps representing AIM indicators in the Western Lower 48 states using AIM data, Google Earth Engine, and machine learning prediction methods. For more information and to use LandCART click here: (landcart.org).

NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

ACCESS CONSTRAINT

None, these data are considered public domain.

USE CONSTRAINT

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LANDCART COVER CHANGE TOOL REPORT TEMPLATE

(<<tagged>> and yellow-highlighted items in the template below are dynamic variables that the user must fill in based on their selections within the LandCART Tool. Variables are Case Dependent! Variables to find and replace multiple times are: <<Location>>, <<ioi>>, <<yyyy-mm-dd1a>>, <<yyyy-mm-dd1b>>, <<yyyy-mm-dd2a>>, <<yyyy-mm-dd2b>>, <<yyyy1>>, and <<yyyy2>>. The rest will need to be manually inserted from your LandCART session. Screen captures can be inserted for figures and tables.)

<<Location>> <<ioi>> Cover Prediction Change, <<yyyy-mm-dd1a>> and <<yyyy-mm-dd2a>>

<<User should write a summary of the project and management question(s) here.>>

LandCART Cover Change Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation indicators. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM indicators where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) indicators (IOI) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM indicators, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Cover Change Tool allows a user to select one indicator at a time (IOI) at one location of interest (AOI) on two different dates (TOIs). The user can decide to map the indicator during one season over two different years or early spring and late summer in one year. The Cover Change Tool provides the user with true color and infrared images of the area of interest for both dates. It produces two indicator maps of the selected indicator at selected times, a difference map, comparative histograms, conducts a two-sample Kolmogorov-Smirnoff test of differences for the histograms, and conducts a one-sample Kolmogorov-Smirnoff test for similarity between the difference histogram and a normal distribution. This tool can be used to determine the distribution, direction, and magnitude of change in an indicator from one year to another.

Inputs and Outputs:

- **LandCART version:** <<V.B.#>> **and run date:** <<yyyy-mm-dd>>
- **AIM Indicator:** <<ioi>>
- **<<ioi>> Definition:** <<LandCART Indicator Definition (from page 15 of this User Guide)>>
- **Dates predicted TOI1:** <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>
- **Dates predicted TOI2:** <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>
- **Landsat images used TOI1:** <<Landsat image IDs TOI1>>
- **Landsat images used TOI2:** <<Landsat image IDs TOI2>>

- **Shapefile Name:** <<Location>>.shp
(if the user uploaded a shapefile for the AOI)
OR
Bounding box rectangular extent coordinates: <<LL>> and <<UR>>
(if the user used map extent or drew a rectangular polygon for the AOI)
OR
Bounding Polygon coordinates: <<P1: x, y>> <<P2: x, y>> <<P3: x, y>> <<P4: x, y>> <<P5: x, y>> <<...>> <<Pn: x, y>>
(if the user drew a non-rectangular polygon for the AOI)
- **Vector Acreage:** <<# acres>>
- **Output Predicted Images:**
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.TIF
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.xml
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>.xml
- **Two-sample Kolmogorov-Smirnoff p-value:** <<#.###>>
- **One-sample Kolmogorov-Smirnoff p-value:** <<#.###>>

Results

Figure 1. [LandCART Cover Change Tool](#) <<Location>> boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default imagery base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

Figure 2a. [LandCART Cover Change Tool](#) <<Location>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default imagery base map. Percent <<ioi>> cover ranges from <<##min1%>> to <<##max1%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Cover Change Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 2b. [LandCART Cover Change Tool](#) <<Location>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>> displayed over the default imagery base map. Percent <<ioi>> cover ranges from <<##min2%>> to <<##max2%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Cover Change Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 3a. [LandCART Cover Change Tool](#) <<Location>> boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default imagery base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI1>>.

Figure 3b. [LandCART Cover Change Tool](#) <<Location>> boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite from <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>> displayed over the default imagery base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI2>>.

Figure 4a. LandCART Cover Change Tool <<Location>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default imagery base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI1>>.

Figure 4b. LandCART Cover Change Tool <<Location>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>> displayed over the default imagery base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI2>>.

Figure 5. Histogram of LandCART Cover Change Tool <<Location>> <<ioi>> percent cover from <<yyyy1>> and <<yyyy2>> by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

Figure 6. LandCART Cover Change Tool <<Location>> boundary (black line) with <<ioi>> difference map from <<yyyy2>> minus <<yyyy1>> displayed over the default imagery base map. The LandCART Cover Change Tool creates a difference image by subtracting predicted <<ioi>> fractional cover <<yyyy1>> from predicted <<ioi>> fractional cover <<yyyy2>>. Positive values (yellow) indicate an increase from the earlier date to the later date and negative values (purple) indicate a decrease. No change is represented in white.

Figure 7. Difference histogram of LandCART Cover Change Tool <<Location>> <<ioi>> percent cover <<yyyy2>> minus <<yyyy1>> by percent area.

Table 1. Histogram values of LandCART Cover Change Tool <<Location>> <<ioi>> percent cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> and <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>> by percent area and number of acres. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

<<ioi>> <<yyyy1>>		<<ioi>> <<yyyy2>>	
%Cover	%Area		%Area
0	#		#
5	#		#
10	#		#
15	#		#
20	#		#
25	#		#
30	#		#
35	#		#
40	#		#
45	#		#
50	#		#
55	#		#
60	#		#
65	#		#
70	#		#
75	#		#
80	#		#
85	#		#
90	#		#
95	#		#

Table 2. LandCART Cover Change Tool <<Location>> summary statistics for <<ioi>> percent cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> and <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>.

<<ioi>> <<yyyy1>>	<<ioi>> <<yyyy2>>	Difference <<yyyy2>> minus <<yyyy1>>
Mean: <<##>>%	Mean: <<##>>%	
Standard Deviation: <<#>>%	Standard Deviation: <<#>>%	
5 th Percentile: <<##>>%	5 th Percentile: <<##>>%	5 th Percentile: <<##>>%
10 th Percentile: <<##>>%	10 th Percentile: <<##>>%	10 th Percentile: <<##>>%
50 th Percentile: <<##>>%	50 th Percentile: <<##>>%	50 th Percentile: <<##>>%
90 th Percentile: <<##>>%	90 th Percentile: <<##>>%	90 th Percentile: <<##>>%
95 th Percentile: <<##>>%	95 th Percentile: <<##>>%	95 th Percentile: <<##>>%

References

- Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ####. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.
- Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.
- Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.
- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

Thank you for using LandCART!

Landscape Cover Analysis and Reporting Tools (LandCART) is a NASA-funded collaboration between the BLM, UCLA, and the USGS (see grant information, below). LandCART tools generate continuous fractional cover maps representing AIM indicators in the Western Lower 48 states using AIM data, Google Earth Engine, and machine learning prediction methods. For more information and to use LandCART click here: (landcart.org).

NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

ACCESS CONSTRAINT

None, these data are considered public domain.

USE CONSTRAINT

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LANDCART TIME SERIES TOOL REPORT TEMPLATE

(<<tagged>> and yellow-highlighted items in the template below are dynamic variables that the user must fill in based on their selections within the LandCART Tool. Variables are Case Dependent! Variables to find and replace multiple times are: <<Location>>, <<ioi>>, <<yyyy-mm-dd1a>>, <<yyyy-mm-dd1b>>, <<yyyy-mm-dd2a>>, <<yyyy-mm-dd2b>>, <<yyyy-mm-dd3a>>, <<yyyy-mm-dd3b>>, <<...>>, <<yyyy-mm-ddLasta>>, <<yyyy-mm-ddLastb>>, and <<yyyy1>>, <<yyyy2>>, <<yyyy3>>, <<...>>, <<yyyyLast>. The rest will need to be manually inserted from your LandCART session. Screen captures can be inserted for figures and tables.)

<<Location>> <<ioi>> Cover Prediction Time Series, <<yyyy1>> to <<yyyyLast>>

<<User should write a summary of the project and management question(s) here.>>

LandCART Time Series Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation indicators. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM indicators where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) indicators (IOI) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM indicators, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Time Series Tool allows a user to select one indicator at a time (IOI) at one location of interest (AOI) for a date range from 1984 to present (TOIs). The user can decide to map an indicator during a specific date range within multiple years. The Time Series Tool provides the user with true color and infrared images of the area of interest. It allows the user to predict a continuous fractional cover map to represent AIM indicators for a selected area of interest (AOI) for a range of times of interest (TOIs) (currently annually, seasonally in the future). It produces multiple indicator maps depending on the time range you choose, a difference map of the first and last dates you choose, comparative histograms, and conducts a Sen's Slope test for trend. This tool can be used to observe the trend of indicator distribution over many years.

Inputs and Outputs:

- **LandCART version:** <<V.B.#>> **and run date:** <<yyyy-mm-dd>>
- **AIM Indicator:** <<ioi>>
- **<<ioi>> Definition:** <<LandCART Indicator Definition (from page 15 in this User Guide)>>
- **Dates predicted TOI1:** <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>
- **Dates predicted TOI2:** <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>
- **Dates predicted TOI3:** <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>>
- **Dates predicted TOI...:** ...
- **Dates predicted TOILast:** <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>>

- **Landsat images used TOI1:** <<Landsat image IDs TOI1>>
- **Landsat images used TOI2:** <<Landsat image IDs TOI2>>
- **Landsat images used TOI3:** <<Landsat image IDs TOI3>>
- **Landsat images used TOI...:** <<Landsat image IDs TOI...>>
- **Landsat images used TOILast:** <<Landsat image IDs TOILast>>
- **Shapefile Name:** <<Location>>.shp
(if the user uploaded a shapefile for the AOI)
OR
Bounding box rectangular extent coordinates: <<LL>> and <<UR>>
(if the user used map extent or drew a rectangular polygon for the AOI)
OR
Bounding Polygon coordinates: <<P1: x, y>> <<P2: x, y>> <<P3: x, y>> <<P4: x, y>> <<P5: x, y>> <<...>> <<Pn: x, y>>
(if the user drew a non-rectangular polygon for the AOI)
- **Vector Acreage:** <<# acres>>
- **Output Predicted Images:**
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.TIF
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>.TIF
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>>.TIF
...
Landcart <<Location>> <<ioi>> <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>>.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.xml
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>.xml
Landcart <<Location>> <<ioi>> <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>>.xml
...
Landcart <<Location>> <<ioi>> <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>>.xml
- **Sen's Slope test for trend p-value:** <<#.###>>
- **Sen's Slope test for trend average slope:** <<#.##%/year>>

Results

Figure 1. [LandCART Time Series Tool](#) <<Location>> boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default imagery base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

Figure 2a. [LandCART Time Series Tool](#) <<Location>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default imagery base map. Percent <<ioi>> cover ranges from <<##min1%>> to <<##max1%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 2b. [LandCART Time Series Tool](#) <<Location>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>> displayed over the default imagery base map. Percent <<ioi>> cover ranges from <<##min2%>> to <<##max2%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 2c. [LandCART Time Series Tool](#) <<Location>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>> displayed over the default imagery base map. Percent <<ioi>> cover ranges from <<##min3%>> to <<##max3%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

...

Figure 2Last. [LandCART Time Series Tool](#) <<Location>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>> displayed over the default imagery base map. Percent <<ioi>> cover ranges from <<##minLast%>> to <<##maxLast%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 3a. [LandCART Time Series Tool](#) <<Location>> boundary (black line) with true color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default imagery base map. The LandCART Time

Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI1>>.

Figure 3b. LandCART Time Series Tool <<Location>> boundary (black line) with true color Landsat imagery composite from <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>> displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI2>>.

Figure 3c. LandCART Time Series Tool <<Location>> boundary (black line) with true color Landsat imagery composite from <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>> displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI3>>.

...

Figure 3Last. LandCART Time Series Tool <<Location>> boundary (black line) with true color Landsat imagery composite from <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>> displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOILast>>.

Figure 4a. LandCART Time Series Tool <<Location>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI1>>.

Figure 4b. LandCART Time Series Tool <<Location>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>> displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI2>>.

Figure 4c. LandCART Time Series Tool <<Location>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>> displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOI3>>.

...

Figure 4Last. LandCART Time Series Tool <<Location>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>> displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location>>: <<Landsat image IDs TOILast>>.

Figure 5. Histogram of LandCART Time Series Tool <<Location>> <<ioi>> percent cover from <<yyyy1>>, <<yyyy2>>, <<yyyy3>>, ..., and <<yyyyLast>> by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ...,90-95%, 95-100%.

Figure 6. LandCART Time Series Tool <<Location>> boundary (black line) with <<ioi>> difference map from <<yyyyLast>> minus <<yyyy1>> displayed over the default imagery base map. The LandCART Time Series Tool creates a difference image by subtracting predicted <<ioi>> fractional cover <<yyyy1>> from predicted <<ioi>> fractional cover <<yyyyLast>>. Positive values (yellow) indicate an increase from the earlier date to the later date and negative values (purple) indicate a decrease. No change is represented in white.

Figure 7. Difference histogram of LandCART Time Series Tool <<Location>> <<ioi>> percent cover <<yyyyLast>> minus <<yyyy1>> by percent area.

Figure 8. Time series plot of LandCART Time Series Tool <<Location>> <<ioi>> median percent cover from <<yyyy1>> to <<yyyyLast>>.

Table 1. Histogram values of LandCART Time Series Tool <<Location>> <<ioi>> percent cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>, <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>, <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>>, ..., and <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>> by percent area and number of acres. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

%Cover		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
<<ioi>> <<yyyy1>>	%Area	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
	%Area	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
<<ioi>> <<yyyy2>>	%Area	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
	Acres	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
<<ioi>> <<yyyy3>>	%Area	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
	Acres	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
<<ioi>> ...	%Area	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
	Acres	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
<<ioi>> <<yyyyLast>>	%Area	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
	Acres	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#

Table 2. LandCART Time Series Tool <<Location>> summary statistics for <<ioi>> percent cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>, <<yyyy-mm-dd2a>> to <<yyyy-mm-dd2b>>, <<yyyy-mm-dd3a>> to <<yyyy-mm-dd3b>>, ..., and <<yyyy-mm-ddLasta>> to <<yyyy-mm-ddLastb>>.

<<ioi>><<yyyy1>>	<<ioi>><<yyyy2>>	<<ioi>><<yyyy3>>
Mean: <<##>>%	Mean: <<##>>%	Mean: <<##>>%
Standard Deviation: <<#>>%	Standard Deviation: <<#>>%	Standard Deviation: <<#>>%
5 th Percentile: <<##>>%	5 th Percentile: <<##>>%	5 th Percentile: <<##>>%
10 th Percentile: <<##>>%	10 th Percentile: <<##>>%	10 th Percentile: <<##>>%
50 th Percentile: <<##>>%	50 th Percentile: <<##>>%	50 th Percentile: <<##>>%
90 th Percentile: <<##>>%	90 th Percentile: <<##>>%	90 th Percentile: <<##>>%
95 th Percentile: <<##>>%	95 th Percentile: <<##>>%	95 th Percentile: <<##>>%
<<ioi>> ...	<<ioi>><<yyyyLast>>	Difference <<yyyyLast>> minus <<yyyy1>>
Mean: <<##>>%	Mean: <<##>>%	
Standard Deviation: <<#>>%	Standard Deviation: <<#>>%	
5 th Percentile: <<##>>%	5 th Percentile: <<##>>%	5 th Percentile: <<##>>%
10 th Percentile: <<##>>%	10 th Percentile: <<##>>%	10 th Percentile: <<##>>%
50 th Percentile: <<##>>%	50 th Percentile: <<##>>%	50 th Percentile: <<##>>%
90 th Percentile: <<##>>%	90 th Percentile: <<##>>%	90 th Percentile: <<##>>%
95 th Percentile: <<##>>%	95 th Percentile: <<##>>%	95 th Percentile: <<##>>%

References

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- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

Thank you for using LandCART!

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NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

ACCESS CONSTRAINT

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LANDCART SPATIAL COMPARE TOOL REPORT TEMPLATE

(<<tagged>> and yellow-highlighted items in the template below are dynamic variables that the user must fill in based on their selections within the LandCART Tool. Variables are Case Dependent! Variables to find and replace multiple times are: <<Location1>>, <<Location2>>, <<ioi>>, <<yyyy-mm-dd1a>>, <<yyyy-mm-dd1b>>. The rest will need to be manually inserted from your LandCART session. Screen captures can be inserted for figures and tables.)

<<Location1>> and <<Location2>> <<ioi>> Cover Prediction, <<yyyy-mm-dd1a>>

<<User should write a summary of the project and management question(s) here.>>

LandCART Spatial Compare Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation indicators. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM indicators where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) indicators (IOI) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM indicators, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Spatial Compare Tool allows a user to select one indicator at a time (IOI) at two different locations of interest (AOIs) at one time (TOI). The user can decide to map an indicator during one season, multiple seasons separately (in different sessions), and annually based on the local growing season. The user can select two different locations anywhere in the western U.S. to compare to one another. The Spatial Compare Tool provides the user with true color and infrared images of two areas of interest. It produces two indicator maps of the selected indicator at one selected time, comparative histograms, conducts a two-sample Kolmogorov-Smirnov test of differences for the histograms, and conducts a one-sample Kolmogorov-Smirnov test for similarity between the difference histogram and a normal distribution. This tool can be used to compare indicator distribution in an area that has been seeded against an area that has been left as is (a control) or perhaps a smaller area within a larger area.

Inputs and Outputs:

- **LandCART version:** <<V.B.# >> **and run date:** <<yyyy-mm-dd>>
- **AIM Indicator:** <<ioi>>
- **<<ioi>> Definition:** <<LandCART Indicator Definition (from page 15 in this User Guide) >>
- **Dates predicted:** <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>
- **Landsat images used AOI1:** <<Landsat image IDs AOI1>>
- **Landsat images used AOI2:** <<Landsat image IDs AOI2>>
- **Shapefile Name AOI1:** <<Location1>>.shp
- **Shapefile Name AOI2:** <<Location2>>.shp
(if the user uploaded a shapefile for the AOI)

OR

Bounding box rectangular extent coordinates AOI1: <<Location1>> <<LL>> and <<UR>>

Bounding box rectangular extent coordinates AOI2: <<Location2>> <<LL>> and <<UR>>

(if the user used map extent or drew a rectangular polygon for the AOI)

OR

Bounding Polygon coordinates AOI1: <<Location1>> <<P1: x, y>> <<P2: x, y>> <<P3: x, y>> <<P4: x, y>> <<P5: x, y>> <<...>> <<Pn: x, y>>

Bounding Polygon coordinates AOI2: <<Location2>> <<P1: x, y>> <<P2: x, y>> <<P3: x, y>> <<P4: x, y>> <<P5: x, y>> <<...>> <<Pn: x, y>>

(if the user drew a non-rectangular polygon for the AOI)

- **Vector Acreage AOI1:** <<Location1>> <<# acres>>
- **Vector Acreage AOI2:** <<Location2>> <<# acres>>
- **Output Predicted Images:**
Landcart <<Location1>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.TIF
Landcart <<Location2>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
Landcart <<Location1>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.xml
Landcart <<Location2>> <<ioi>> <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.xml
- **Two-sample Kolmogorov-Smirnoff p-value:** <<#.###>>

Results

Figure 1a. [LandCART Spatial Compare Tool](#) <<Location1>> boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default topo base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

Figure 1b. [LandCART Spatial Compare Tool](#) <<Location2>> boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default topo base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

Figure 2a. [LandCART Spatial Compare Tool](#) <<Location1>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default topo base map. Percent <<ioi>> cover ranges from <<## min1%>> to <<## max1%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Spatial Compare Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 2b. [LandCART Spatial Compare Tool](#) <<Location2>> boundary (black line) with predicted <<ioi>> fractional cover from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default topo base map. Percent <<ioi>> cover ranges from <<## min2%>> to <<## max2%>>. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Spatial Compare Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, <<ioi>>, is defined as: <<definition used in the AIM TerrADat DB>>. See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

Figure 3a. [LandCART Spatial Compare Tool](#) <<Location1>> boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default topo base map. The LandCART Spatial Compare Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location1>>: <<Landsat image IDs AOI1>>.

Figure 3b. [LandCART Spatial Compare Tool](#) <<Location2>> boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default topo base map. The LandCART Spatial Compare Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting <<ioi>> cover in <<Location2>>: <<Landsat image IDs AOI2>>.

Figure 4a. LandCART Spatial Compare Tool <<Location1>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default topo base map. The LandCART Spatial Compare Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location1>>: <<Landsat image IDs AOI1>>.

Figure 4b. LandCART Spatial Compare Tool <<Location2>> boundary (black line) and false color Landsat imagery composite from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> displayed over the default topo base map. The LandCART Spatial Compare Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting <<ioi>> cover in <<Location2>>: <<Landsat image IDs AOI2>>.

Figure 5. Histogram of LandCART Spatial Compare Tool <<ioi>> percent cover for <<Location1>> and <<Location2>> from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ...,90-95%, 95-100%.

Table 1. Histogram values of LandCART Spatial Compare Tool <<ioi>> percent cover for <<Location1>> and <<Location2>> from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>> by percent area. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

<<ioi>> <<Location1>>		<<ioi>> <<Location2>>	
%Cover	%Area		%Area
0	#		#
5	#		#
10	#		#
15	#		#
20	#		#
25	#		#
30	#		#
35	#		#
40	#		#
45	#		#
50	#		#
55	#		#
60	#		#
65	#		#
70	#		#
75	#		#
80	#		#
85	#		#
90	#		#
95	#		#

Table 2. LandCART Spatial Compare Tool summary statistics for <<ioi>> percent cover for <<Location1>> and <<Location2>> from <<yyyy-mm-dd1a>> to <<yyyy-mm-dd1b>>.

<<ioi>> <<Location1>>	<<ioi>> <<Location2>>
Mean: <<##>>%	Mean: <<##>>%
Standard Deviation: <<#>>%	Standard Deviation: <<#>>%
5 th Percentile: <<##>>%	5 th Percentile: <<##>>%
10 th Percentile: <<##>>%	10 th Percentile: <<##>>%
50 th Percentile: <<##>>%	50 th Percentile: <<##>>%
90 th Percentile: <<##>>%	90 th Percentile: <<##>>%
95 th Percentile: <<##>>%	95 th Percentile: <<##>>%

References

- Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ####. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.
- Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.
- Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.
- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

Thank you for using LandCART!

Landscape Cover Analysis and Reporting Tools (LandCART) is a NASA-funded collaboration between the BLM, UCLA, and the USGS (see grant information, below). LandCART tools generate continuous fractional cover maps representing AIM indicators in the Western Lower 48 states using AIM data, Google Earth Engine, and machine learning prediction methods. For more information and to use LandCART click here: (landcart.org).

NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

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APPENDIX H – EXAMPLE REPORTS

LANDCART COVER TOOL REPORT EXAMPLE

McInnis Canyons NCA Annual Grass Cover Prediction, 2021-06-01

Here is a summary of the project at McInnis Canyons National Conservation Area. Distribution of Annual Grass during the summer of 2021.

LandCART Cover Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation Annual Grass. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM Annual Grass where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) Annual Grass (IOI) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM Annual Grass, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Cover Tool allows a user to select one indicator at a time (IOI) at one location of interest (AOI) for one timeframe (TOI). The user can decide to map an indicator during one season, multiple seasons separately, and annually based on the local growing season. The Cover Tool provides the user with true color and infrared images of the area of interest. It predicts a continuous fractional cover map of the selected indicator, calculates simple summary statistics, and produces a histogram for the selected indicator. This tool can be used to determine distribution of an indicator in an area of interest at one point in time, perhaps to determine where weed treatment needs to be applied, for example.

Inputs and Outputs:

- **LandCART version:** V1.0 **and run date:** 2021-12-20
- **AIM Indicaor:** Annual Grass
- Annual Grass **Definition:** The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot).
- **Date predicted:** 2021-06-01 to 2021-09-01
- **Landsat images used:** LC08_035033_20210712, LC08_035033_20210728, LC08_035033_20210813, LC08_035033_20210829, LC08_036033_20210617, LC08_036033_20210703, LC08_036033_20210719, LC08_036033_20210804, LC08_036033_20210820, LE07_035033_20210704, LE07_035033_20210720, LE07_035033_20210805, LE07_036033_20210711, LE07_036033_20210727, LE07_036033_20210812, LE07_036033_20210828
- **Shapefile Name:** McInnisCanyonsNCA.shp
- **Vector Acreage:** 124,293 acres

- **Output Predicted Image:**
Landcart McInnis Canyons NCA Annual Grass 2021-06-01 to 2021-09-01.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
Landcart McInnis Canyons NCA Annual Grass 2021-06-01 to 2021-09-01.xml

Results

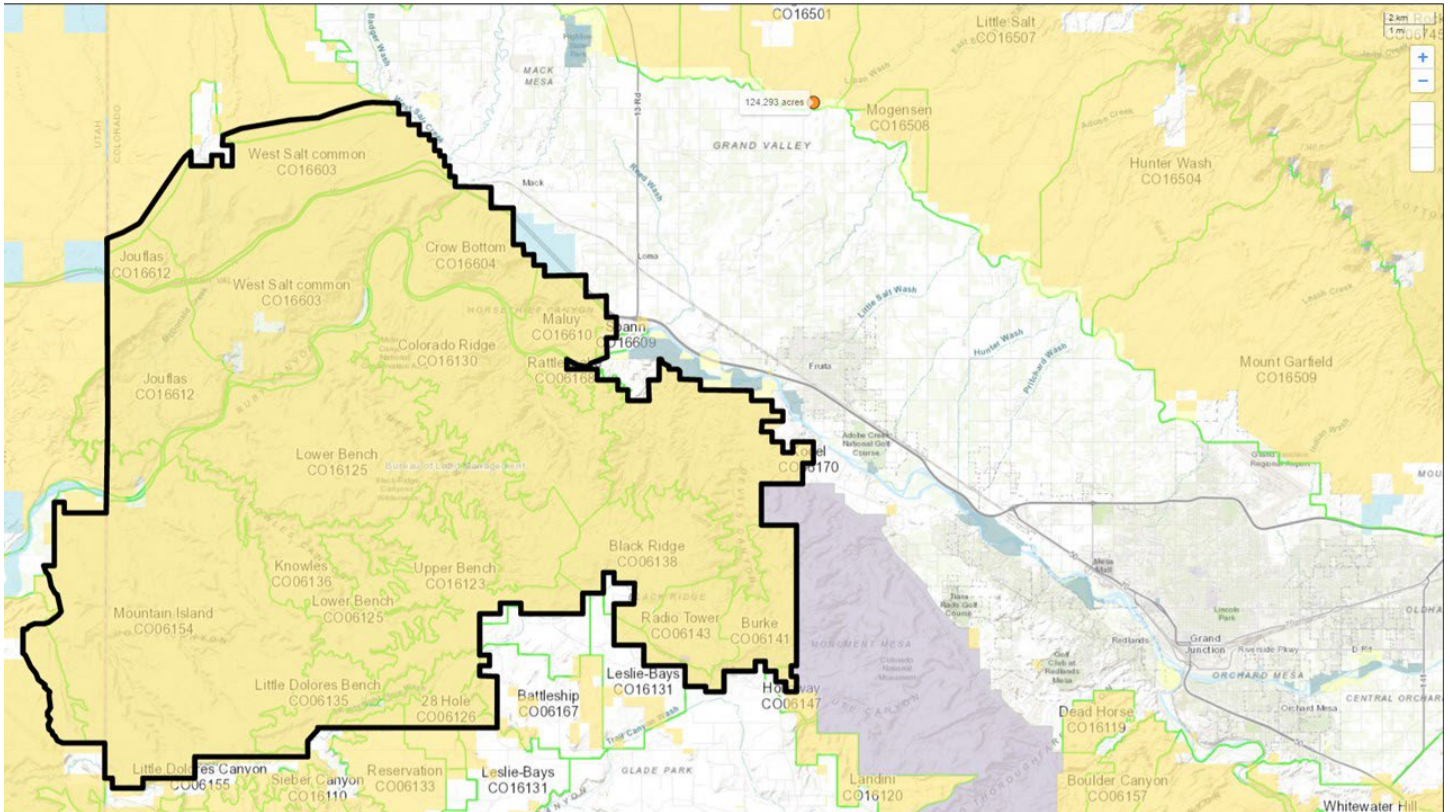


Figure 1. LandCART Cover Tool McInnis Canyons NCA boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default topo base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

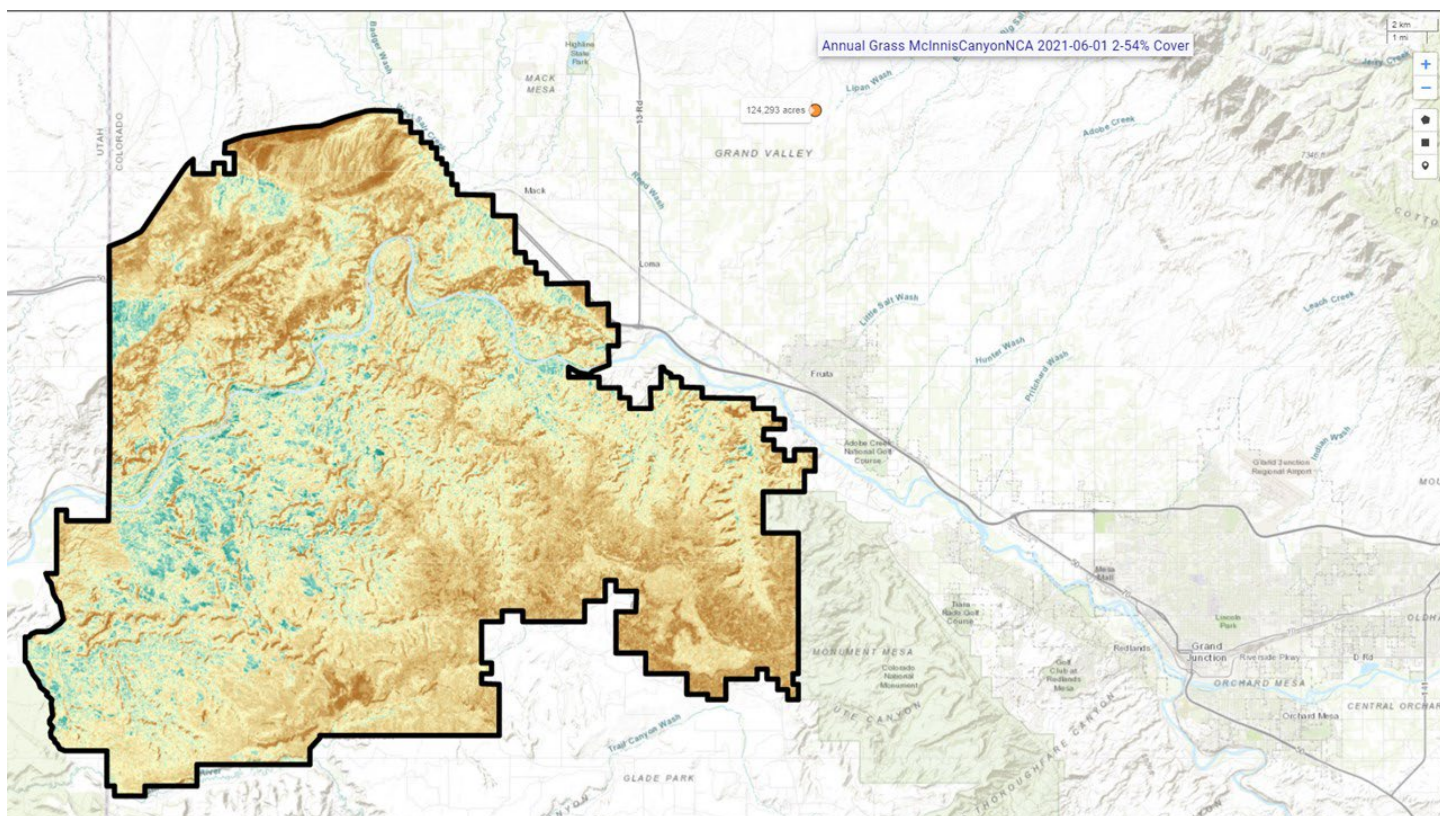


Figure 2. [LandCART Cover Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2021-06-01 to 2021-09-01 displayed over the default topo base map. Percent Annual Grass cover ranges from 2% to 54%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Cover Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: the any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

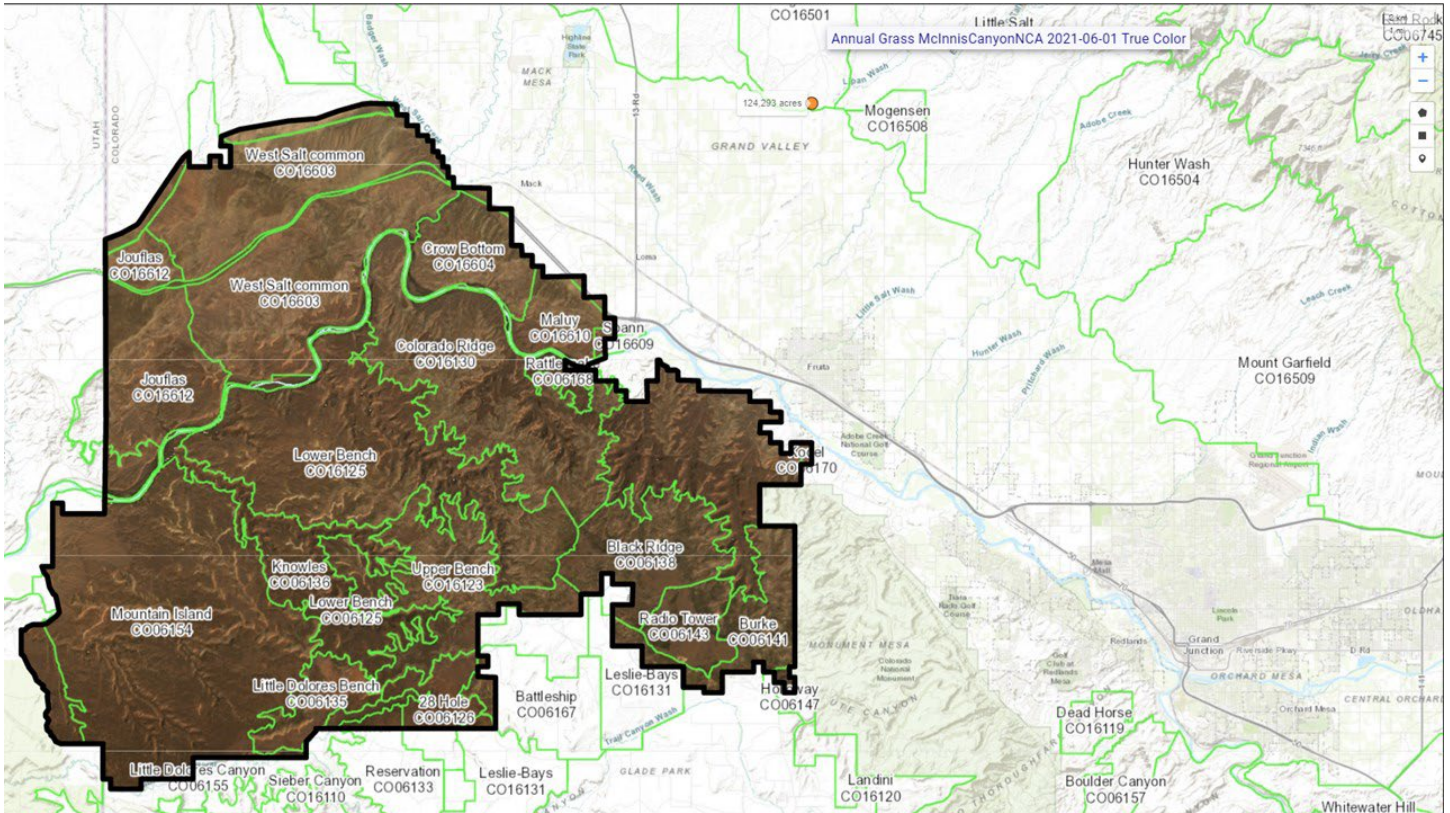


Figure 3. **LandCART Cover Tool** McInnis Canyons NCA boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite displayed over the default topo base map. The LandCART Cover Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20210712, LC08_035033_20210728, LC08_035033_20210813, LC08_035033_20210829, LC08_036033_20210617, LC08_036033_20210703, LC08_036033_20210719, LC08_036033_20210804, LC08_036033_20210820, LE07_035033_20210704, LE07_035033_20210720, LE07_035033_20210805, LE07_036033_20210711, LE07_036033_20210727, LE07_036033_20210812, LE07_036033_20210828.

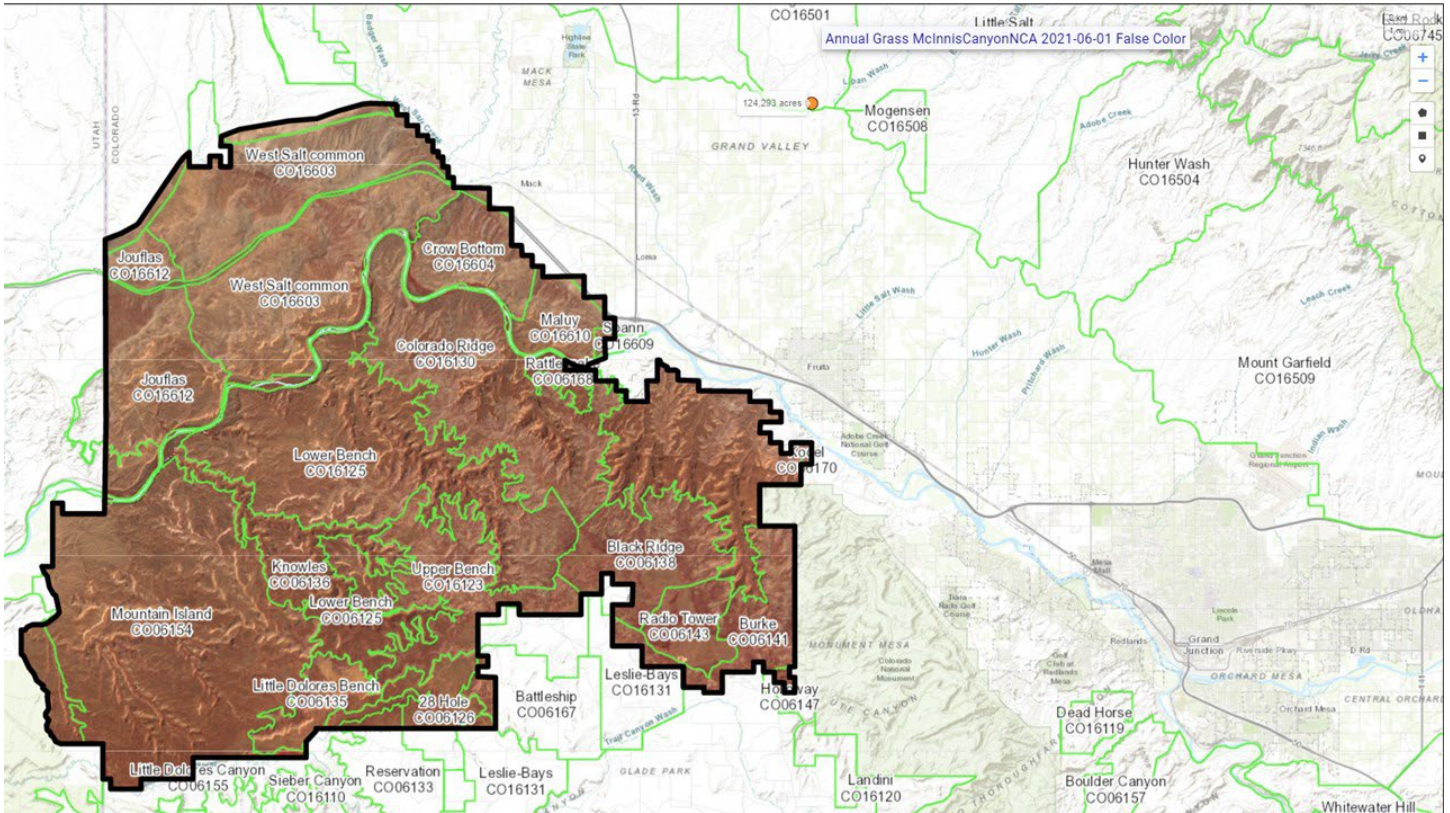


Figure 4. [LandCART Cover Tool](#) McInnis Canyons NCA boundary (black line) with grazing allotments (green lines) and false color Landsat imagery composite displayed over the default topo base map. The LandCART Cover Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20210712, LC08_035033_20210728, LC08_035033_20210813, LC08_035033_20210829, LC08_036033_20210617, LC08_036033_20210703, LC08_036033_20210719, LC08_036033_20210804, LC08_036033_20210820, LE07_035033_20210704, LE07_035033_20210720, LE07_035033_20210805, LE07_036033_20210711, LE07_036033_20210727, LE07_036033_20210812, LE07_036033_20210828.

Annual Grass McInnisCanyonNCA 2021-06-01

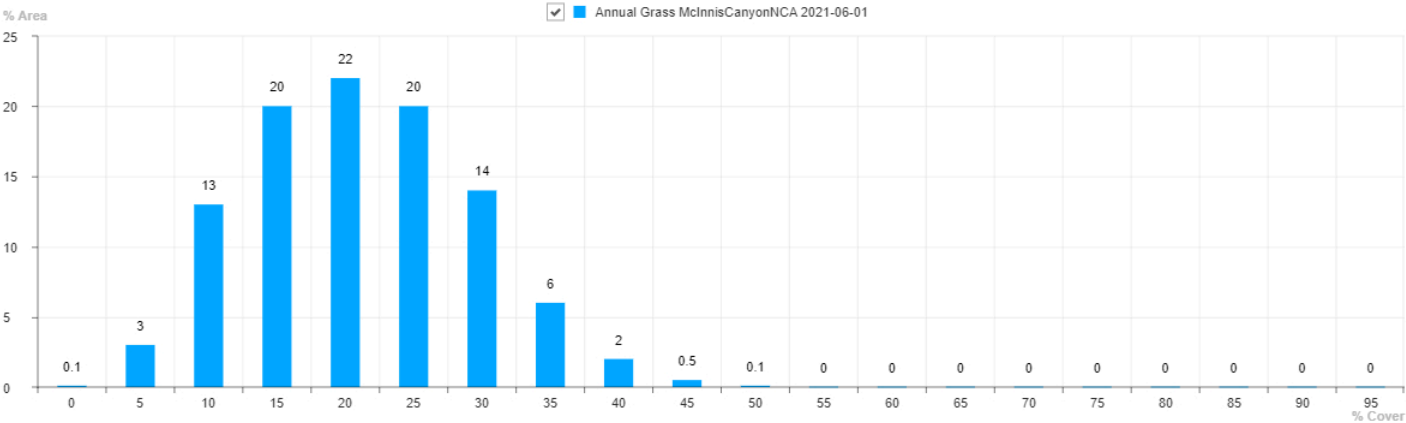
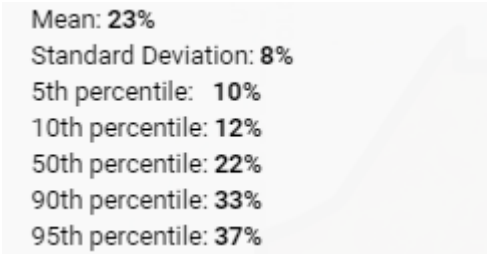


Figure 5. Histogram of LandCART Cover Tool McInnis Canyons NCA Annual Grass percent cover from 2021-06-01 to 2021-09-01 by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ...,90-95%, 95-100%.

Table 1. Histogram values of LandCART Cover Tool McInnis Canyons NCA Annual Grass percent cover from 2021-06-01 to 2021-09-01 by percent area. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

%Cover	%Area
0	0.1
5	3
10	13
15	20
20	22
25	20
30	14
35	6
40	2
45	0.5
50	0.1
55	0
60	0
65	0
70	0
75	0
80	0
85	0
90	0
95	0

Table 2. [LandCART Cover Tool](#) McInnis Canyons NCA summary statistics for Annual Grass percent cover from 2021-06-01 to 2021-09-01.



Mean: **23%**
Standard Deviation: **8%**
5th percentile: **10%**
10th percentile: **12%**
50th percentile: **22%**
90th percentile: **33%**
95th percentile: **37%**

References

- Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ####. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.
- Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.
- Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface Annual Grass in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.
- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

Thank you for using LandCART!

Landscape Cover Analysis and Reporting Tools (LandCART) is a NASA-funded collaboration between the BLM, UCLA, and the USGS (see grant information, below). LandCART tools generate continuous fractional cover maps representing AIM Annual Grass in the Western Lower 48 states using AIM data, Google Earth Engine, and machine learning prediction methods. For more information and to use LandCART click here: (landcart.org).

NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

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LANDCART COVER CHANGE TOOL REPORT EXAMPLE

McInnis Canyons NCA Annual Grass Cover Prediction Change, 1990-06-01 and 2020-06-01

Here is a summary of the project at McInnis Canyons National Conservation Area. Change of Annual Grass distribution from summer of 1990 to summer of 2020.

LandCART Cover Change Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation indicators. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM indicators where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) indicators (IOI) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM indicators, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Cover Change Tool allows a user to select one indicator at a time (IOI) at one location of interest (AOI) on two different dates (TOIs). The user can decide to map the indicator during one season over two different years or early spring and late summer in one year. The Cover Change Tool provides the user with true color and infrared images of the area of interest for both dates. It produces two indicator maps of the selected indicator at selected times, a difference map, comparative histograms, conducts a two-sample Kolmogorov-Smirnoff test of differences for the histograms, and conducts a one-sample Kolmogorov-Smirnoff test for similarity between the difference histogram and a normal distribution. This tool can be used to determine the distribution, direction, and magnitude of change in an indicator from one year to another.

Inputs and **Outputs**:

- **LandCART version:** V1.0 **and run date:** 2021-12-20
- **AIM Indicator:** Annual Grass
- Annual Grass **Definition:** The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot).
- **Dates predicted TOI1:** 1990-06-01 to 1990-09-01
- **Dates predicted TOI2:** 2020-06-01 to 2020-09-01
- **Landsat images used TOI1:** LT05_035033_19900605, LT05_035033_19900621, LT05_035033_19900824
- **Landsat images used TOI2:** LC08_035033_20200623, LC08_035033_20200709, LC08_035033_20200810, LC08_035033_20200826, LC08_036033_20200614, LC08_036033_20200630, LC08_036033_20200801, LC08_036033_20200817, LE07_035033_20200615, LE07_035033_20200701, LE07_035033_20200717,

LE07_035033_20200802, LE07_035033_20200818, LE07_036033_20200622,
LE07_036033_20200708, LE07_036033_20200825

- **Shapefile Name:** McInnisCanyonsNCA.shp
- **Vector Acreage:** 124,293 acres
- **Output Predicted Images:**
Landcart McInnis Canyons NCA Annual Grass 1990-06-01 to 1990-09-01.TIF
Landcart McInnis Canyons NCA Annual Grass 2020-06-01 to 2020-09-01.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
Landcart McInnis Canyons NCA Annual Grass 1990-06-01 to 1990-09-01.xml
Landcart McInnis Canyons NCA Annual Grass 2020-06-01 to 2020-09-01.xml
- **Two-sample Kolmogorov-Smirnoff p-value:** 0.000
- **One-sample Kolmogorov-Smirnoff p-value:** 0.396

Results

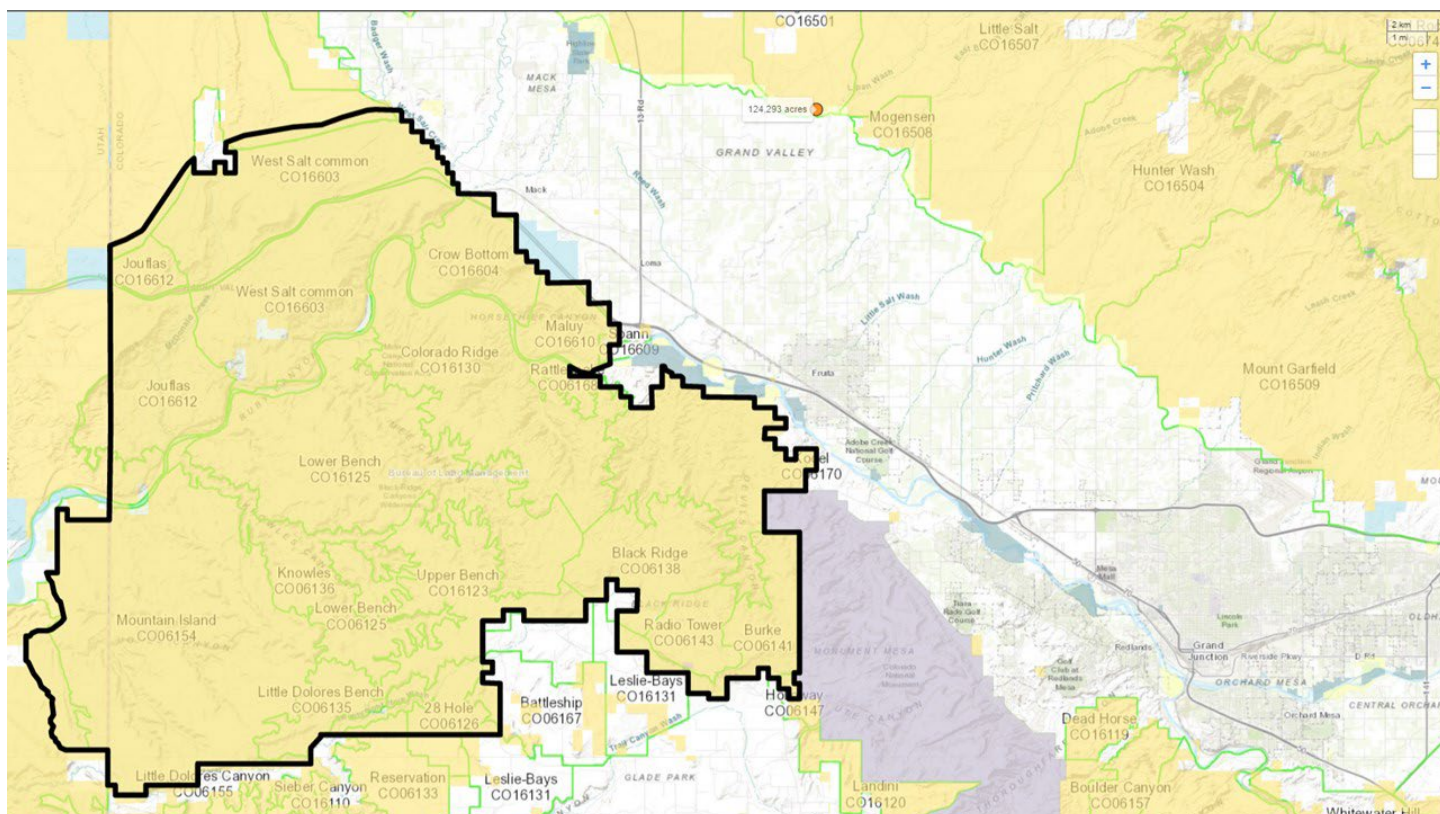


Figure 1. LandCART Cover Change Tool McInnis Canyons NCA boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default topo base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

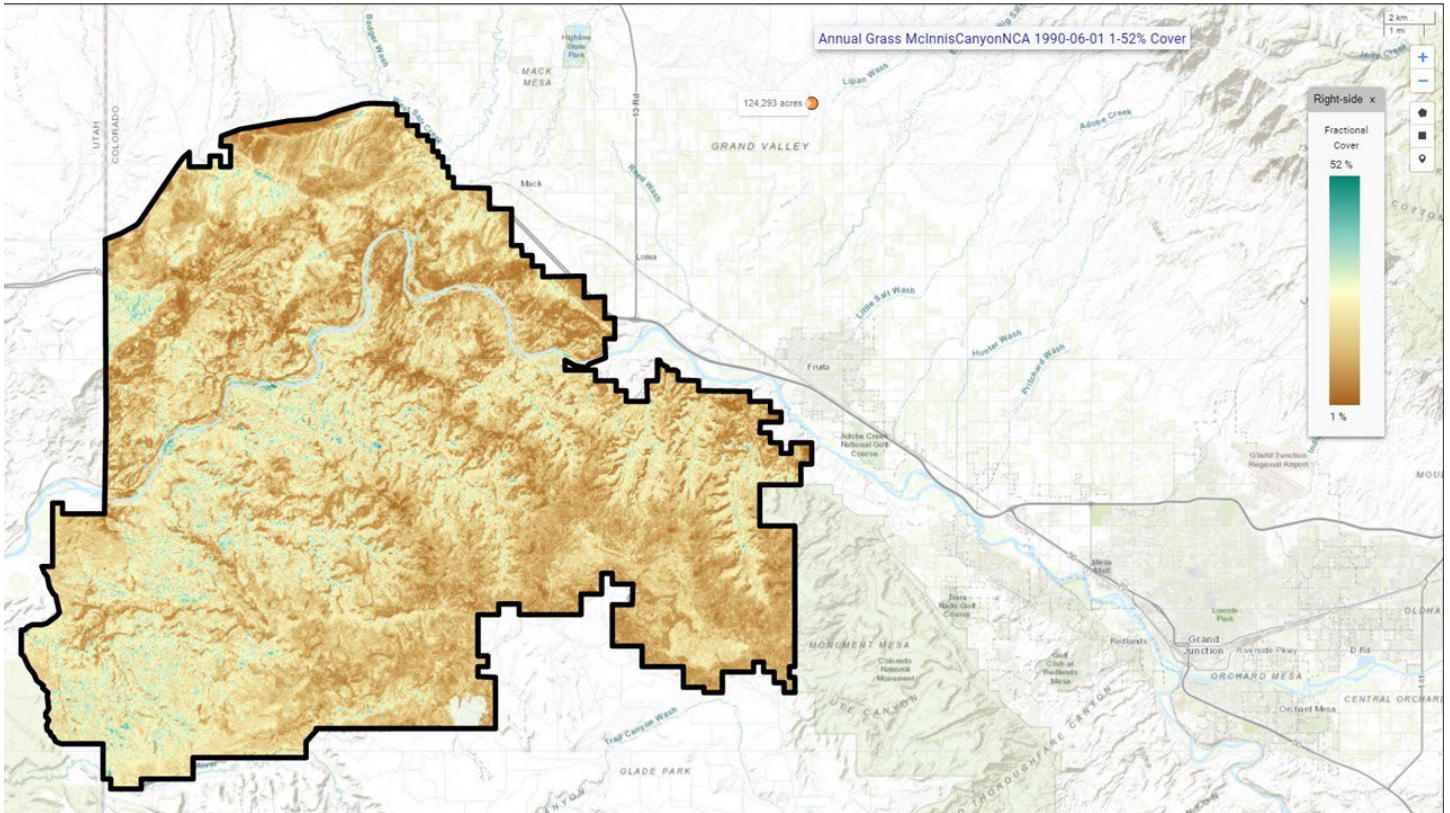


Figure 2a. [LandCART Cover Change Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 1990-06-01 to 1990-09-01 displayed over the default topo base map. Percent Annual Grass cover ranges from 1% to 52%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Cover Change Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: the any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

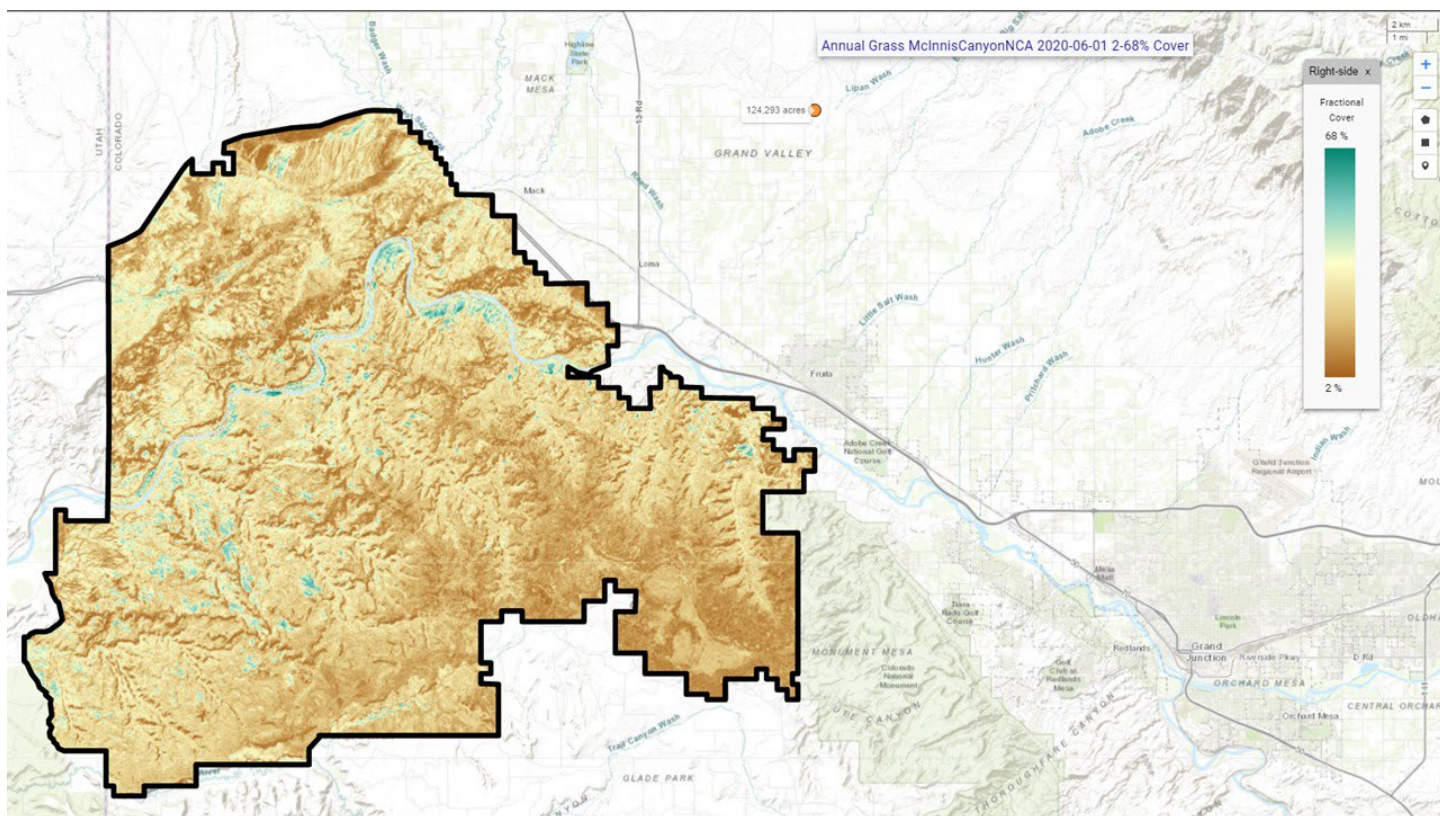


Figure 2b. [LandCART Cover Change Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2020-06-01 to 2020-09-01 displayed over the default topo base map. Percent Annual Grass cover ranges from 2% to 68%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Cover Change Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: the any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

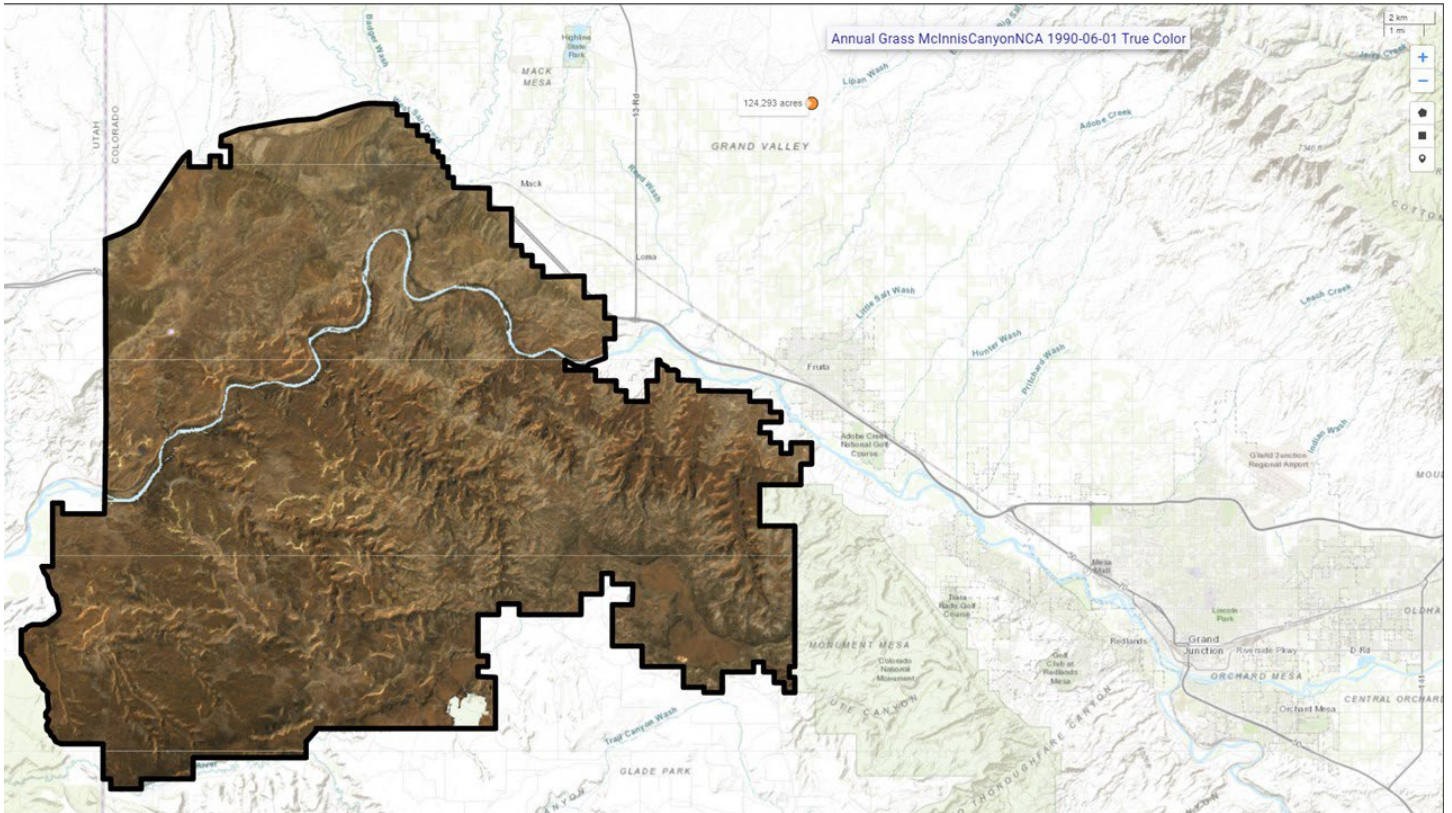


Figure 3a. LandCART Cover Change Tool McInnis Canyons NCA boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite from 1990-06-01 to 1990-09-01 displayed over the default topo base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LT05_035033_19900605, LT05_035033_19900621, LT05_035033_19900824.

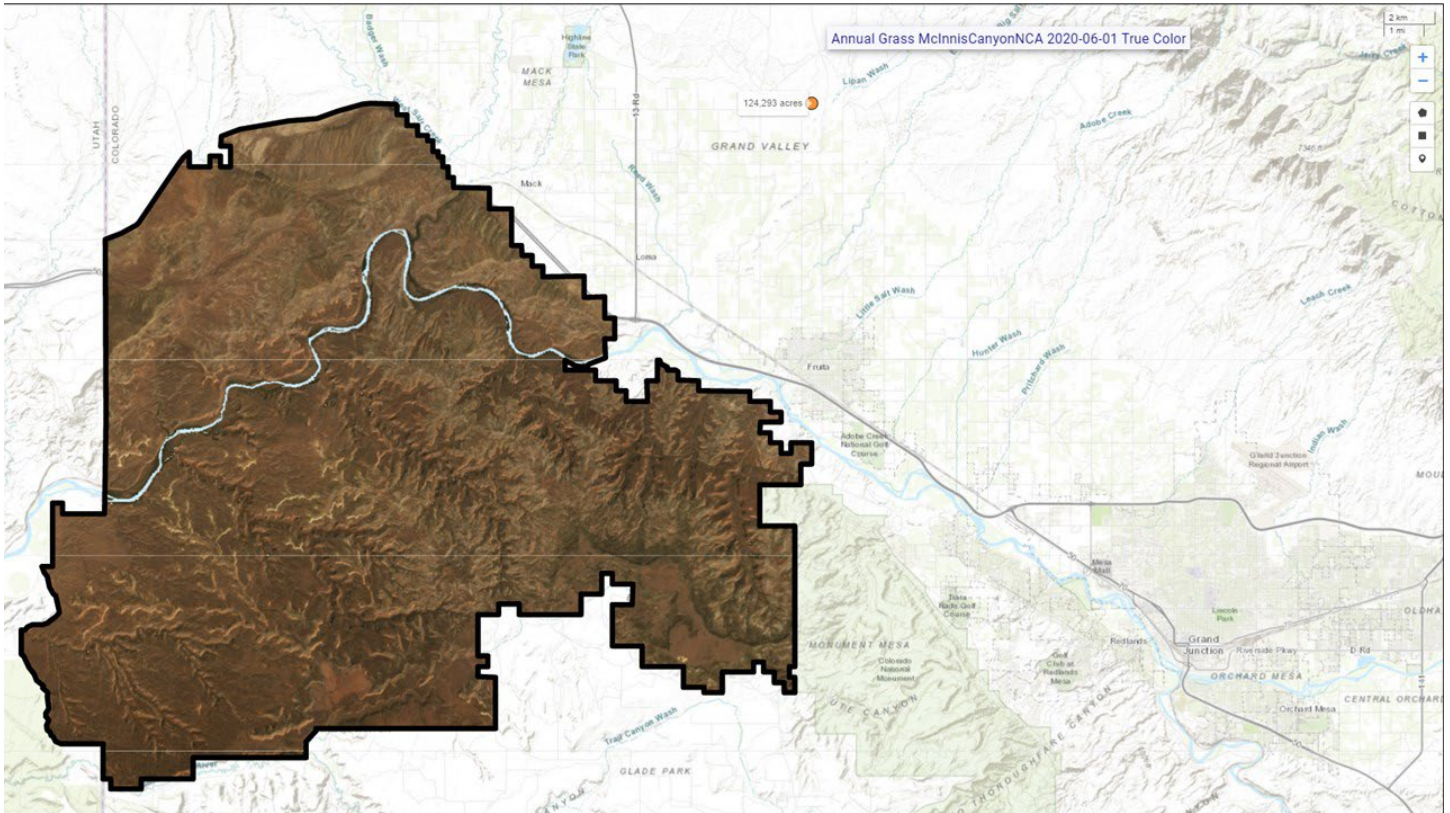


Figure 3b. LandCART Cover Change Tool McInnis Canyons NCA boundary (black line) with grazing allotments (green lines) and true color Landsat imagery composite from 2020-06-01 to 2020-09-01 displayed over the default topo base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA:

LC08_035033_20200623, LC08_035033_20200709, LC08_035033_20200810, LC08_035033_20200826, LC08_036033_20200614, LC08_036033_20200630, LC08_036033_20200801, LC08_036033_20200817, LE07_035033_20200615, LE07_035033_20200701, LE07_035033_20200717, LE07_035033_20200802, LE07_035033_20200818, LE07_036033_20200622, LE07_036033_20200708, LE07_036033_20200825.

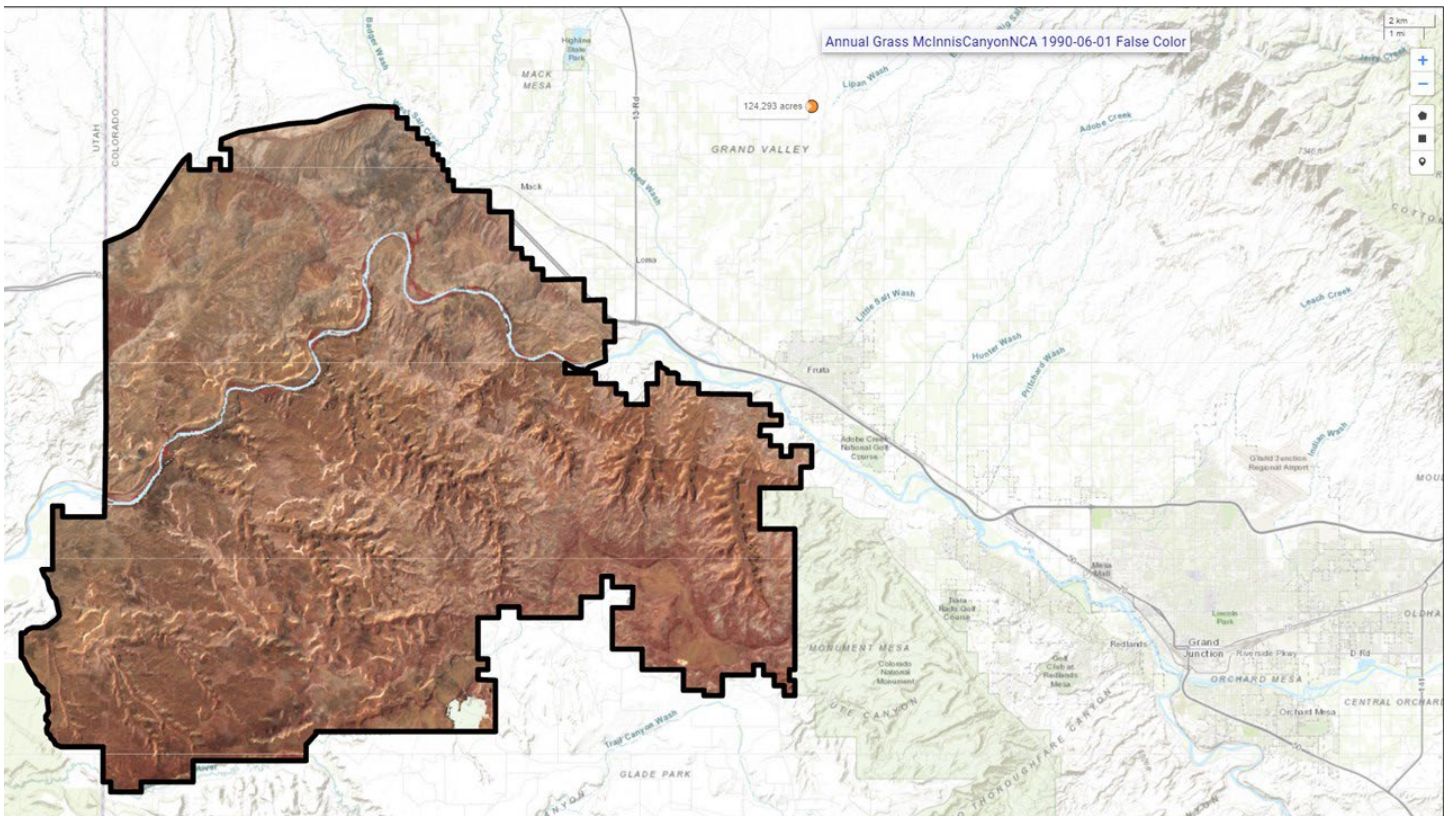


Figure 4a. [LandCART Cover Change Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 1990-06-01 to 1990-09-01 displayed over the default topo base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LT05_035033_19900605, LT05_035033_19900621, LT05_035033_19900824.

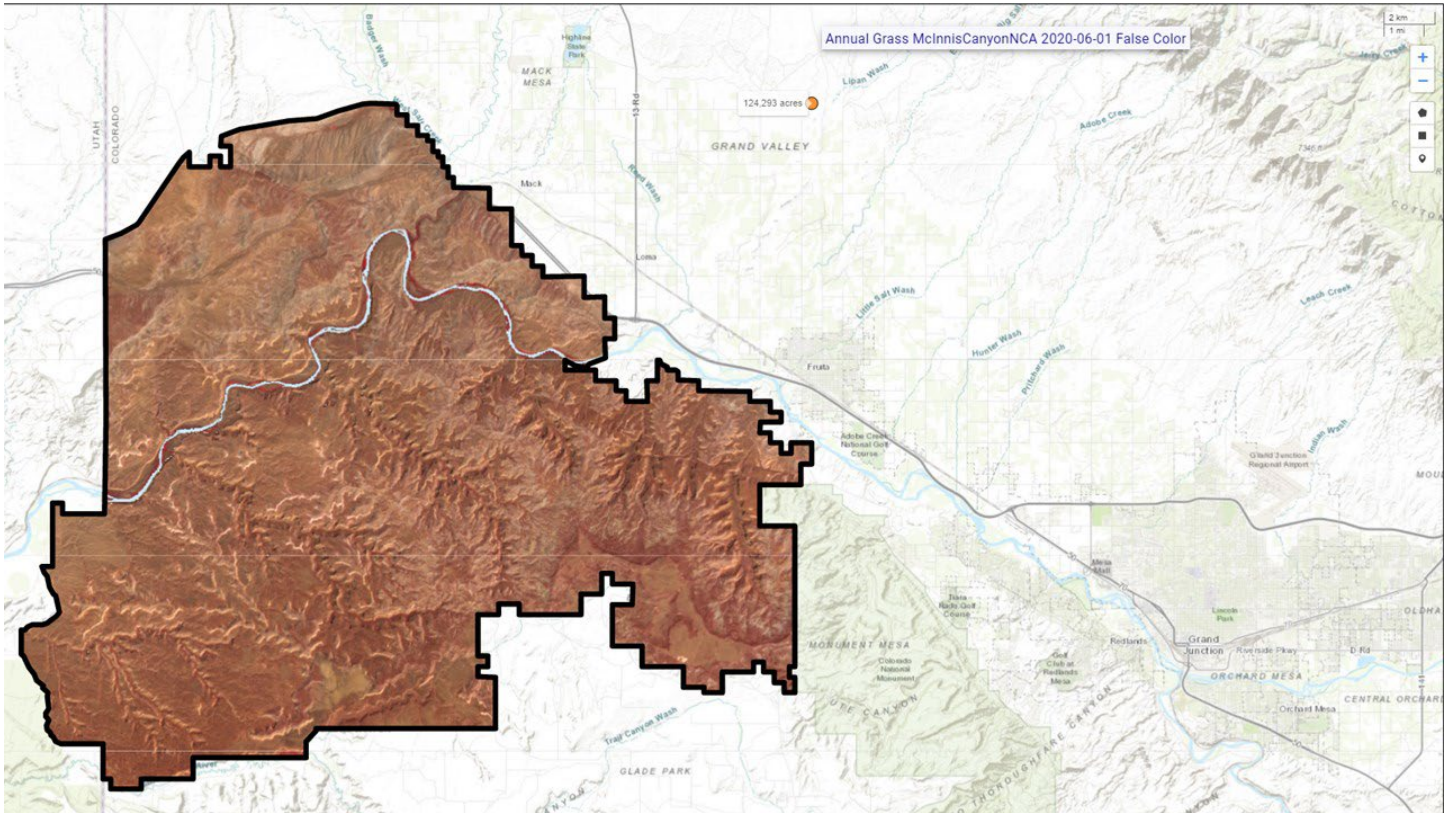


Figure 4b. [LandCART Cover Change Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2020-06-01 to 2020-09-01 displayed over the default topo base map. The LandCART Cover Change Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20200623, LC08_035033_20200709, LC08_035033_20200810, LC08_035033_20200826, LC08_036033_20200614, LC08_036033_20200630, LC08_036033_20200801, LC08_036033_20200817, LE07_035033_20200615, LE07_035033_20200701, LE07_035033_20200717, LE07_035033_20200802, LE07_035033_20200818, LE07_036033_20200622, LE07_036033_20200708, LE07_036033_20200825.

Annual Grass McInnisCanyonNCA 2020-06-01

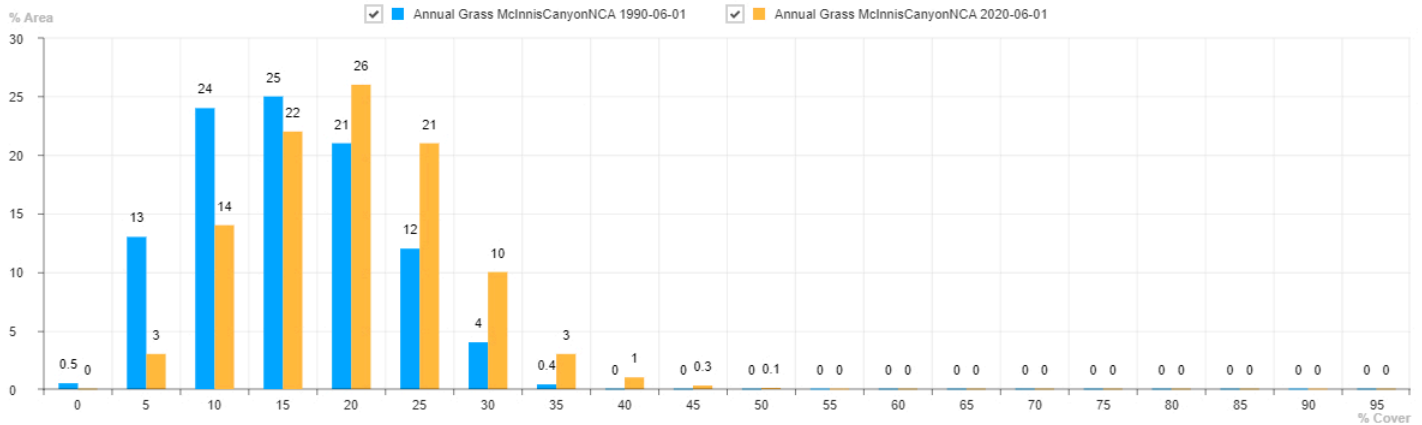


Figure 5. Histogram of *LandCART Cover Change Tool* McInnis Canyons NCA Annual Grass percent cover from 1990 and 2020 by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ...,90-95%, 95-100%.

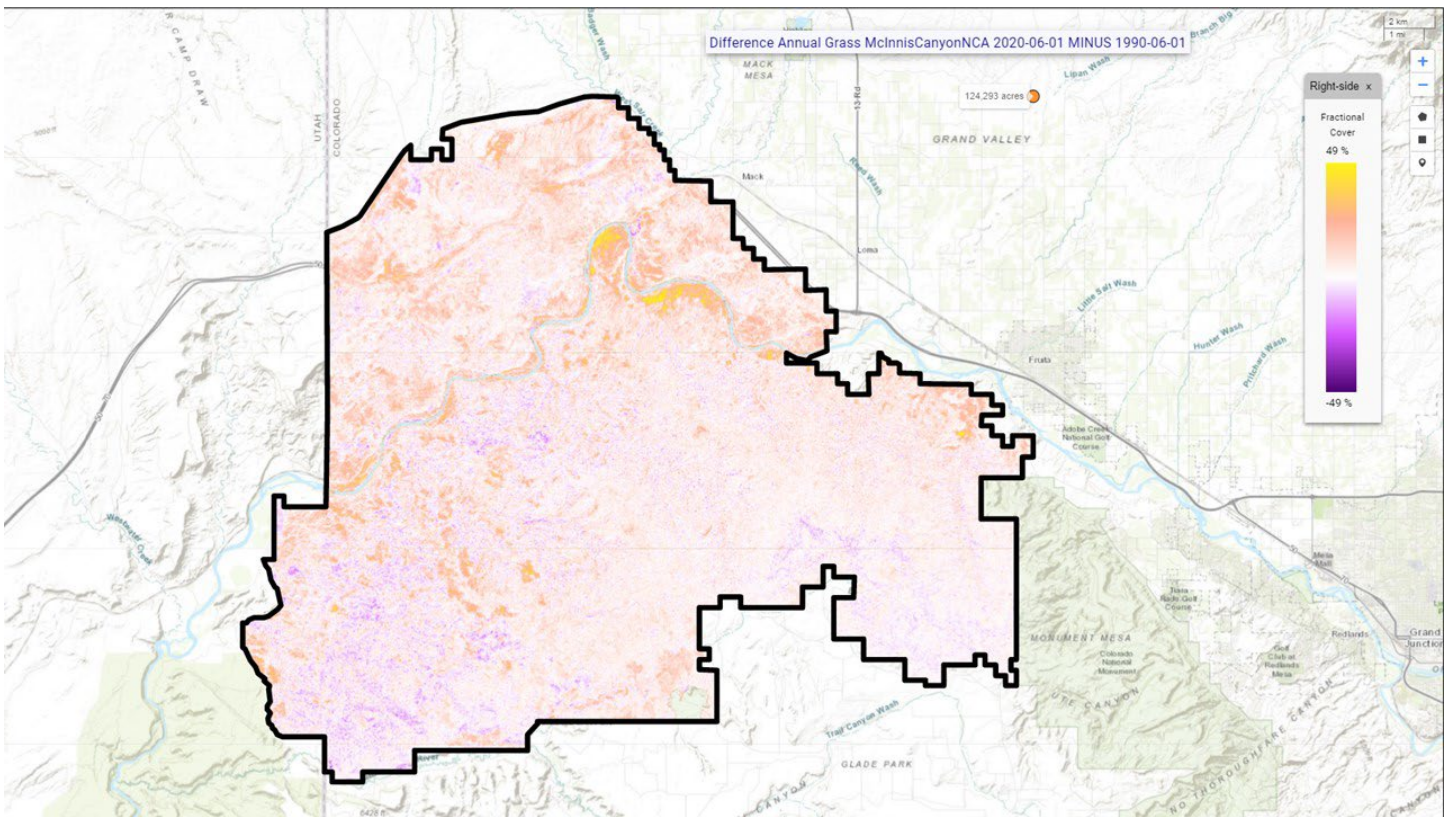


Figure 6. *LandCART Cover Change Tool* McInnis Canyons NCA boundary (black line) with Annual Grass difference map from 2020 minus 1990 displayed over the default topo base map. The *LandCART Cover Change Tool* creates a difference image by subtracting predicted Annual Grass fractional cover 1990 from predicted Annual Grass fractional cover 2020. Positive values (yellow) indicate an increase from the earlier date to the later date and negative values (purple) indicate a decrease. No change is represented in white.

Difference Annual Grass McInnisCanyonNCA 2020-06-01 MINUS 1990-06-01

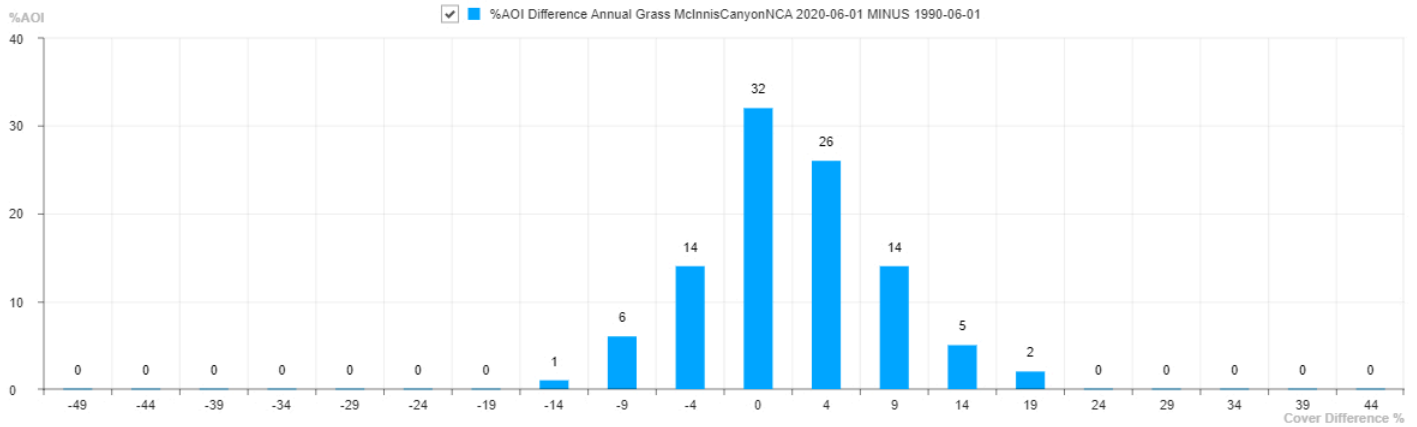


Figure 7. Difference histogram of LandCART Cover Change Tool McInnis Canyons NCA Annual Grass percent cover 2020 minus 1990 by percent area.

Table 1. Histogram values of [LandCART Cover Change Tool](#) McInnis Canyons NCA Annual Grass percent cover from 1990-06-01 to 1990-09-01 and 2020-06-01 to 2020-09-01 by percent area. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

Annual Grass 1990		Annual Grass 2020	
%Cover	%Area		%Area
0	0.5	0	
5	13	3	
10	24	14	
15	25	22	
20	21	26	
25	12	21	
30	4	10	
35	0.4	3	
40	0	1	
45	0	0.3	
50	0	0.1	
55	0	0	
60	0	0	
65	0	0	
70	0	0	
75	0	0	
80	0	0	
85	0	0	
90	0	0	
95	0	0	

Table 2. [LandCART Cover Change Tool](#) McInnis Canyons NCA summary statistics for Annual Grass percent cover from 1990-06-01 to 1990-09-01 and 2020-06-01 to 2020-09-01.

Annual Grass McInnisCanyonNCA 1990-06-01

Mean: 17%
Standard Deviation: 6%
5th percentile: 7%
10th percentile: 8%
50th percentile: 17%
90th percentile: 26%
95th percentile: 29%

Annual Grass McInnisCanyonNCA 2020-06-01

Mean: 22%
Standard Deviation: 8%
5th percentile: 9%
10th percentile: 11%
50th percentile: 21%
90th percentile: 32%
95th percentile: 35%

**Difference Annual Grass
McInnisCanyonNCA 2020-06-01 MINUS
1990-06-01**

5th percentile: -6%
10th percentile: -4%
50th percentile: 4%
90th percentile: 12%
95th percentile: 16%

References

- Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ###. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.
- Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.
- Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.
- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

Thank you for using LandCART!

Landscape Cover Analysis and Reporting Tools (LandCART) is a NASA-funded collaboration between the BLM, UCLA, and the USGS (see grant information, below). LandCART tools generate continuous fractional cover maps representing AIM indicators in the Western Lower 48 states using AIM data, Google Earth Engine, and machine learning prediction methods. For more information and to use LandCART click here: (landcart.org).

NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

ACCESS CONSTRAINT

None, these data are considered public domain.

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LANDCART TIME SERIES TOOL REPORT EXAMPLE

McInnis Canyons NCA Annual Grass Cover Prediction Time Series, 2015 to 2021

Here is a summary about looking at annual grass cover trends through a time series from 2015 to 2021. Annual grass distributions for seven years and a time series plot of median.

LandCART Time Series Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation indicators. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM indicators where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) indicators (IOI) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM indicators, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Time Series Tool allows a user to select one indicator at a time (IOI) at one location of interest (AOI) for a date range from 1984 to present (TOIs). The user can decide to map an indicator during a specific date range within multiple years. The Time Series Tool provides the user with true color and infrared images of the area of interest. It allows the user to predict a continuous fractional cover map to represent AIM indicators for a selected area of interest (AOI) for a range of times of interest (TOIs) (currently annually, seasonally in the future). It produces multiple indicator maps depending on the time range you choose, a difference map of the first and last dates you choose, comparative histograms, and conducts a Sen's Slope test for trend. This tool can be used to observe the trend of indicator distribution over many years.

Inputs and **Outputs**:

- **LandCART version:** V1.0 **and run date:** 2021-12-21
- **AIM Indicator:** Annual Grass
- **Annual Grass Definition:** The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot).
- **Dates predicted TOI1:** 2015-06-01 to 2015-09-01
- **Dates predicted TOI2:** 2016-06-01 to 2016-09-01
- **Dates predicted TOI3:** 2017-06-01 to 2017-09-01
- **Dates predicted TOI4:** 2018-06-01 to 2018-09-01
- **Dates predicted TOI5:** 2019-06-01 to 2019-09-01
- **Dates predicted TOI6:** 2020-06-01 to 2020-09-01
- **Dates predicted TOI7:** 2021-06-01 to 2021-09-01
- **Landsat images used TOI1:** LC08_035033_20150626, LC08_035033_20150712, LC08_035033_20150728, LC08_035033_20150813, LC08_035033_20150829,

- LC08_036033_20150601, LC08_036033_20150617, LC08_036033_20150703,
LC08_036033_20150804, LE07_035033_20150602, LE07_035033_20150618,
LE07_035033_20150805, LE07_035033_20150821, LE07_036033_20150609,
LE07_036033_20150625, LE07_036033_20150727, LE07_036033_20150828
- **Landsat images used TOI2:** LC08_035033_20160628, LC08_035033_20160714,
LC08_035033_20160815, LC08_035033_20160831, LC08_036033_20160603,
LC08_036033_20160619, LC08_036033_20160705, LE07_035033_20160620,
LE07_035033_20160706, LE07_035033_20160807, LE07_036033_20160627,
LE07_036033_20160713, LE07_036033_20160729, LE07_036033_20160814,
LE07_036033_20160830
 - **Landsat images used TOI3:** LC08_035033_20170615, LC08_035033_20170701,
LC08_035033_20170717, LC08_035033_20170802, LC08_035033_20170818,
LC08_036033_20170622, LC08_036033_20170708, LC08_036033_20170724,
LC08_036033_20170809, LC08_036033_20170825, LE07_035033_20170607,
LE07_035033_20170623, LE07_035033_20170709, LE07_035033_20170810,
LE07_035033_20170826, LE07_036033_20170614, LE07_036033_20170630,
LE07_036033_20170716, LE07_036033_20170801, LE07_036033_20170817
 - **Landsat images used TOI4:** LC08_036033_20180609, LC08_036033_20180625,
LC08_036033_20180711, LC08_036033_20180727, LC08_035033_20180602,
LC08_035033_20180618, LC08_035033_20180704, LC08_036033_20180609,
LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727,
LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610,
LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829,
LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804,
LE07_036033_20180820
 - **Landsat images used TOI5:** LC08_035033_20190723, LC08_036033_20190612,
LC08_036033_20190628, LC08_036033_20190714, LC08_036033_20190815,
LC08_036033_20190831, LE07_035033_20190613, LE07_035033_20190629,
LE07_035033_20190816, LE07_036033_20190604, LE07_036033_20190620,
LE07_036033_20190706, LE07_036033_20190722
 - **Landsat images used TOI6:** LC08_035033_20200623, LC08_035033_20200709,
LC08_035033_20200810, LC08_035033_20200826, LC08_036033_20200614,
LC08_036033_20200630, LC08_036033_20200801, LC08_036033_20200817,
LE07_035033_20200615, LE07_035033_20200701, LE07_035033_20200717,
LE07_035033_20200802, LE07_035033_20200818, LE07_036033_20200622,
LE07_036033_20200708, LE07_036033_20200825
 - **Landsat images used TOI7:** LC08_035033_20210712, LC08_035033_20210728,
LC08_035033_20210813, LC08_035033_20210829, LC08_036033_20210617,
LC08_036033_20210703, LC08_036033_20210719, LC08_036033_20210804,
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LE07_036033_20210812, LE07_036033_20210828
 - **Shapefile Name:** McInnis Canyons NCA.shp

- **Vector Acreage:** 124,293 acres
- **Output Predicted Images:**
 - Landcart McInnis Canyons NCA Annual Grass 2015-06-01 to 2015-09-01.TIF
 - Landcart McInnis Canyons NCA Annual Grass 2016-06-01 to 2016-09-01.TIF
 - Landcart McInnis Canyons NCA Annual Grass 2017-06-01 to 2017-09-01.TIF
 - Landcart McInnis Canyons NCA Annual Grass 2018-06-01 to 2018-09-01.TIF
 - Landcart McInnis Canyons NCA Annual Grass 2019-06-01 to 2019-09-01.TIF
 - Landcart McInnis Canyons NCA Annual Grass 2020-06-01 to 2020-09-01.TIF
 - Landcart McInnis Canyons NCA Annual Grass 2021-06-01 to 2021-09-01.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
 - Landcart McInnis Canyons NCA Annual Grass 2015-06-01 to 2015-09-01.xml
 - Landcart McInnis Canyons NCA Annual Grass 2016-06-01 to 2016-09-01.xml
 - Landcart McInnis Canyons NCA Annual Grass 2017-06-01 to 2017-09-01.xml
 - Landcart McInnis Canyons NCA Annual Grass 2018-06-01 to 2018-09-01.xml
 - Landcart McInnis Canyons NCA Annual Grass 2019-06-01 to 2019-09-01.xml
 - Landcart McInnis Canyons NCA Annual Grass 2020-06-01 to 2020-09-01.xml
 - Landcart McInnis Canyons NCA Annual Grass 2021-06-01 to 2021-09-01.xml
- **Sen's Slope test for trend p-value:** 0.489
- **Sen's Slope test for trend average slope:** 0%/year

Results

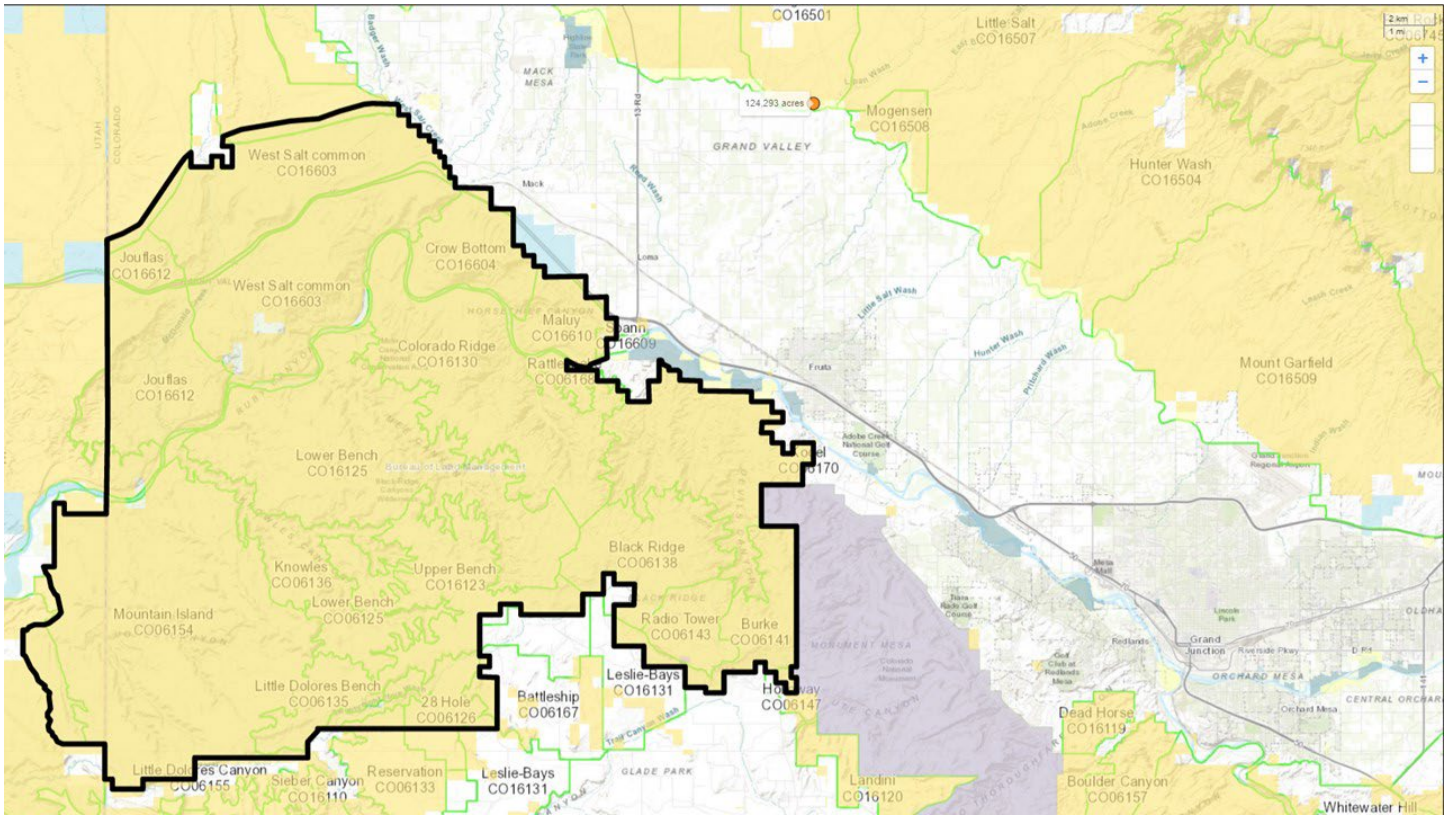


Figure 1. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default imagery base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

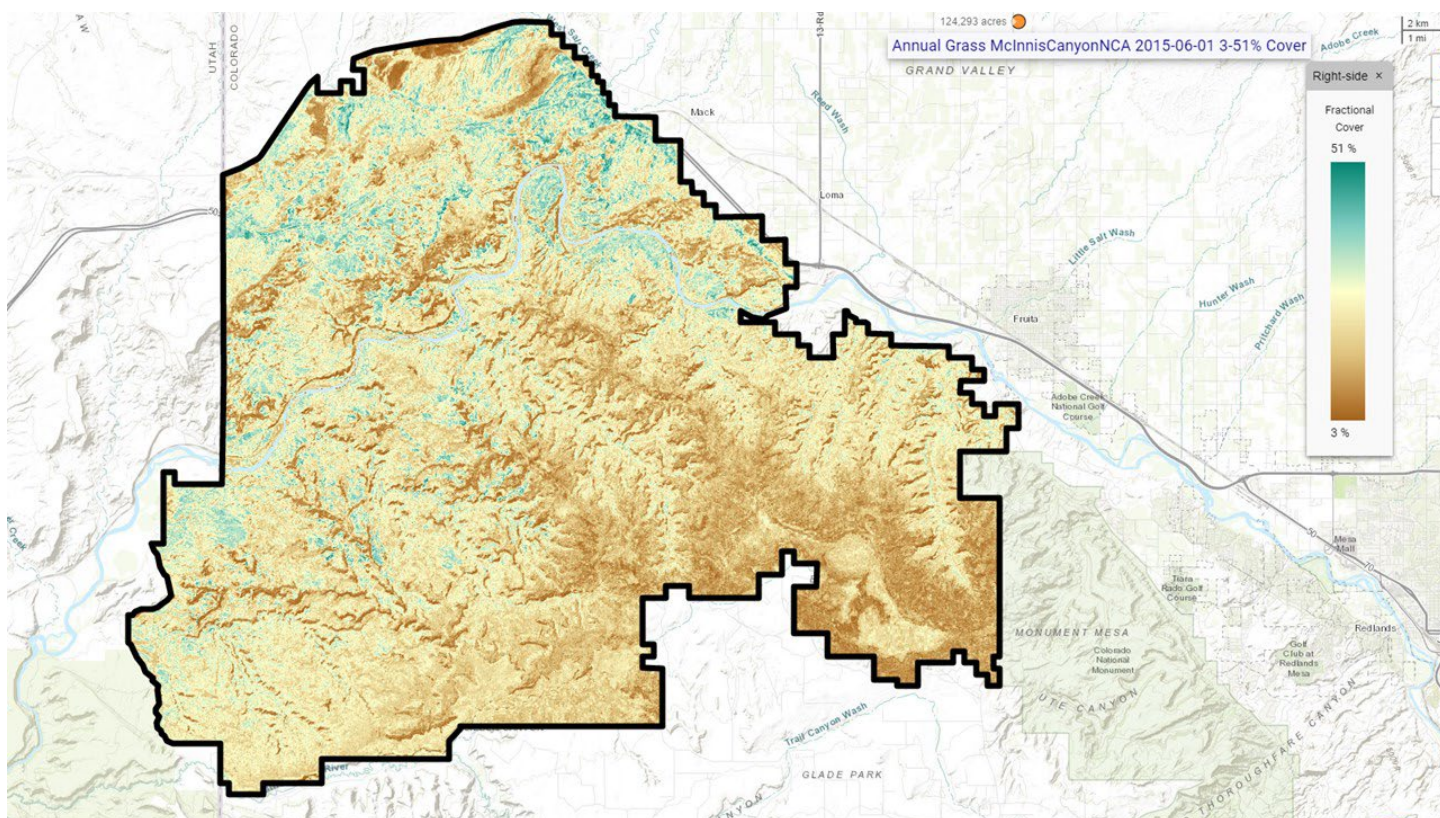


Figure 2a. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2015-06-01 to 2015-09-01 displayed over the default imagery base map. Percent Annual Grass cover ranges from 3% to 51%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

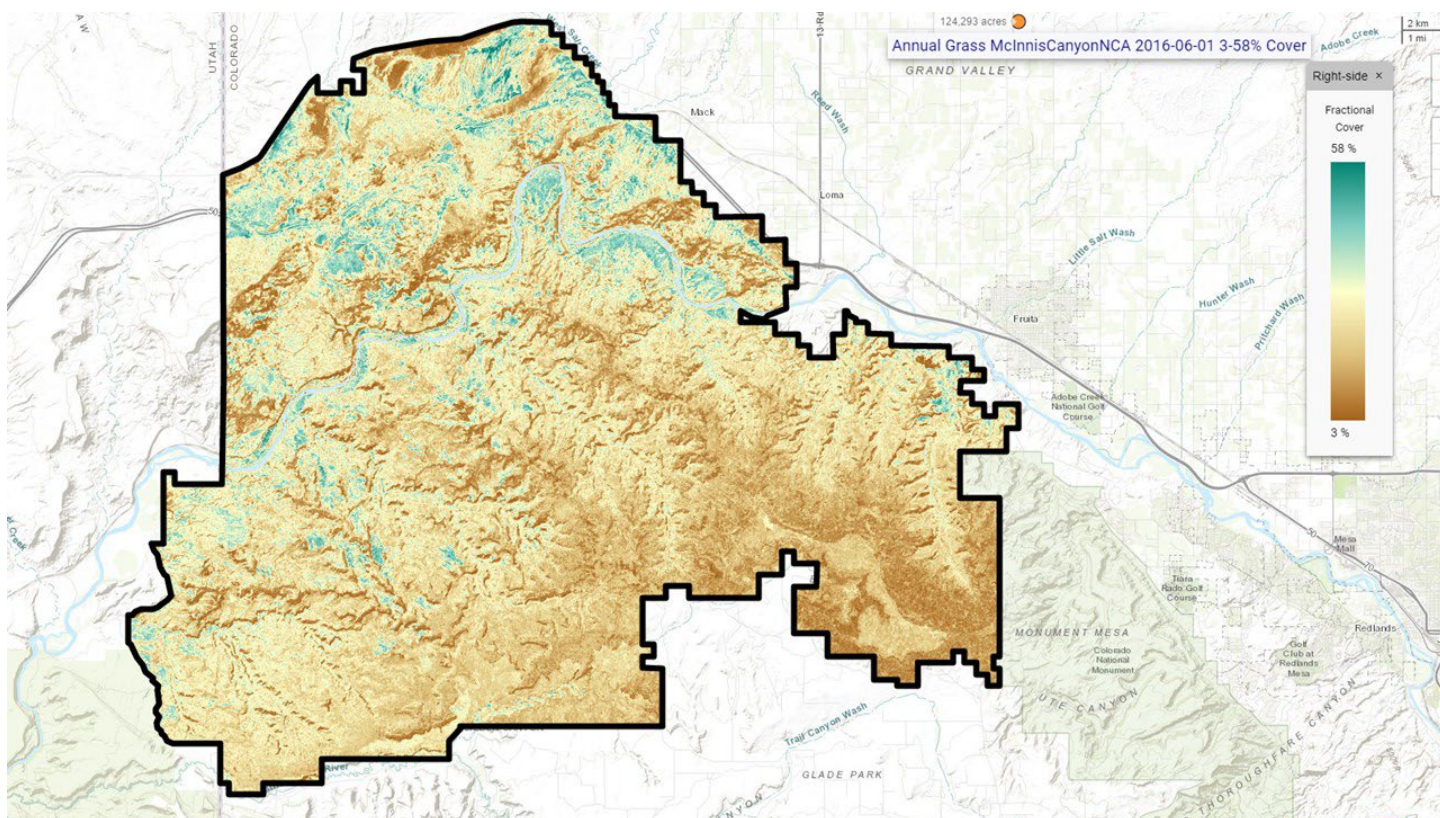


Figure 2b. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2016-06-01 to 2016-09-01 displayed over the default imagery base map. Percent Annual Grass cover ranges from 3% to 58%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

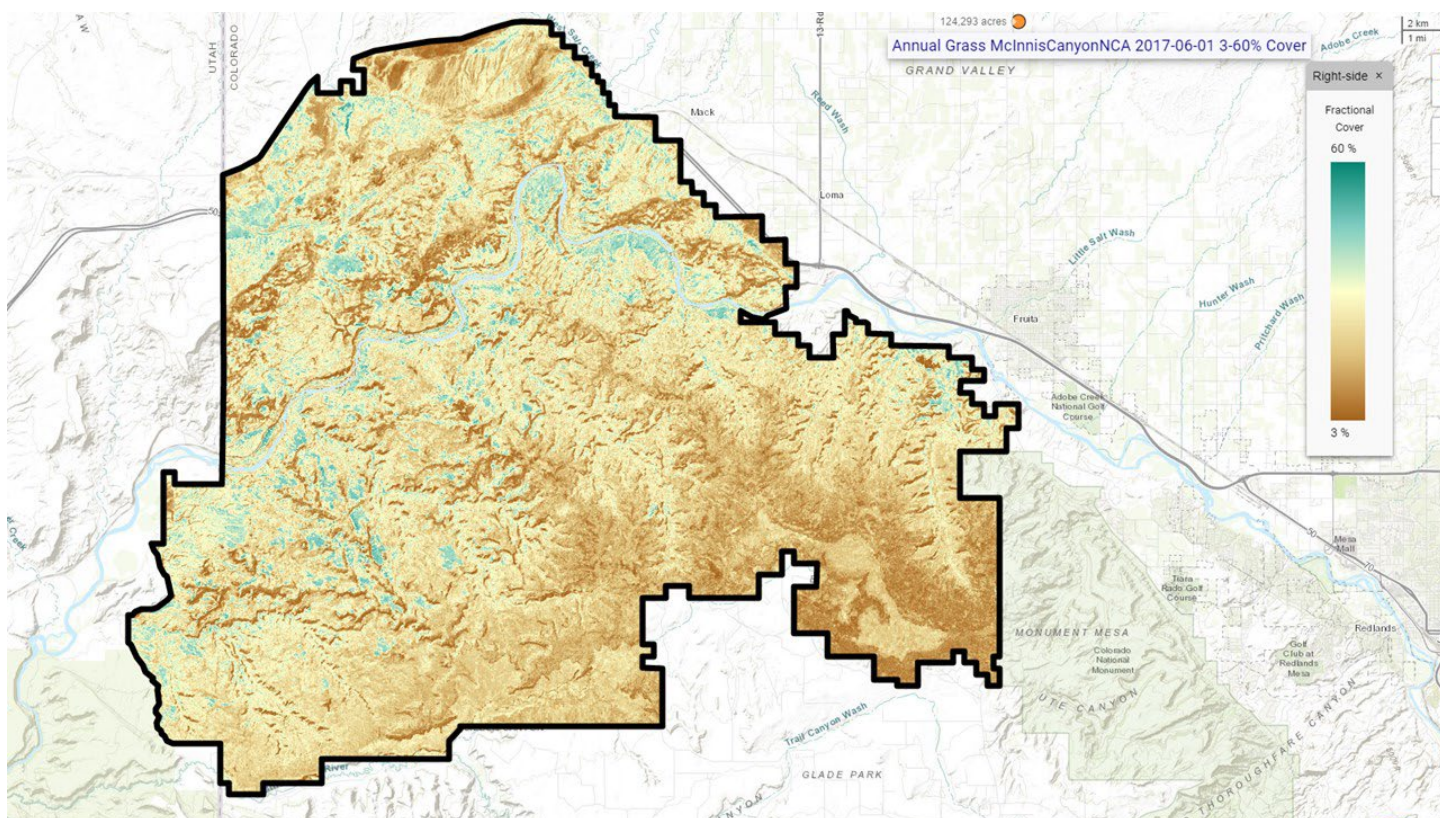


Figure 2c. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2017-06-01 to 2017-09-01 displayed over the default imagery base map. Percent Annual Grass cover ranges from 3% to 60%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

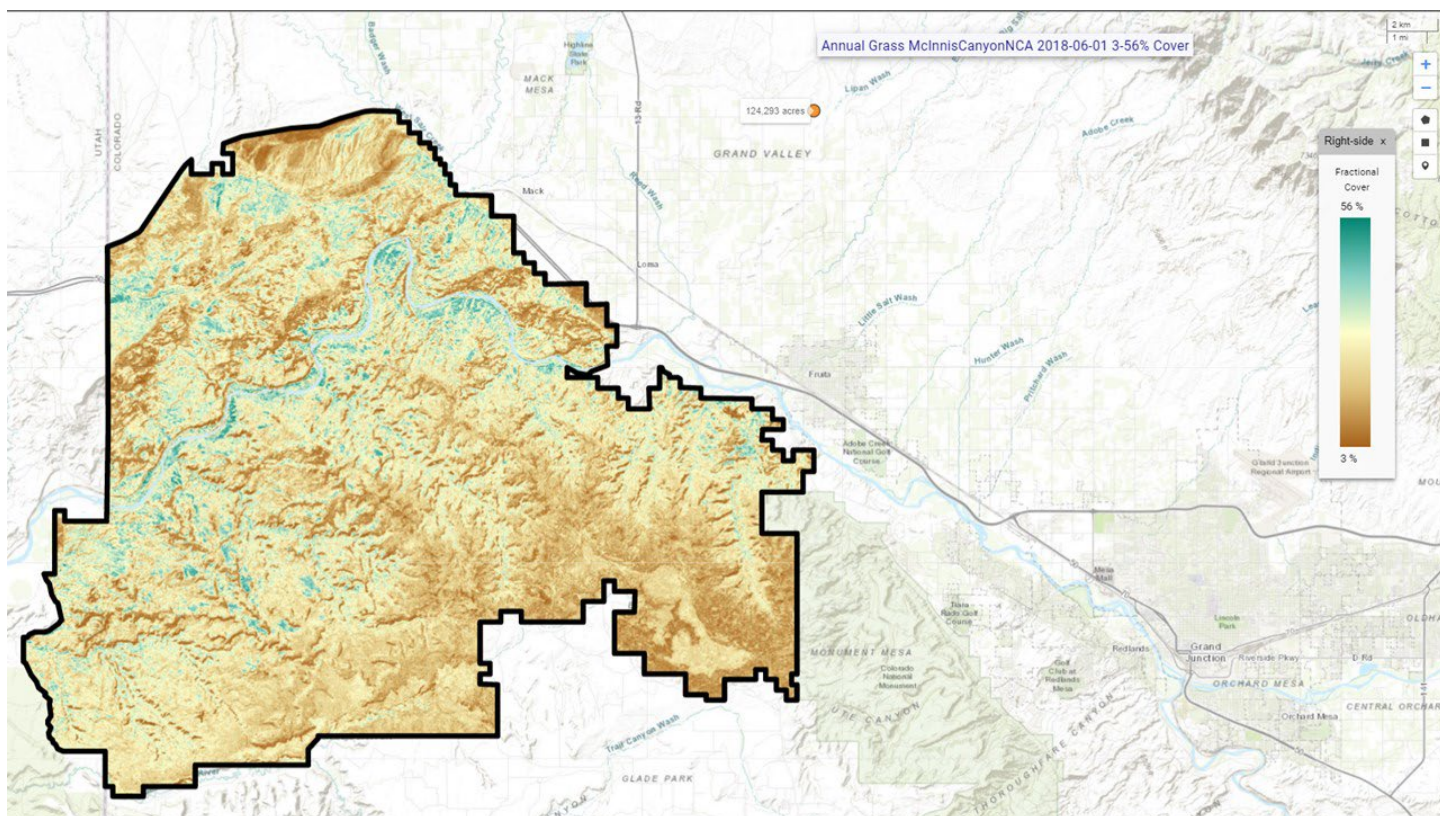


Figure 2d. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2018-06-01 to 2018-09-01 displayed over the default imagery base map. Percent Annual Grass cover ranges from 3% to 56%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

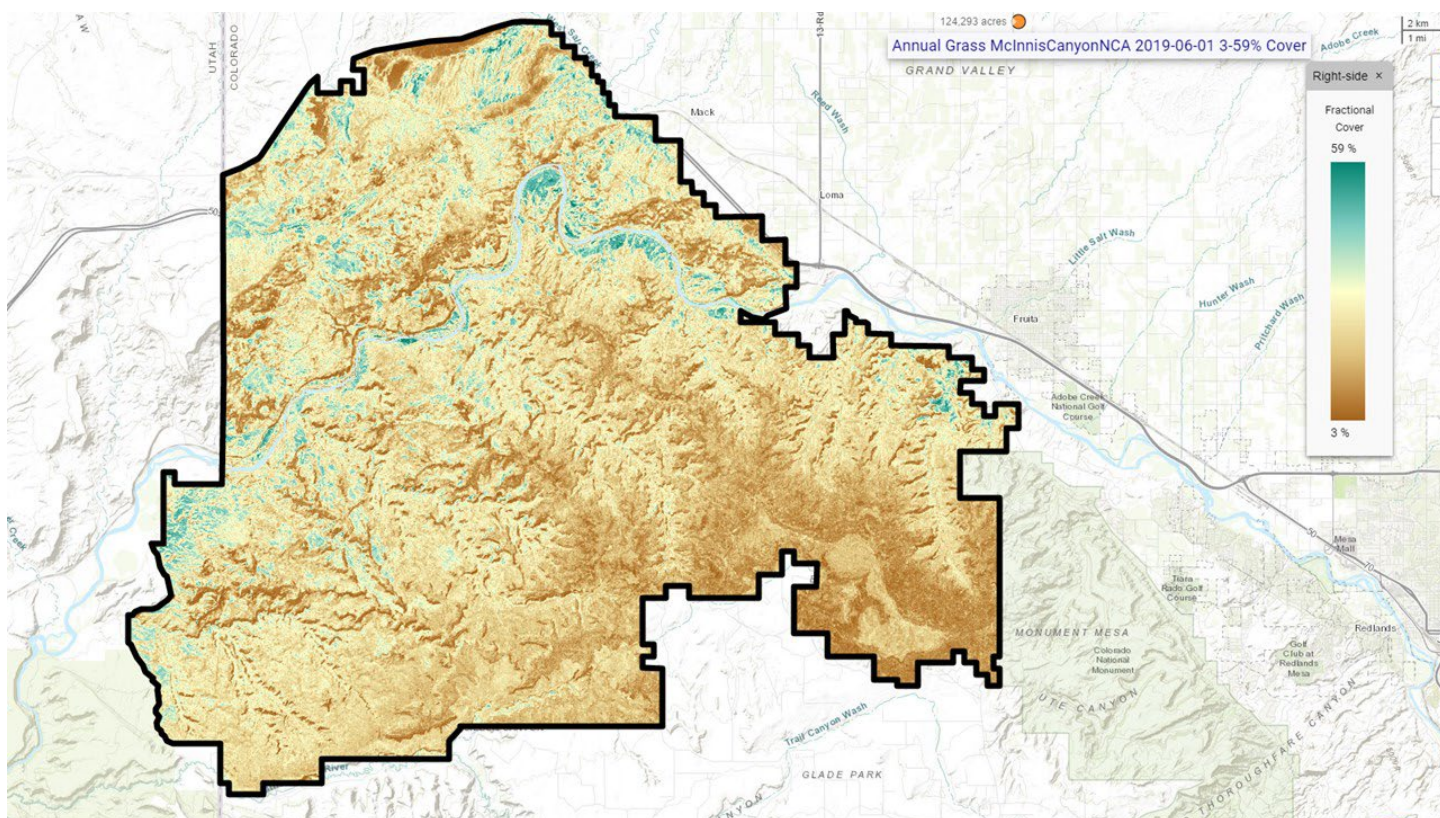


Figure 2e. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2019-06-01 to 2019-09-01 displayed over the default imagery base map. Percent Annual Grass cover ranges from 3 % to 59%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

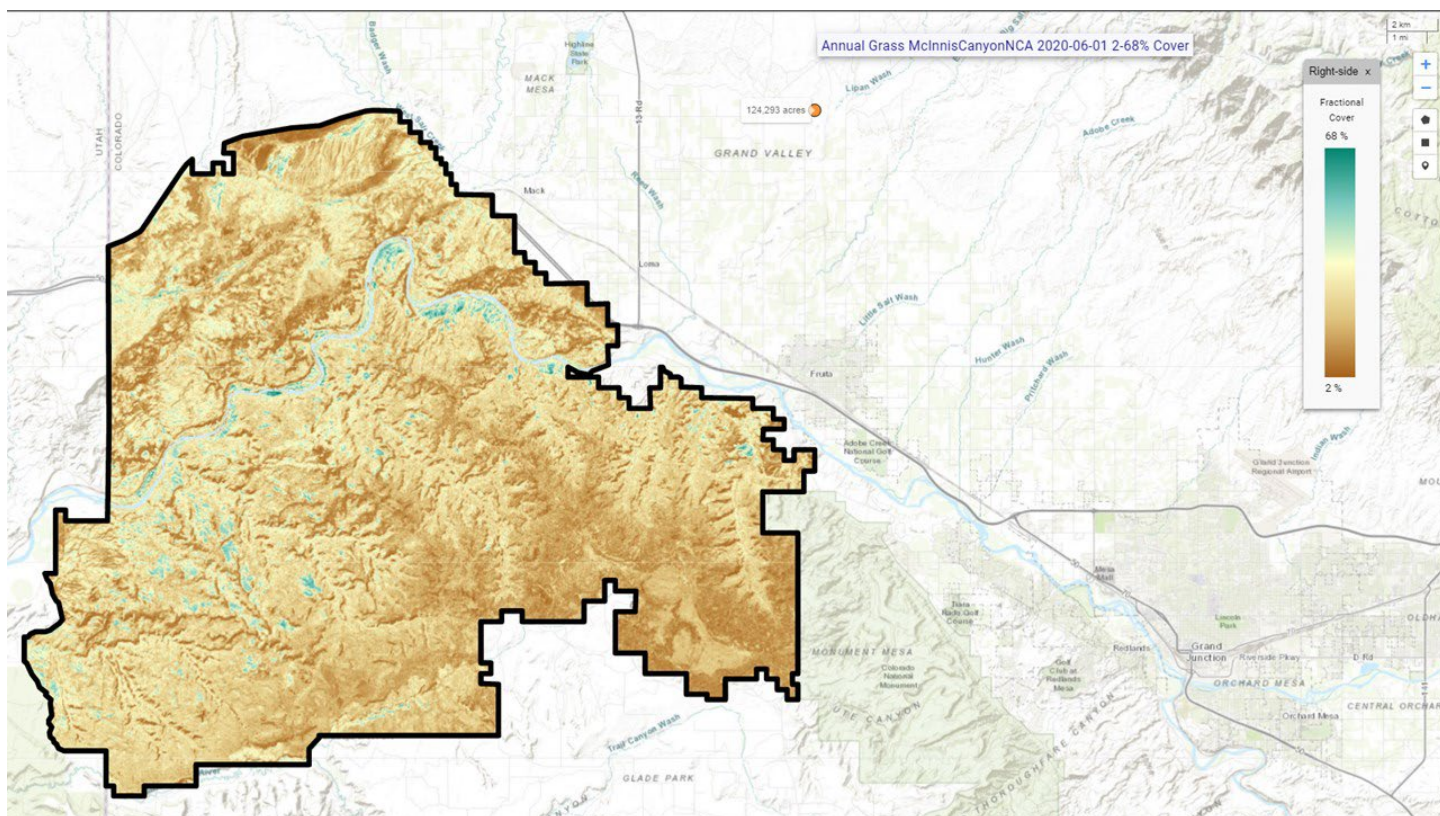


Figure 2f. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2020-06-01 to 2020-09-01 displayed over the default imagery base map. Percent Annual Grass cover ranges from 2% to 68%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

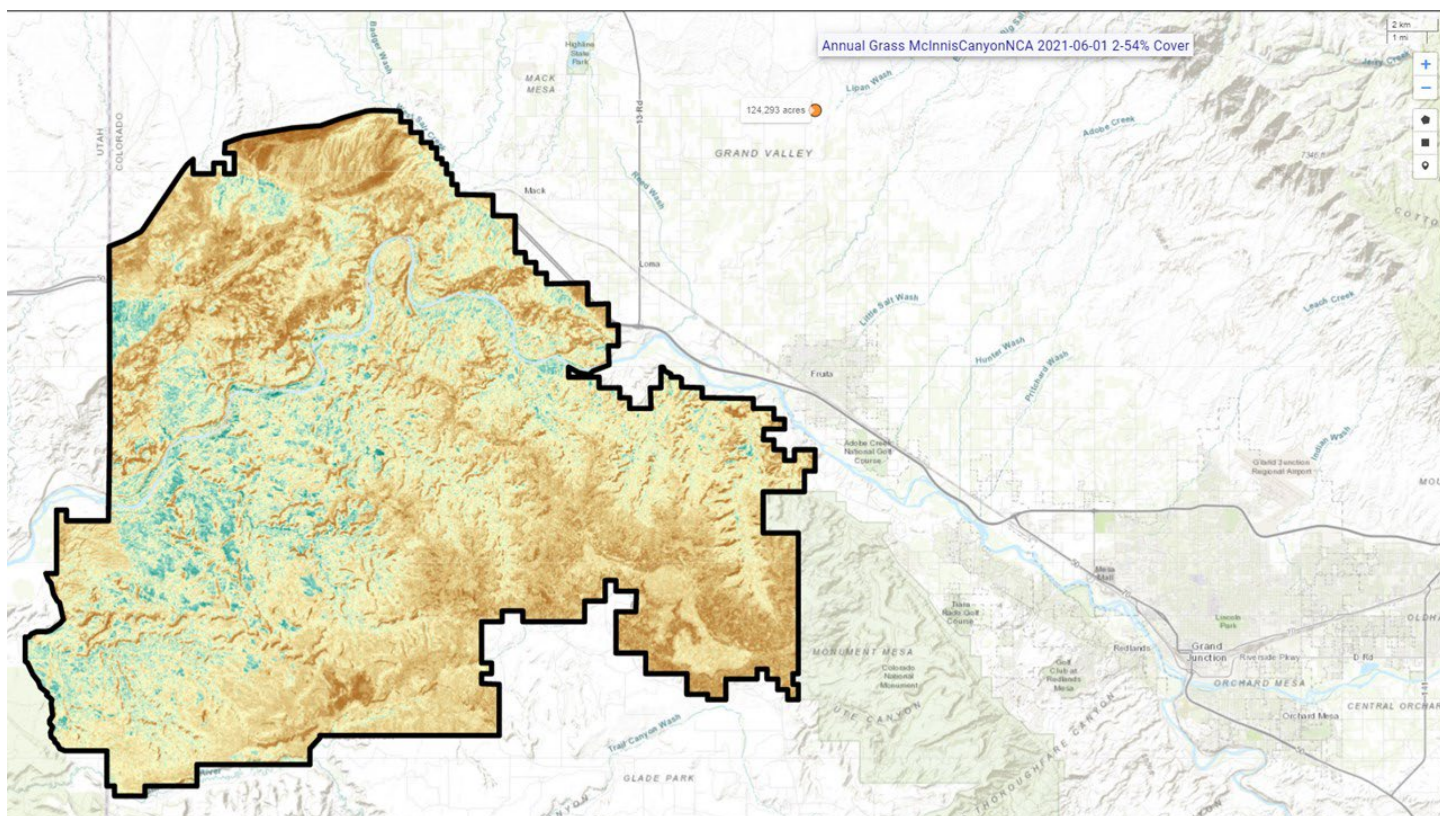


Figure 2g. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2021-06-01 to 2021-09-01 displayed over the default imagery base map. Percent Annual Grass cover ranges from 2% to 54%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Time Series Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

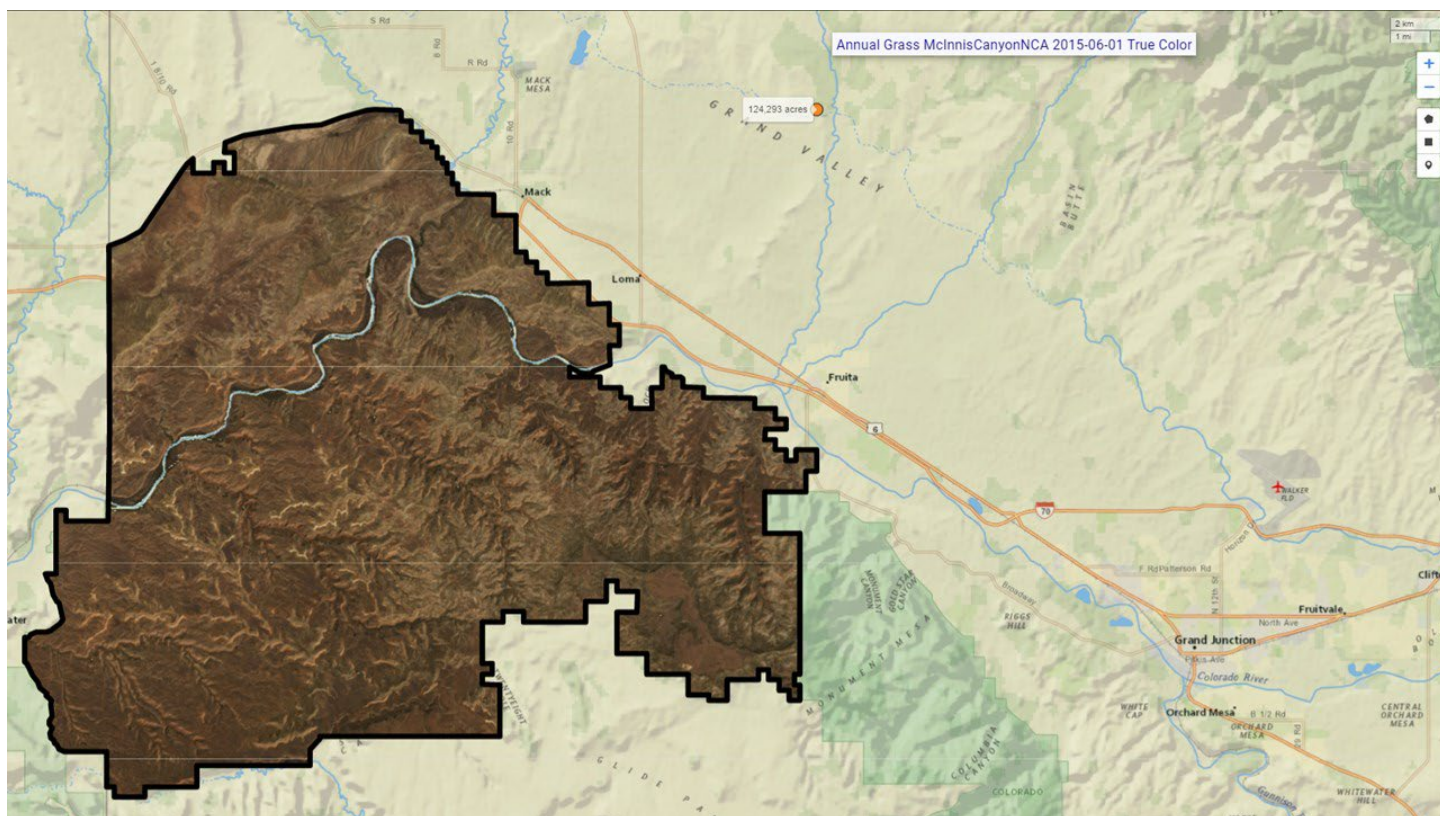


Figure 3a. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2015-06-01 to 2015-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20150626, LC08_035033_20150712, LC08_035033_20150728, LC08_035033_20150813, LC08_035033_20150829, LC08_036033_20150601, LC08_036033_20150617, LC08_036033_20150703, LC08_036033_20150804, LE07_035033_20150602, LE07_035033_20150618, LE07_035033_20150805, LE07_035033_20150821, LE07_036033_20150609, LE07_036033_20150625, LE07_036033_20150727, LE07_036033_20150828.

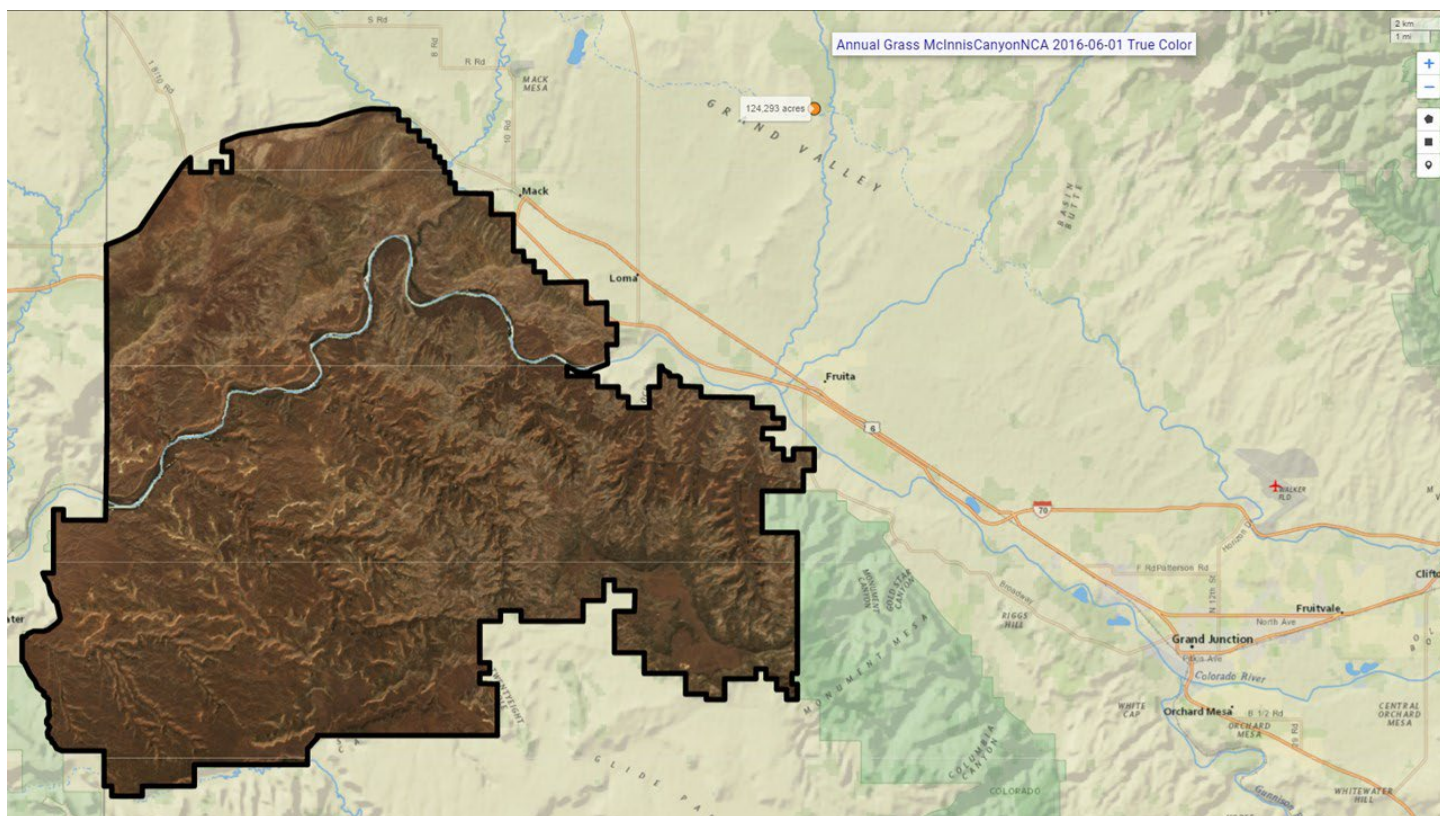


Figure 3b. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2016-06-01 to 2016-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20160628, LC08_035033_20160714, LC08_035033_20160815, LC08_035033_20160831, LC08_036033_20160603, LC08_036033_20160619, LC08_036033_20160705, LE07_035033_20160620, LE07_035033_20160706, LE07_035033_20160807, LE07_036033_20160627, LE07_036033_20160713, LE07_036033_20160729, LE07_036033_20160814, LE07_036033_20160830.

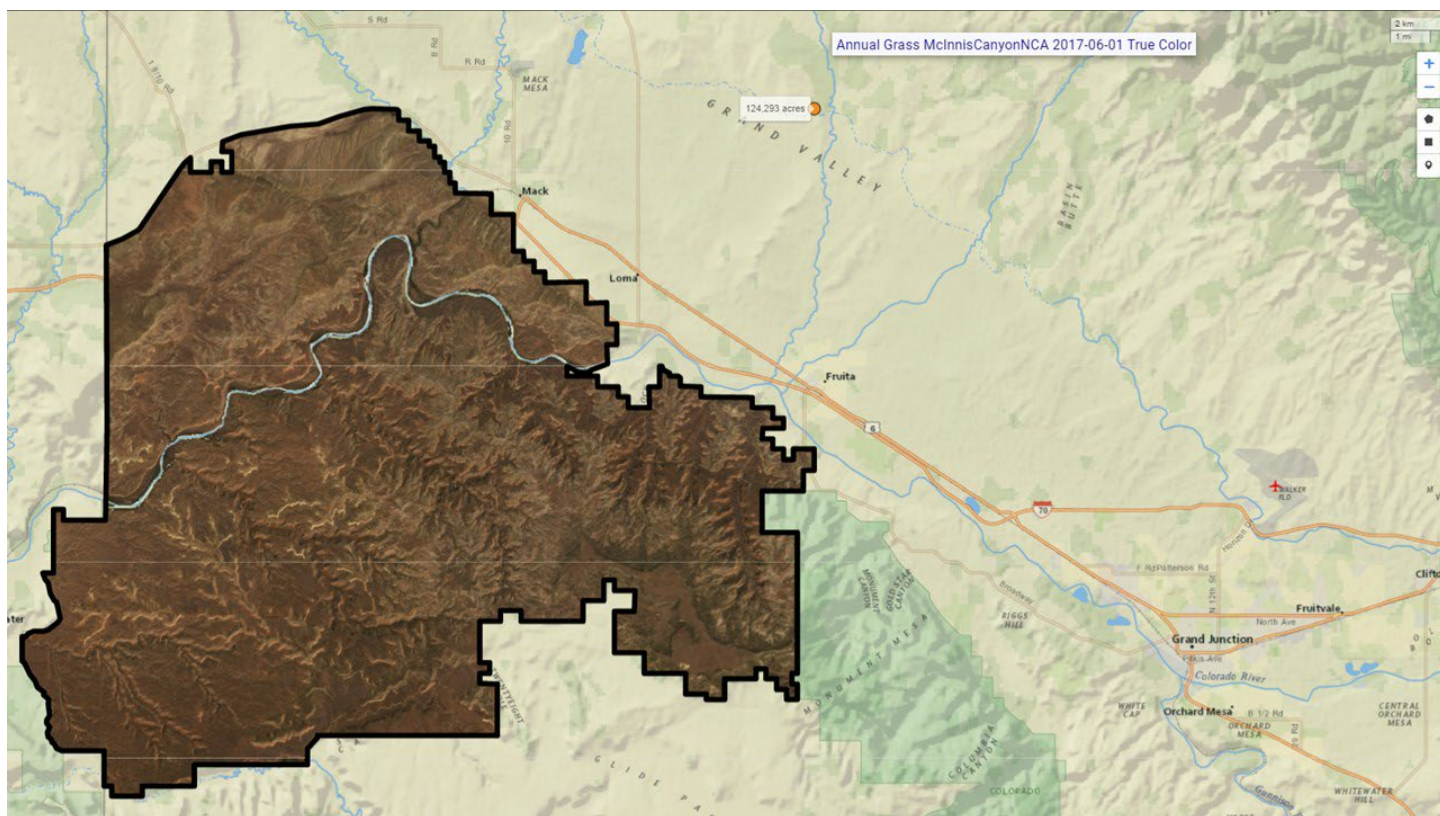


Figure 3c. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2017-06-01 to 2017-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20170615, LC08_035033_20170701, LC08_035033_20170717, LC08_035033_20170802, LC08_035033_20170818, LC08_036033_20170622, LC08_036033_20170708, LC08_036033_20170724, LC08_036033_20170809, LC08_036033_20170825, LE07_035033_20170607, LE07_035033_20170623, LE07_035033_20170709, LE07_035033_20170810, LE07_035033_20170826, LE07_036033_20170614, LE07_036033_20170630, LE07_036033_20170716, LE07_036033_20170801, LE07_036033_20170817.

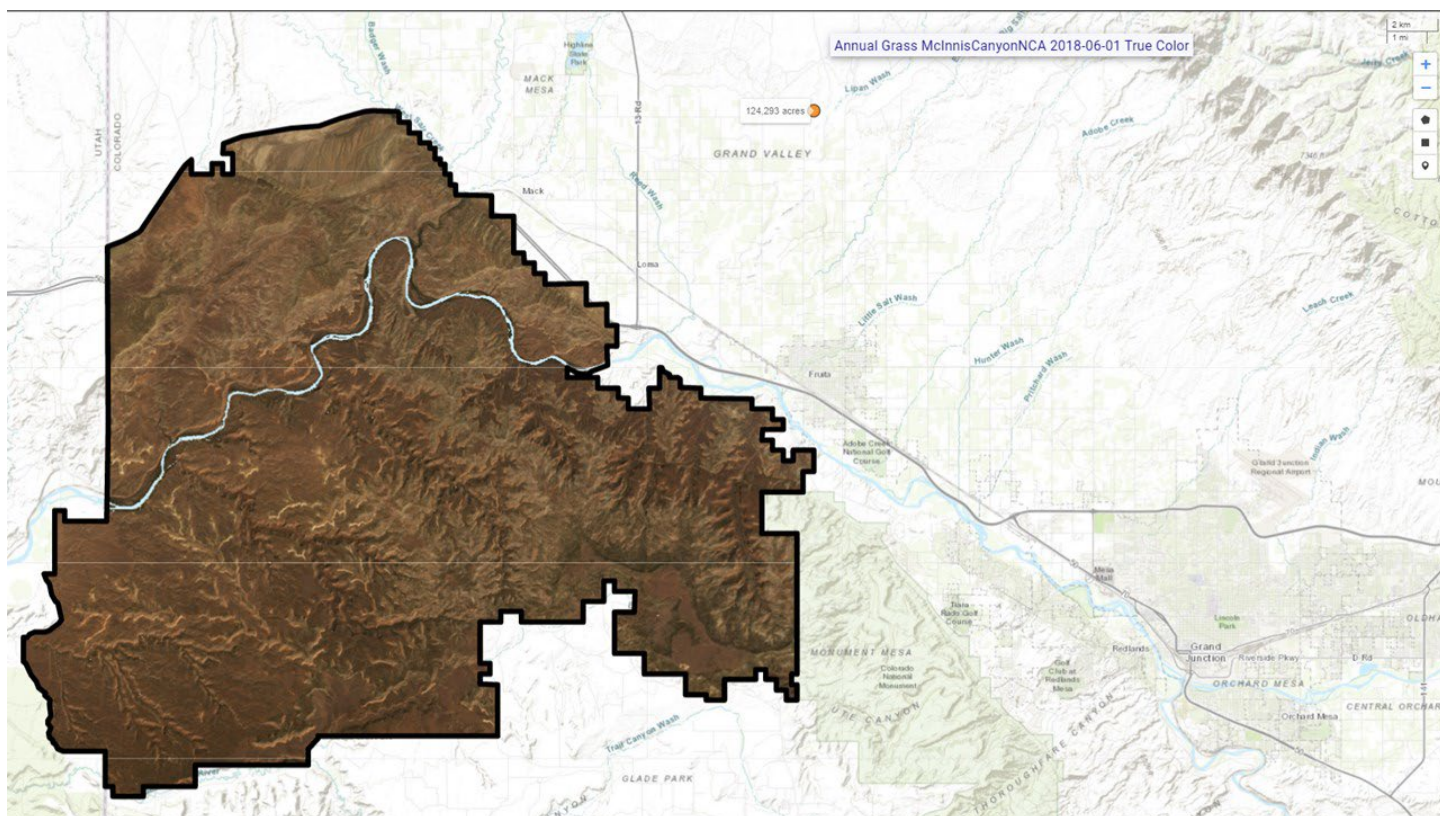


Figure 3d. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2018-06-01 to 2018-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_035033_20180602, LC08_035033_20180618, LC08_035033_20180704, LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829, LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804, LE07_036033_20180820.

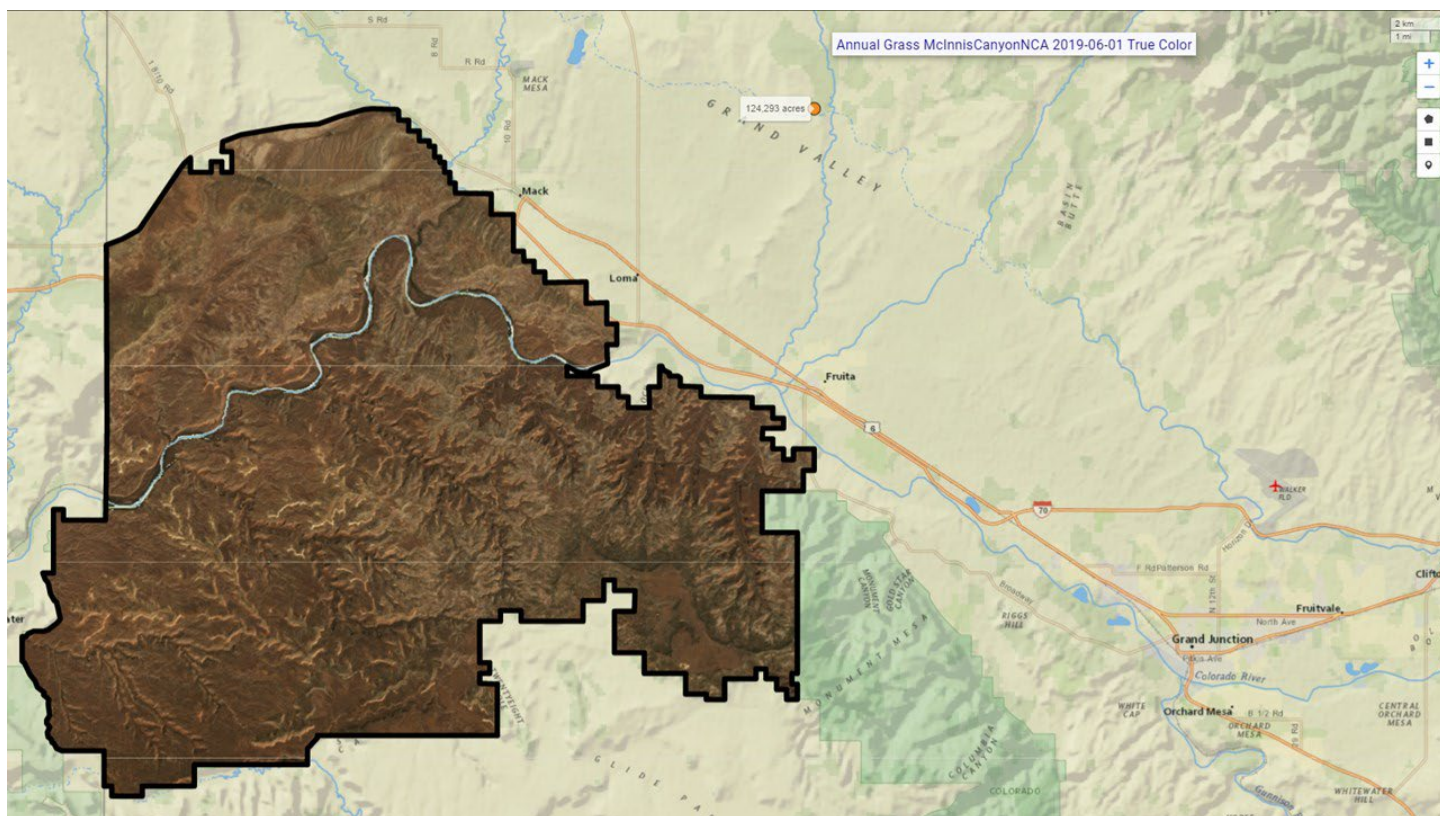


Figure 3e. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2019-06-01 to 2019-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20190723, LC08_036033_20190612, LC08_036033_20190628, LC08_036033_20190714, LC08_036033_20190815, LC08_036033_20190831, LE07_035033_20190613, LE07_035033_20190629, LE07_035033_20190816, LE07_036033_20190604, LE07_036033_20190620, LE07_036033_20190706, LE07_036033_20190722.

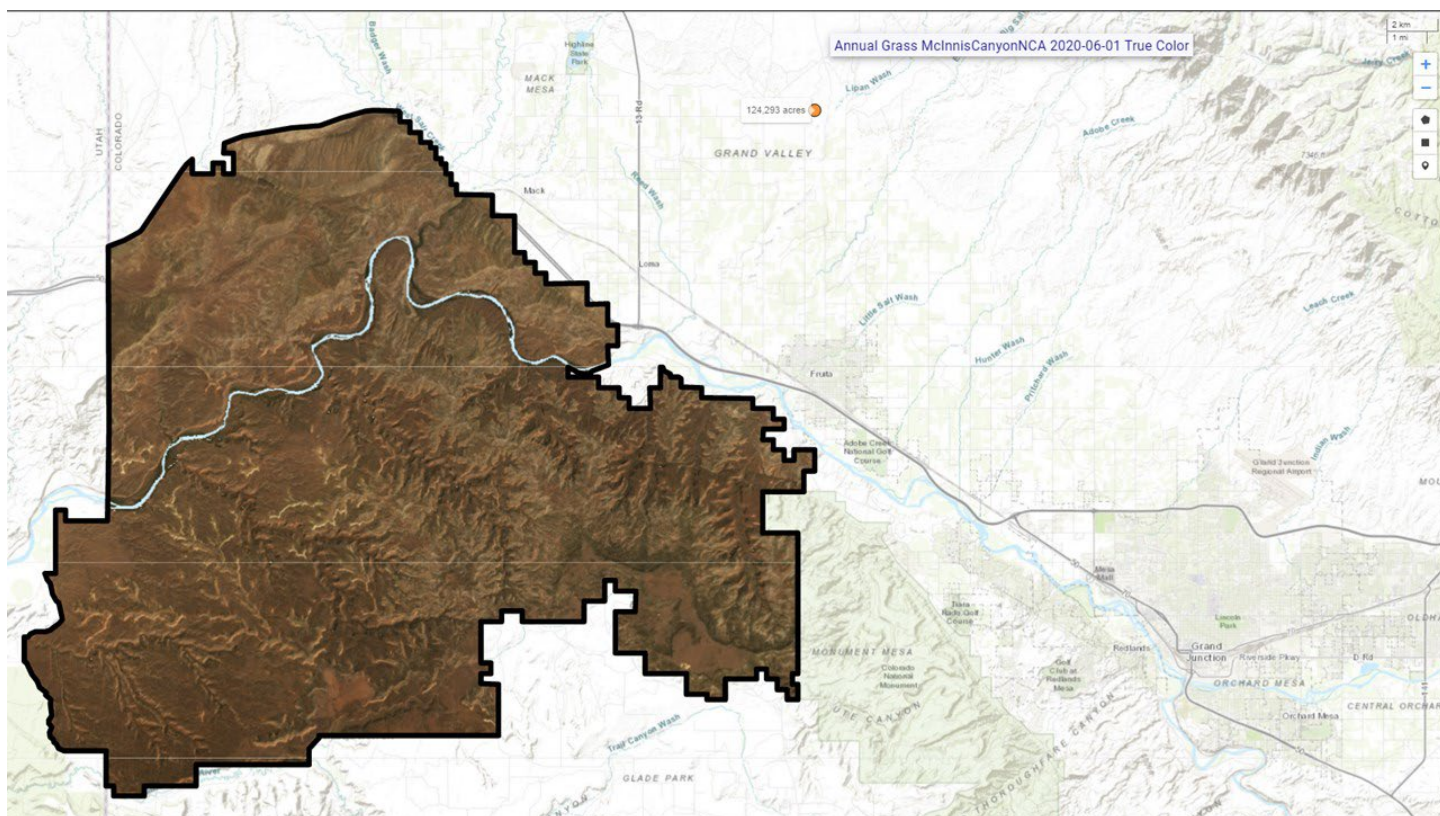


Figure 3f. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2020-06-01 to 2020-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20200623, LC08_035033_20200709, LC08_035033_20200810, LC08_035033_20200826, LC08_036033_20200614, LC08_036033_20200630, LC08_036033_20200801, LC08_036033_20200817, LE07_035033_20200615, LE07_035033_20200701, LE07_035033_20200717, LE07_035033_20200802, LE07_035033_20200818, LE07_036033_20200622, LE07_036033_20200708, LE07_036033_20200825.

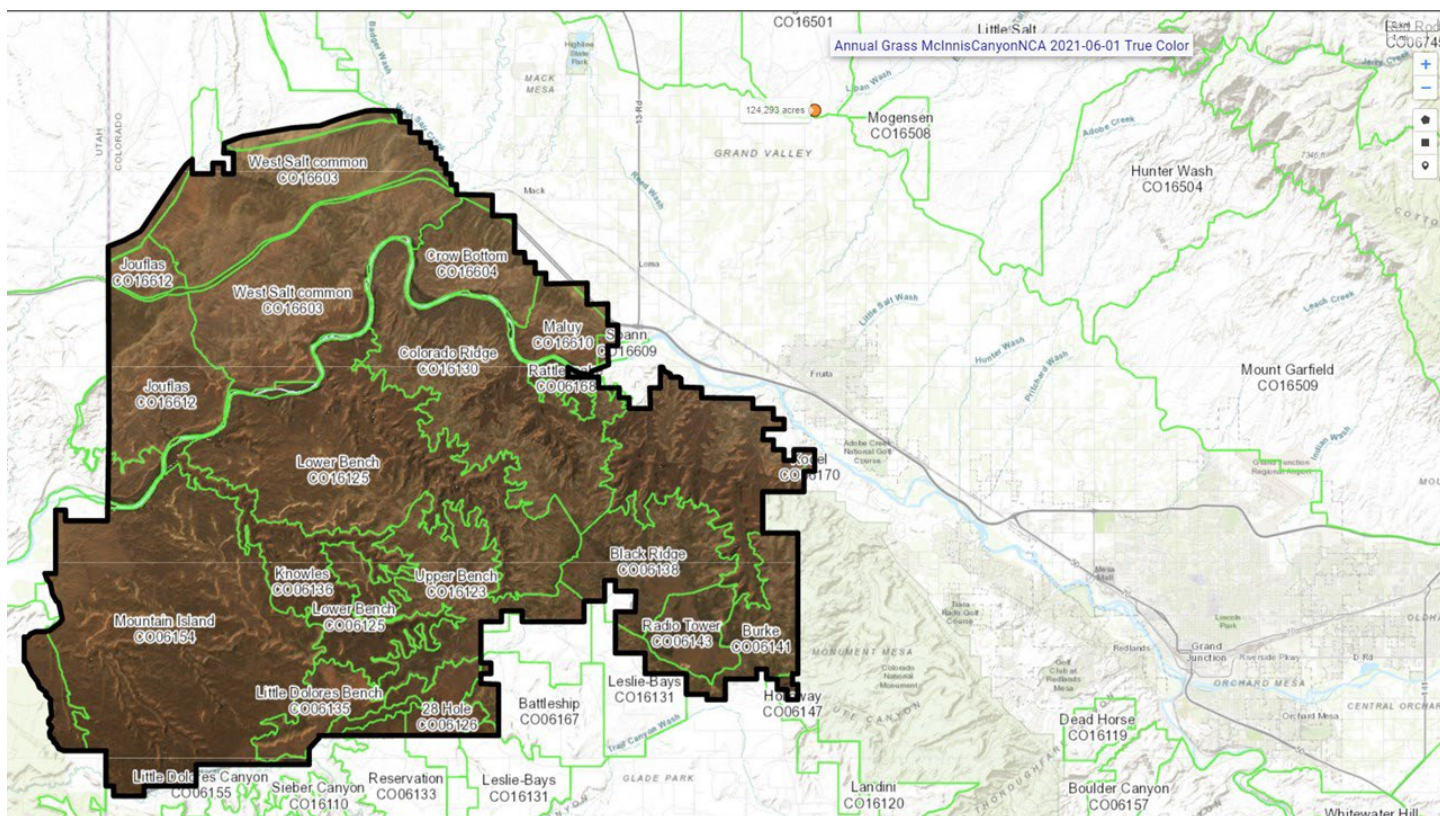


Figure 3g. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2021-06-01 to 2021-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20210712, LC08_035033_20210728, LC08_035033_20210813, LC08_035033_20210829, LC08_036033_20210617, LC08_036033_20210703, LC08_036033_20210719, LC08_036033_20210804, LC08_036033_20210820, LE07_035033_20210704, LE07_035033_20210720, LE07_035033_20210805, LE07_036033_20210711, LE07_036033_20210727, LE07_036033_20210812, LE07_036033_20210828.

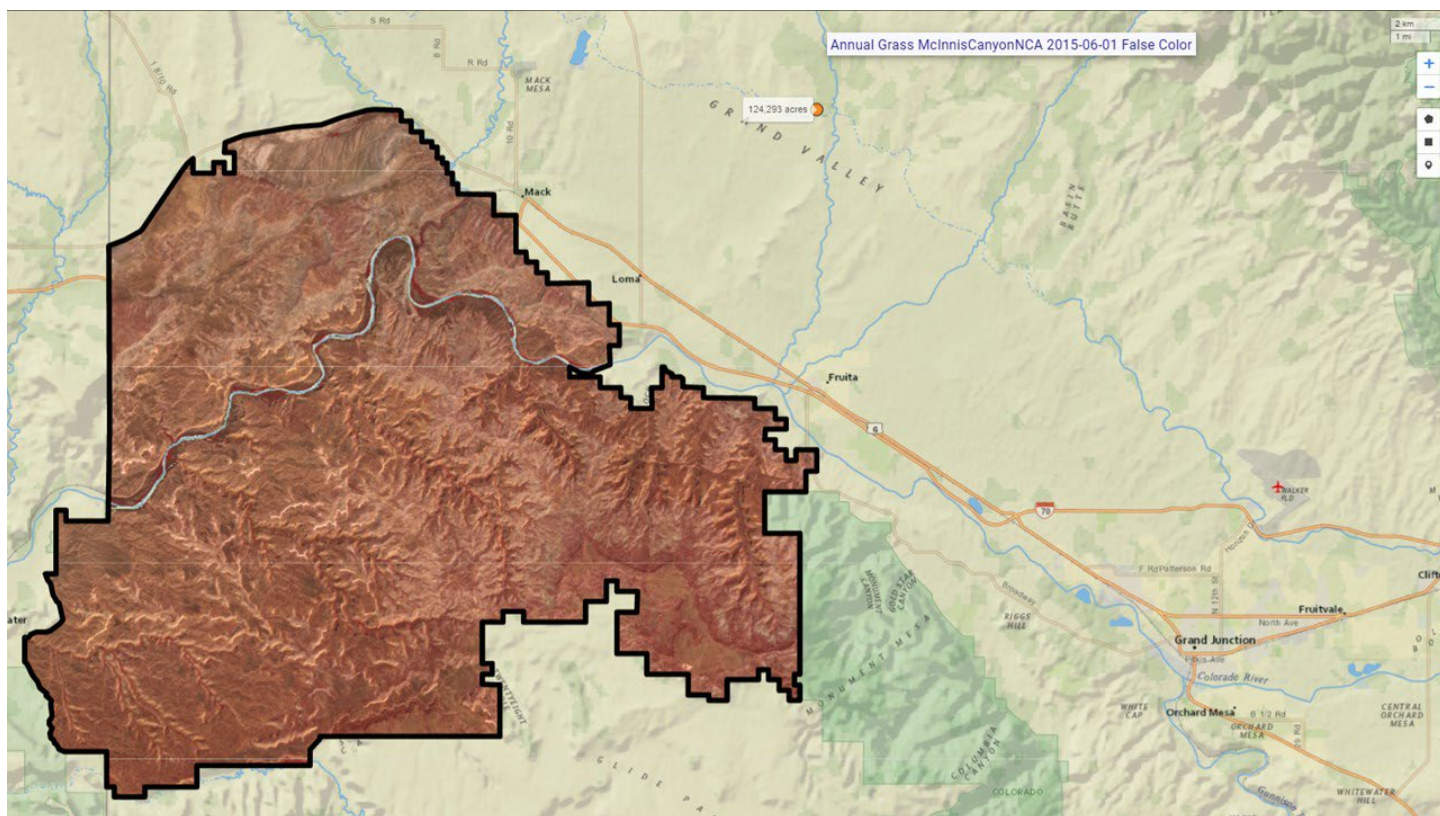


Figure 4a. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2015-06-01 to 2015-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20150626, LC08_035033_20150712, LC08_035033_20150728, LC08_035033_20150813, LC08_035033_20150829, LC08_036033_20150601, LC08_036033_20150617, LC08_036033_20150703, LC08_036033_20150804, LE07_035033_20150602, LE07_035033_20150618, LE07_035033_20150805, LE07_035033_20150821, LE07_036033_20150609, LE07_036033_20150625, LE07_036033_20150727, LE07_036033_20150828.

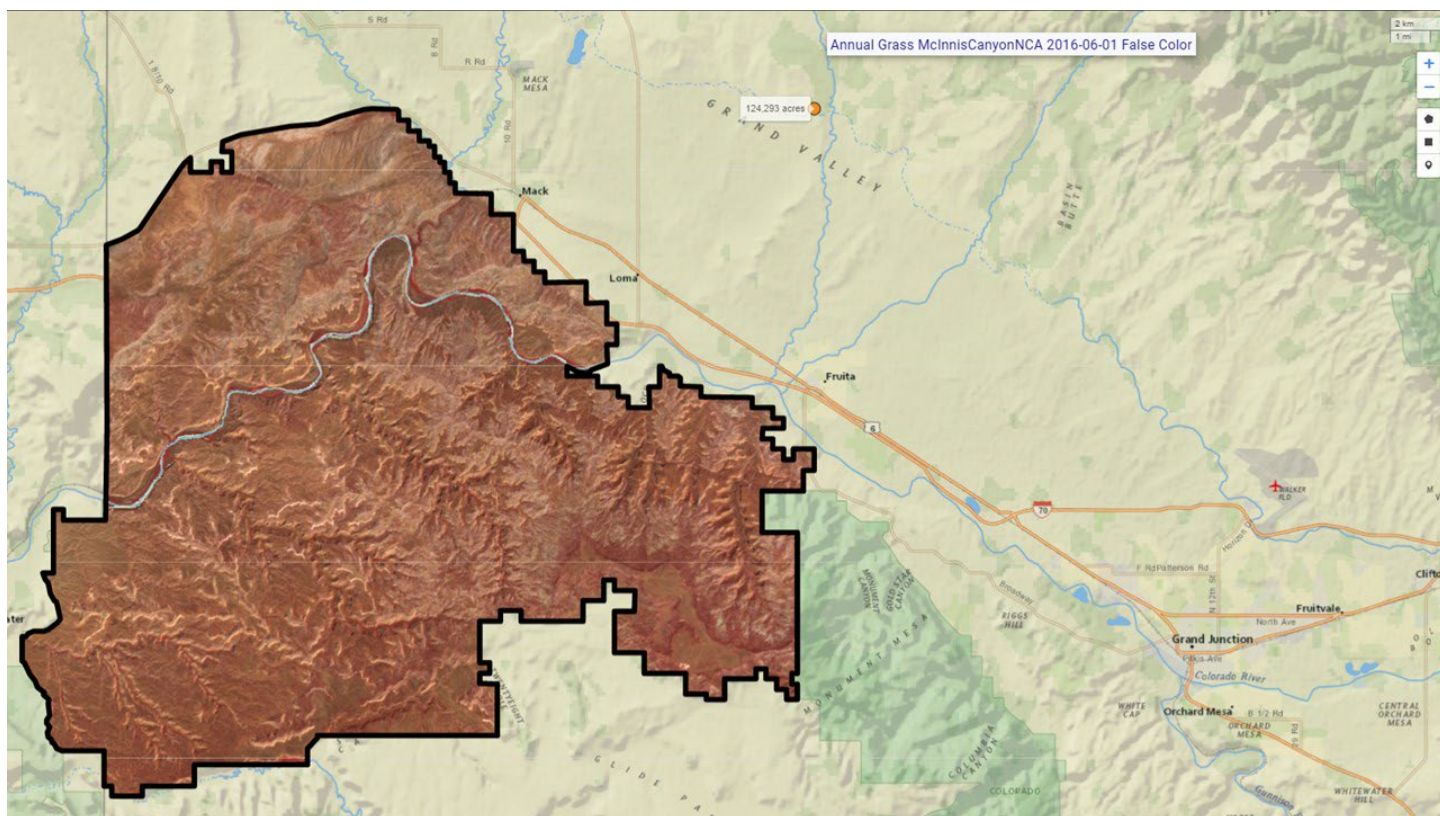


Figure 4b. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2016-06-01 to 2016-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20160628, LC08_035033_20160714, LC08_035033_20160815, LC08_035033_20160831, LC08_036033_20160603, LC08_036033_20160619, LC08_036033_20160705, LE07_035033_20160620, LE07_035033_20160706, LE07_035033_20160807, LE07_036033_20160627, LE07_036033_20160713, LE07_036033_20160729, LE07_036033_20160814, LE07_036033_20160830.

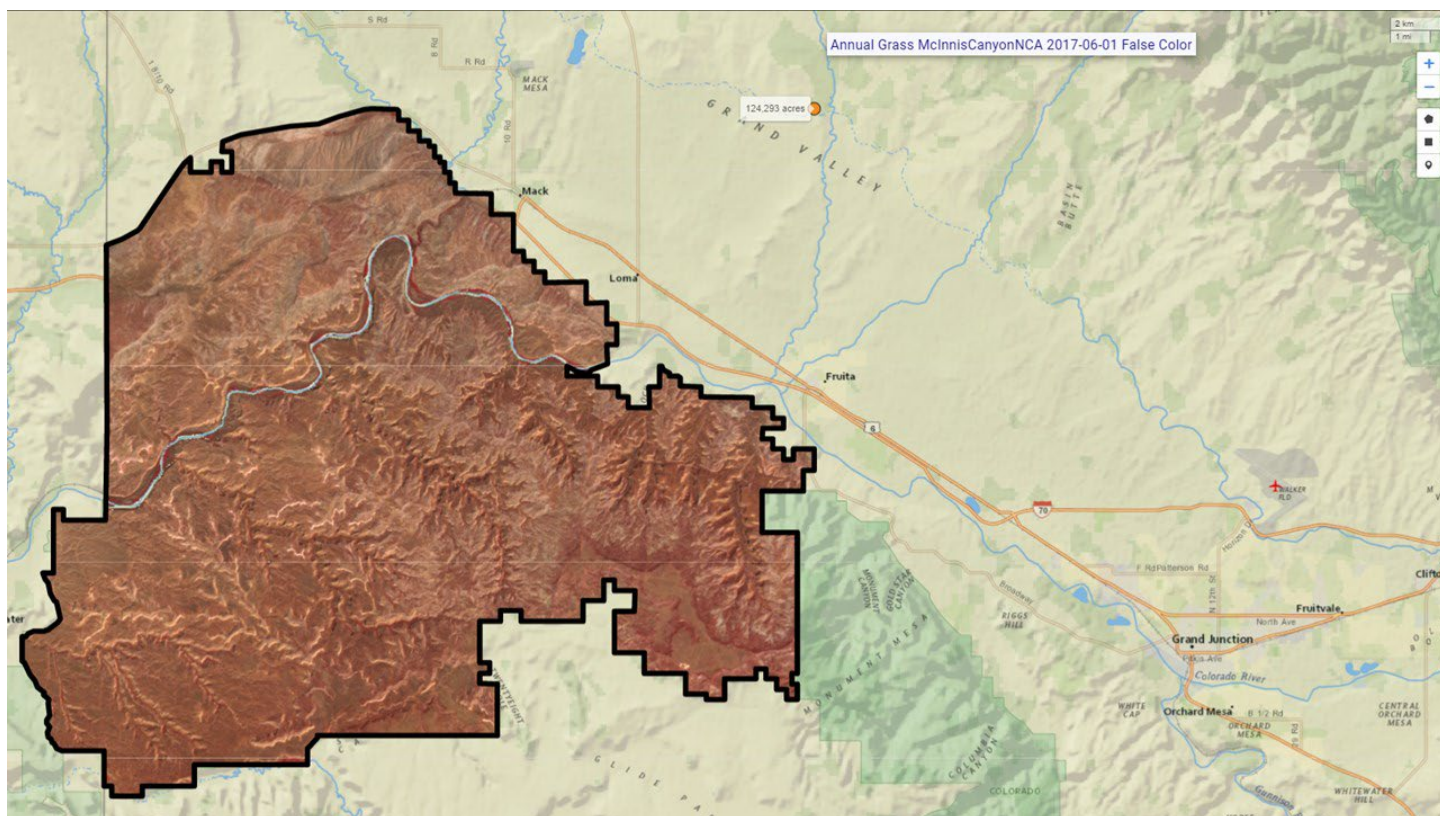


Figure 4c. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2017-06-01 to 2017-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20170615, LC08_035033_20170701, LC08_035033_20170717, LC08_035033_20170802, LC08_035033_20170818, LC08_036033_20170622, LC08_036033_20170708, LC08_036033_20170724, LC08_036033_20170809, LC08_036033_20170825, LE07_035033_20170607, LE07_035033_20170623, LE07_035033_20170709, LE07_035033_20170810, LE07_035033_20170826, LE07_036033_20170614, LE07_036033_20170630, LE07_036033_20170716, LE07_036033_20170801, LE07_036033_20170817.

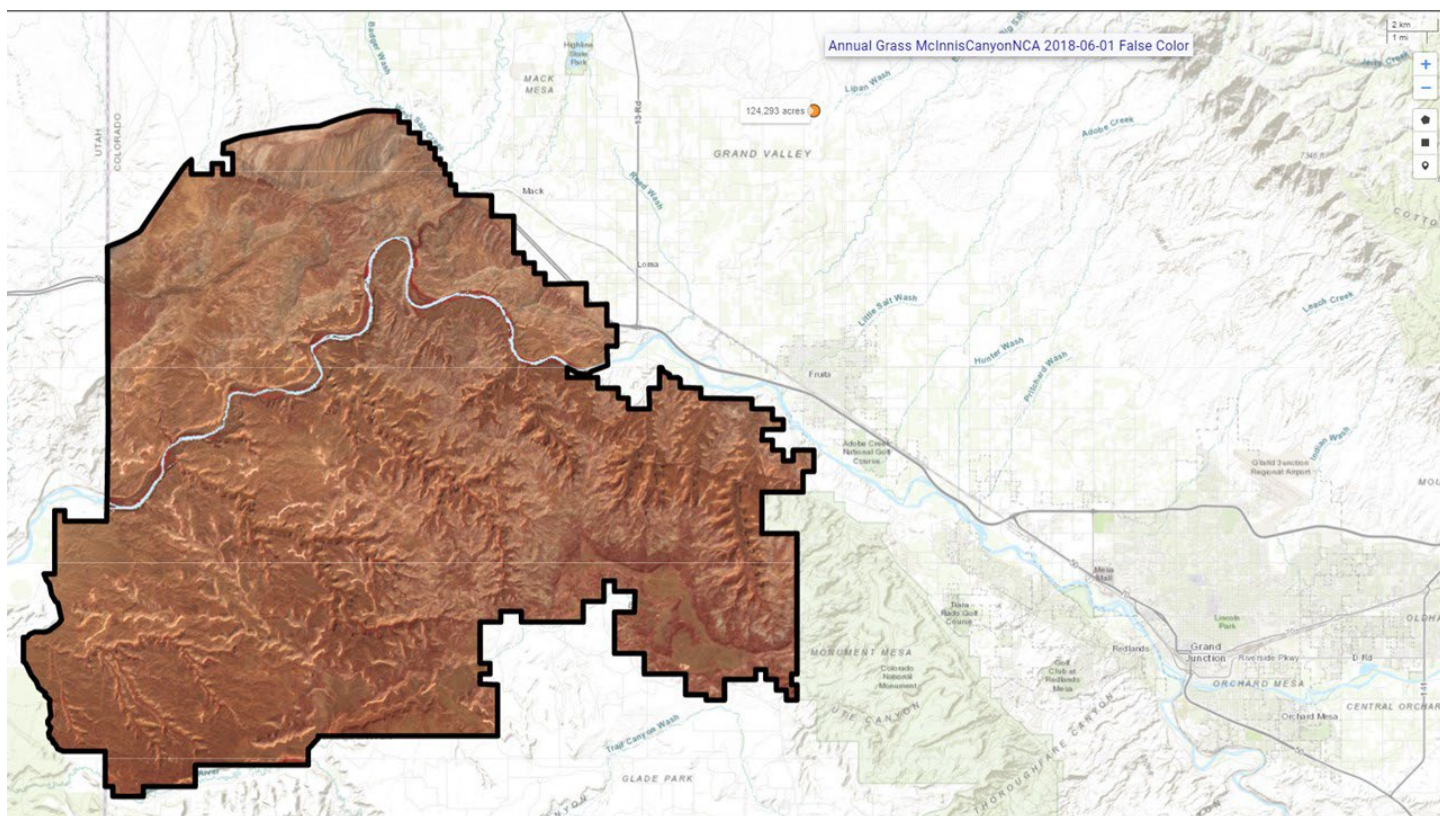


Figure 4d. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2018-06-01 to 2018-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_035033_20180602, LC08_035033_20180618, LC08_035033_20180704, LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829, LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804, LE07_036033_20180820.

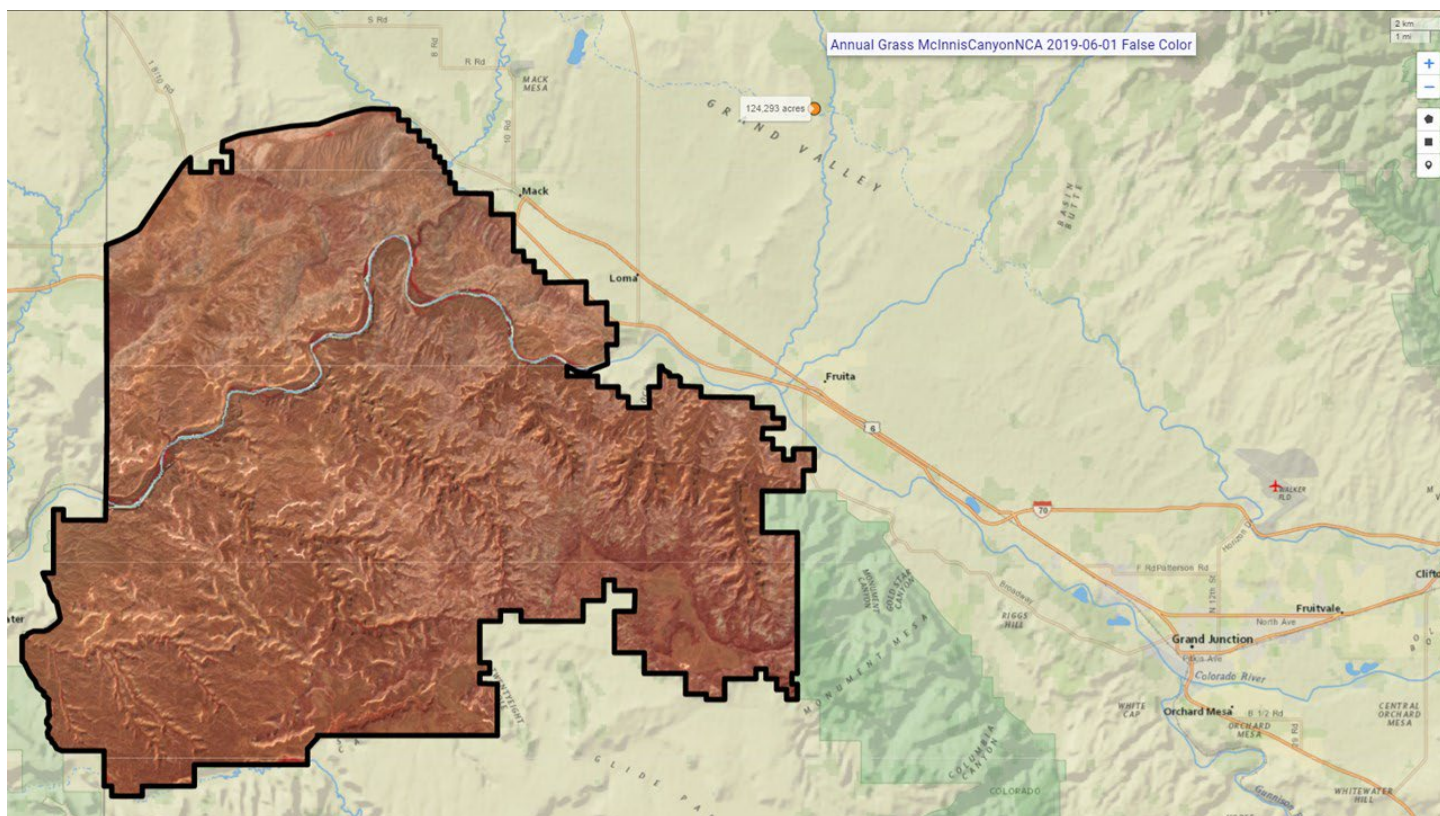


Figure 4e. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2019-06-01 to 2019-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20190723, LC08_036033_20190612, LC08_036033_20190628, LC08_036033_20190714, LC08_036033_20190815, LC08_036033_20190831, LE07_035033_20190613, LE07_035033_20190629, LE07_035033_20190816, LE07_036033_20190604, LE07_036033_20190620, LE07_036033_20190706, LE07_036033_20190722.

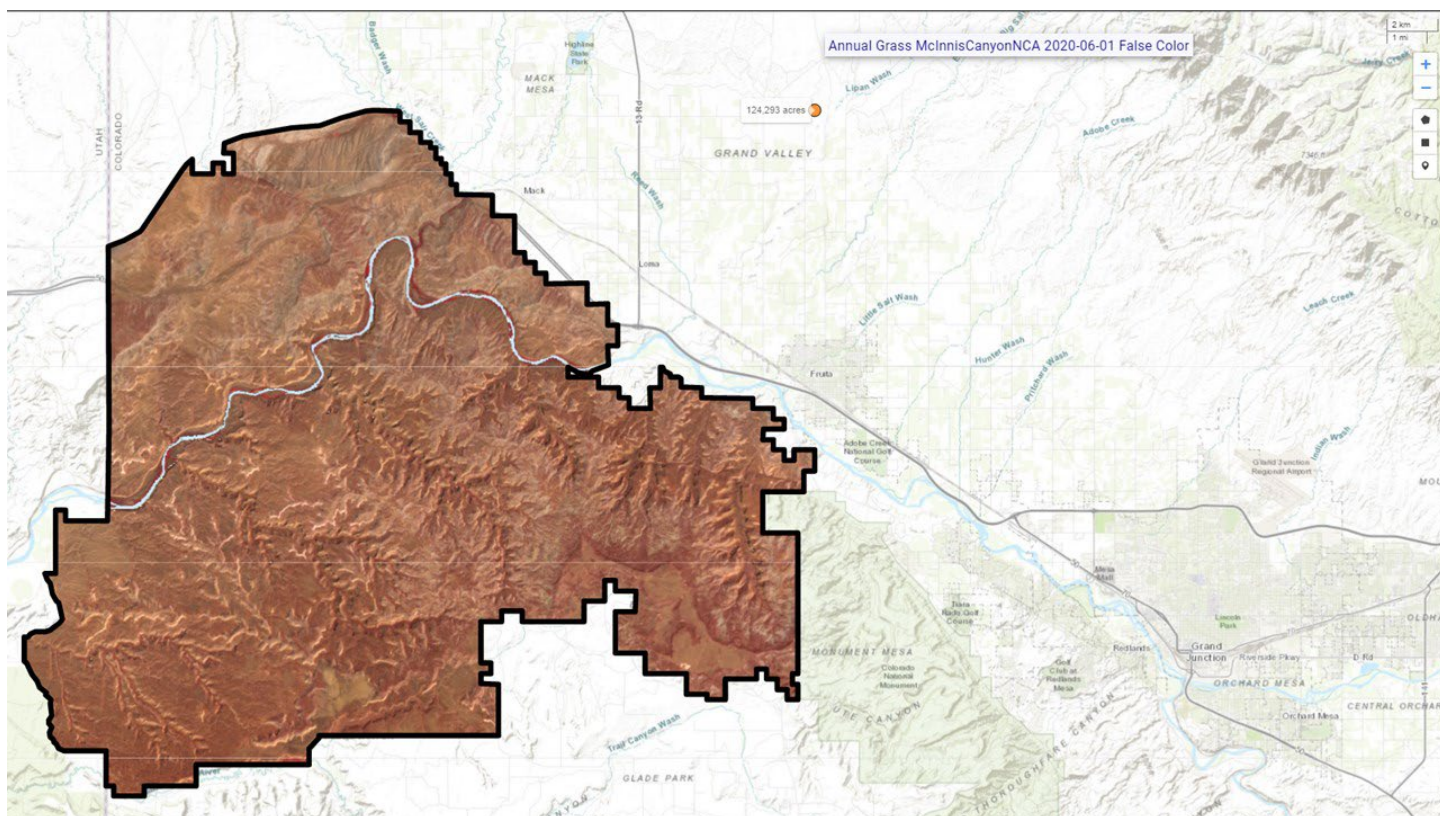


Figure 4f. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2020-06-01 to 2020-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20200623, LC08_035033_20200709, LC08_035033_20200810, LC08_035033_20200826, LC08_036033_20200614, LC08_036033_20200630, LC08_036033_20200801, LC08_036033_20200817, LE07_035033_20200615, LE07_035033_20200701, LE07_035033_20200717, LE07_035033_20200802, LE07_035033_20200818, LE07_036033_20200622, LE07_036033_20200708, LE07_036033_20200825.

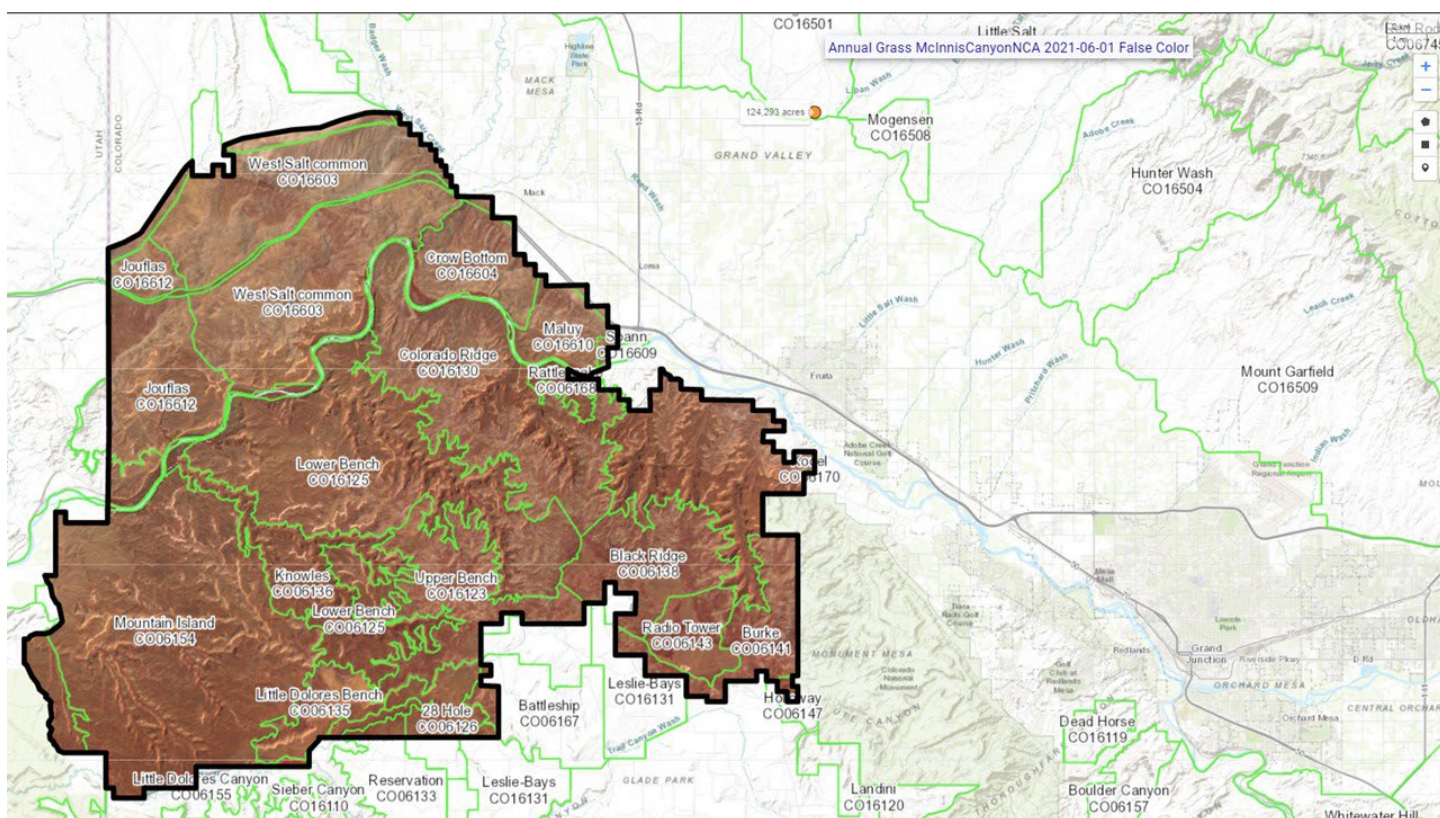


Figure 4g. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2021-06-01 to 2021-09-01 displayed over the default imagery base map. The LandCART Time Series Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_035033_20210712, LC08_035033_20210728, LC08_035033_20210813, LC08_035033_20210829, LC08_036033_20210617, LC08_036033_20210703, LC08_036033_20210719, LC08_036033_20210804, LC08_036033_20210820, LE07_035033_20210704, LE07_035033_20210720, LE07_035033_20210805, LE07_036033_20210711, LE07_036033_20210727, LE07_036033_20210812, LE07_036033_20210828.

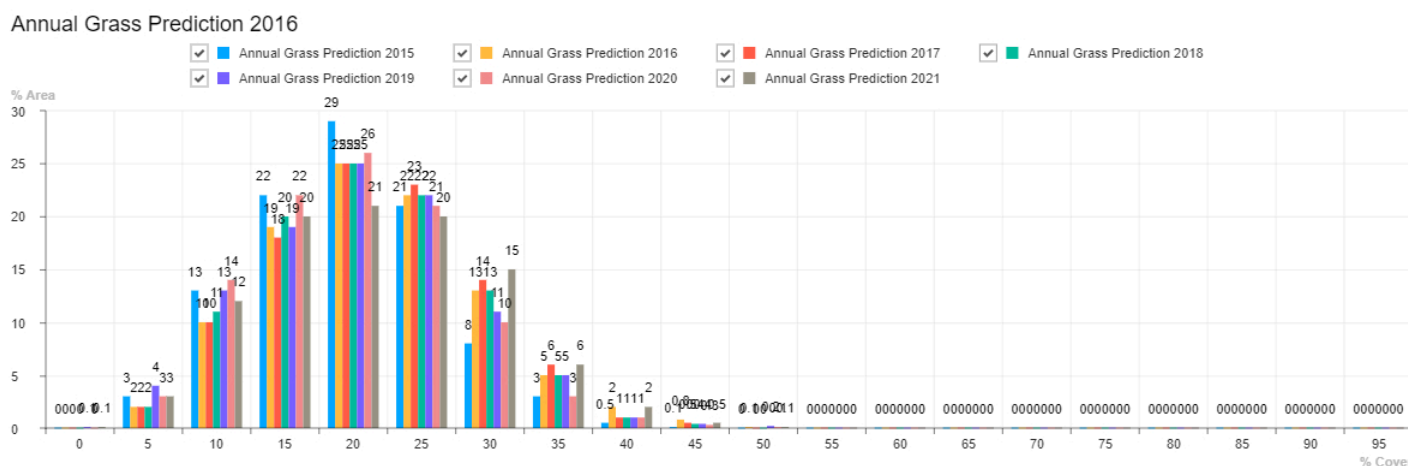


Figure 5. Histogram of LandCART Time Series Tool McInnis Canyons NCA Annual Grass percent cover from 2015, 2016,

2017, 2018, 2019, 2020, and 2021 by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ...,90-95%, 95-100%.

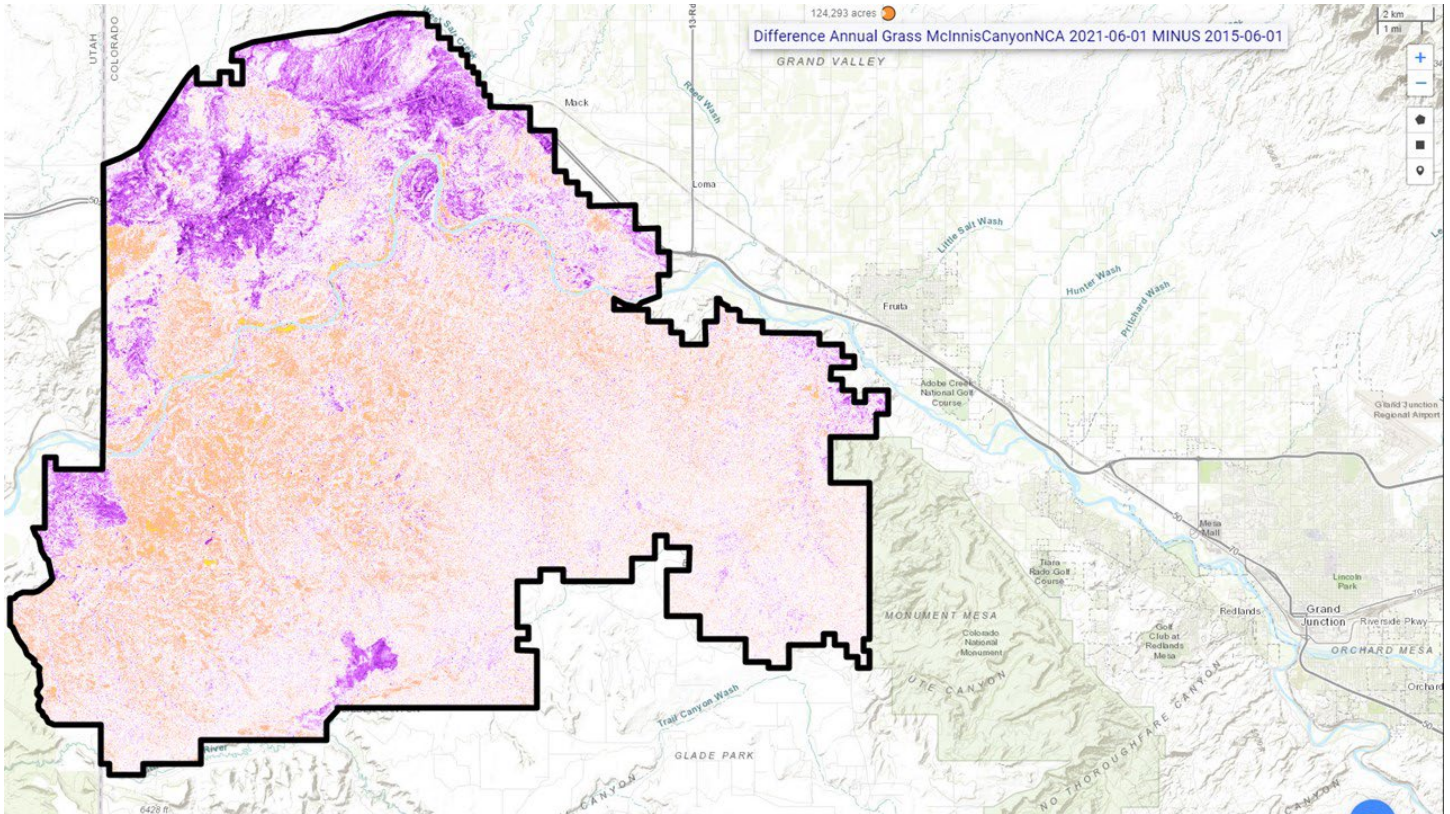


Figure 6. [LandCART Time Series Tool](#) McInnis Canyons NCA boundary (black line) with Annual Grass difference map from 2021 minus 2015 displayed over the default imagery base map. The LandCART Time Series Tool creates a difference image by subtracting predicted Annual Grass fractional cover 2015 from predicted Annual Grass fractional cover 2021. Positive values (yellow) indicate an increase from the earlier date to the later date and negative values (purple) indicate a decrease. No change is represented in white.

Difference Annual Grass McInnisCanyonNCA 2021-06-01 MINUS 2015-06-01

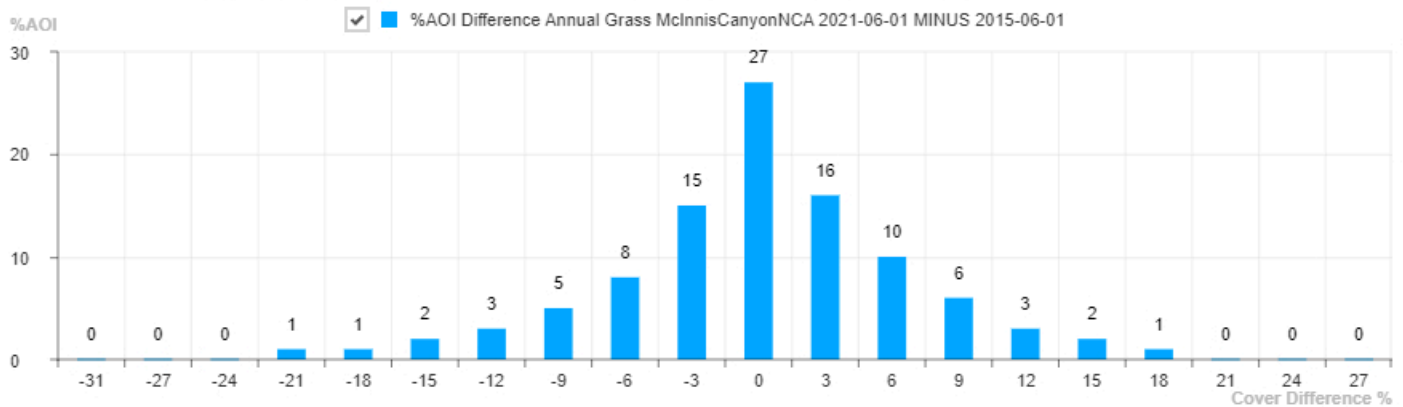


Figure 7. Difference histogram of [LandCART Time Series Tool](#) McInnis Canyons NCA Annual Grass percent cover 2021 minus 2015 by percent area.

Time Series Yearly Median Values

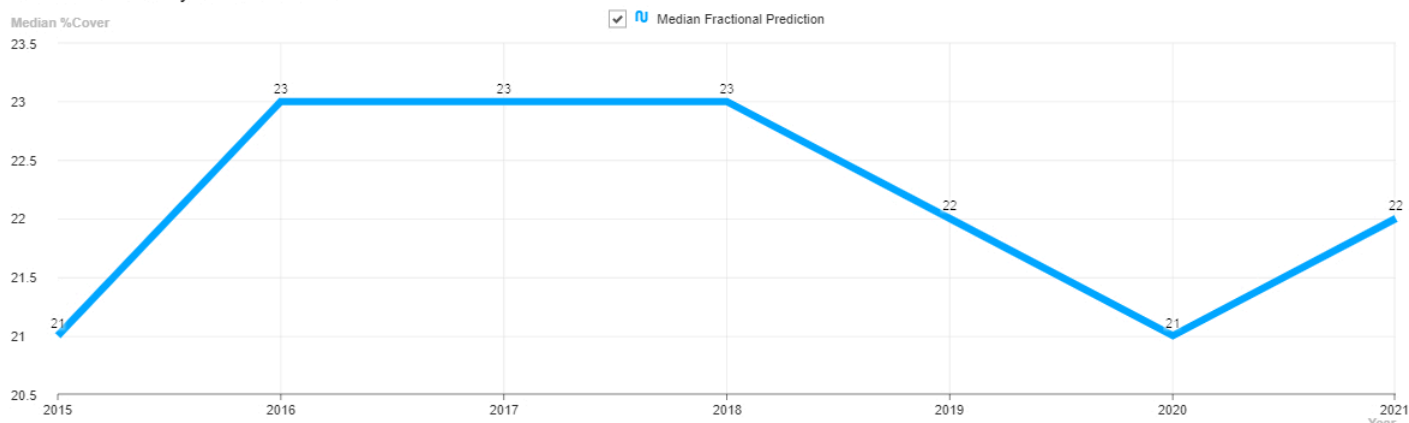


Figure 8. Time series plot of [LandCART Time Series Tool](#) McInnis Canyons NCA Annual Grass median percent cover from 2015 to 2021.

Table 1. Histogram values of [LandCART Time Series Tool](#) McInnis Canyons NCA Annual Grass percent cover from 2015-06-01 to 2015-09-01, 2016-06-01 to 2016-09-01, 2017-06-01 to 2017-09-01, 2018-06-01 to 2018-09-01, 2019-06-01 to 2019-09-01, 2020-06-01 to 2020-09-01, and 2021-06-01 to 2021-09-01 by percent area. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

	%Cover	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
<u>Annual Grass 2015</u>	%Area	0	3	13	22	29	21	8	3	0.4	0.1	0	0	0	0	0	0	0	0	0	0
<u>Annual Grass 2016</u>	%Area	0	2	11	19	25	22	12	5	2	0.8	0.1	0	0	0	0	0	0	0	0	0
<u>Annual Grass 2017</u>	%Area	0	2	10	18	25	23	14	5	1	0.5	0	0	0	0	0	0	0	0	0	0
<u>Annual Grass 2018</u>	%Area	0	3	13	22	29	21	8	3	0.4	0.1	0	0	0	0	0	0	0	0	0	0
<u>Annual Grass 2019</u>	%Area	0	4	13	19	25	22	11	5	1	0.4	0.2	0	0	0	0	0	0	0	0	0
<u>Annual Grass 2020</u>	%Area	0	3	14	22	26	21	10	3	1	0.3	0.1	0	0	0	0	0	0	0	0	0
<u>Annual Grass 2021</u>	%Area	0.1	3	13	20	22	20	14	6	2	0.5	0.1	0	0	0	0	0	0	0	0	0

Table 2. LandCART Time Series Tool McInnis Canyons NCA summary statistics for Annual Grass percent cover from 2015-06-01 to 2015-09-01, 2016-06-01 to 2016-09-01, 2017-06-01 to 2017-09-01, 2018-06-01 to 2018-09-01, 2019-06-01 to 2019-09-01, 2020-06-01 to 2020-09-01, and 2021-06-01 to 2021-09-01.

Annual Grass McInnisCanyonNCA 2015-06-01

Mean: **21%**
Standard Deviation: **7%**
5th percentile: **9%**
10th percentile: **11%**
50th percentile: **21%**
90th percentile: **30%**
95th percentile: **33%**

Annual Grass McInnisCanyonNCA 2017-06-01

Mean: **23%**
Standard Deviation: **8%**
5th percentile: **10%**
10th percentile: **13%**
50th percentile: **23%**
90th percentile: **34%**
95th percentile: **37%**

Annual Grass McInnisCanyonNCA 2019-06-01

Mean: **22%**
Standard Deviation: **8%**
5th percentile: **9%**
10th percentile: **11%**
50th percentile: **22%**
90th percentile: **33%**
95th percentile: **36%**

Annual Grass McInnisCanyonNCA 2021-06-01

Mean: **23%**
Standard Deviation: **8%**
5th percentile: **10%**
10th percentile: **12%**
50th percentile: **22%**
90th percentile: **33%**
95th percentile: **37%**

Annual Grass McInnisCanyonNCA 2016-06-01

Mean: **23%**
Standard Deviation: **8%**
5th percentile: **10%**
10th percentile: **12%**
50th percentile: **23%**
90th percentile: **34%**
95th percentile: **38%**

Annual Grass McInnisCanyonNCA 2018-06-01

Mean: **23%**
Standard Deviation: **8%**
5th percentile: **10%**
10th percentile: **12%**
50th percentile: **23%**
90th percentile: **33%**
95th percentile: **36%**

Annual Grass McInnisCanyonNCA 2020-06-01

Mean: **22%**
Standard Deviation: **8%**
5th percentile: **9%**
10th percentile: **11%**
50th percentile: **21%**
90th percentile: **32%**
95th percentile: **35%**

Difference Annual Grass McInnisCanyonNCA 2021-06-01 MINUS 2015-06-01

5th percentile: **-12%**
10th percentile: **-8%**
50th percentile: **2%**
90th percentile: **11%**
95th percentile: **14%**

References

- Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ###
- Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.
- Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.
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- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

Thank you for using LandCART!

Landscape Cover Analysis and Reporting Tools (LandCART) is a NASA-funded collaboration between the BLM, UCLA, and the USGS (see grant information, below). LandCART tools generate continuous fractional cover maps representing AIM indicators in the Western Lower 48 states using AIM data, Google Earth Engine, and machine learning prediction methods. For more information and to use LandCART click here: (landcart.org).

NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

ACCESS CONSTRAINT

None, these data are considered public domain.

USE CONSTRAINT

These data are provided by Bureau of Land Management (BLM) “as is” and might contain errors or omissions. The User assumes the entire risk associated with its use of these data and bears all responsibility in determining whether these data are fit for the User’s intended use. The information contained in these data is dynamic and may change over time. The data are not better than the sources from which they were derived, and both scale and accuracy may vary across the data set. These data might not have the accuracy, resolution, completeness, timeliness, or other characteristics appropriate for applications that potential users of the data may contemplate. The User is encouraged to carefully consider the content of the metadata file associated with these data. These data are neither legal documents nor land surveys, and must not be used as such. Official records may be referenced at most BLM offices. Please report any errors in the data to the BLM office from which it was obtained.

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LANDCART SPATIAL COMPARE TOOL REPORT EXAMPLE

McInnis Canyons NCA and Lower Bench Grazing Allotment Annual Grass Cover Prediction, 2018-06-01

Here is a summary about the Lower Bench Grazing Allotment within McInnis Canyons National Conservation Area project. Distribution of Annual Grass within both locations.

LandCART Spatial Compare Tool Description

Recognizing the value in fractional vegetation cover datasets for rangeland management, multiple research groups have leveraged extensive satellite imagery and field sampling collections to develop region-wide fractional cover datasets of key vegetation indicators. Landscape Cover Analysis and Reporting Tools (LandCART), a National Aeronautics and Space Administration Research Opportunities in Space and Earth Science (NASA ROSES) grant awarded to a BLM/USGS/UCLA (Bureau of Land Management/United States Geological Survey/University of California, Los Angeles) geospatial partnership, is a collaborative project building on current science and cloud computing to provide the BLM with the ability to fuse AIM field information with remotely sensed data to make current and historic fractional cover predictions of core AIM indicators where and when they were not measured. The project relies on a random forest algorithm in Google Earth Engine (GEE) to develop on-the-fly models of Assessment, Inventory, and Monitoring program (AIM) indicators (ANNUAL GRASS) for users in their specific study area (within the western United States, AOI) and time period (1984 to present, TOI). Landsat satellite imagery, AIM terrestrial field data, and Natural Resources Conservation Service Natural Resources Inventory (NRCS NRI) data are fully utilized for these prediction models. The web-based mapping application features functionality to create maps of AIM indicators, download imagery, calculate statistics, create charts, and incorporate the results into reports that can be included in the NEPA Administrative Record. The products were developed for BLM on-the-ground field staff, BLM planners, and private, as well as public, land managers.

The LandCART Spatial Compare Tool allows a user to select one indicator at a time (ANNUAL GRASS) at two different locations of interest (AOIs) at one time (TOI). The user can decide to map an indicator during one season, multiple seasons separately (in different sessions), and annually based on the local growing season. The user can select two different locations anywhere in the western U.S. to compare to one another. The Spatial Compare Tool provides the user with true color and infrared images of two areas of interest. It produces two indicator maps of the selected indicator at one selected time, comparative histograms, conducts a two-sample Kolmogorov-Smirnoff test of differences for the histograms, and conducts a one-sample Kolmogorov-Smirnoff test for similarity between the difference histogram and a normal distribution. This tool can be used to compare indicator distribution in an area that has been seeded against an area that has been left as is (a control) or perhaps a smaller area within a larger area.

Inputs and Outputs:

- **LandCART version:** V1.0 and **run date:** 2021-12-21
- **AIM Indicator:** Annual Grass
- **Annual Grass Definition:** The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot).
- **Dates predicted:** 2018-06-01 to 2018-09-01
- **Landsat images used AOI1:** LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_035033_20180602, LC08_035033_20180618, LC08_035033_20180704, LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829,

LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804,
LE07_036033_20180820

- **Landsat images used AOI2:** LC08_036033_20180812, LC08_036033_20180828,
LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813,
LE07_035033_20180829, LE07_036033_20180601, LE07_036033_20180719,
LE07_036033_20180804, LE07_036033_20180820
- **Shapefile Name AOI1:** McInnisCanyonsNCA.shp
- **Shapefile Name AOI2:** LowerBenchGA.shp
- **Vector Acreage AOI1:** McInnis Canyons NCA 124,293 acres
- **Vector Acreage AOI2:** Lower Bench Grazing Allotment 15,566 acres
- **Output Predicted Images:**
Landcart McInnis Canyons NCA Annual Grass 2018-06-01 to 2018-09-01.TIF
Landcart Lower Bench Grazing Allotment Annual Grass 2018-06-01 to 2018-09-01.TIF
- **Projection:** Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
- **Spatial Resolution:** 30-m pixels
- **For more details see associated metadata file:**
Landcart McInnis Canyons NCA Annual Grass 2018-06-01 to 2018-09-01.xml
Landcart Lower Bench Grazing Allotment Annual Grass 2018-06-01 to 2018-09-01.xml
- **Two-sample Kolmogorov-Smirnoff p-value:** 0.310

Results

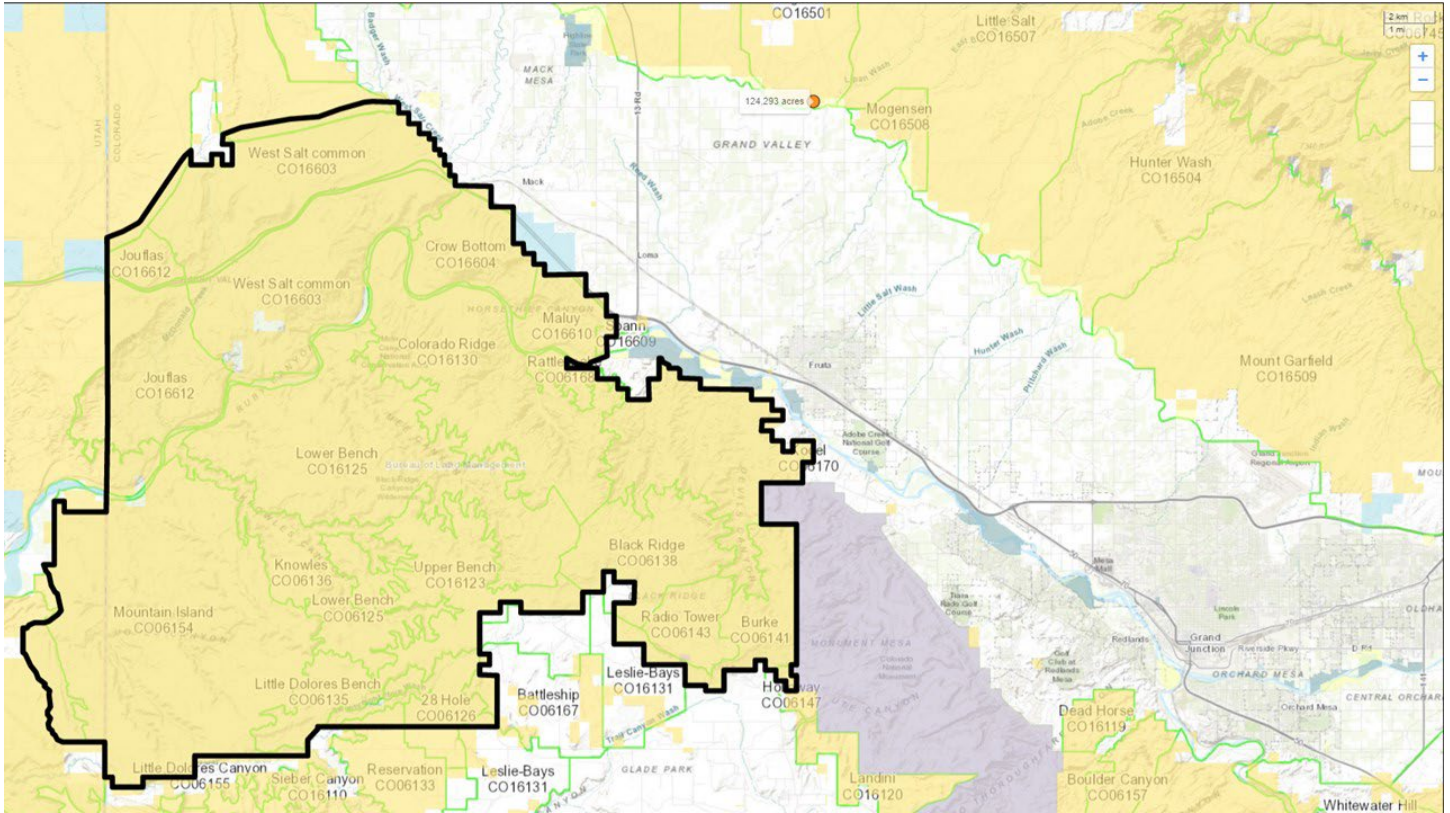


Figure 1a. LandCART Spatial Compare Tool McInnis Canyons NCA boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default topo base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

APPENDIX H
LandCART Spatial Compare Tool Report EXAMPLE

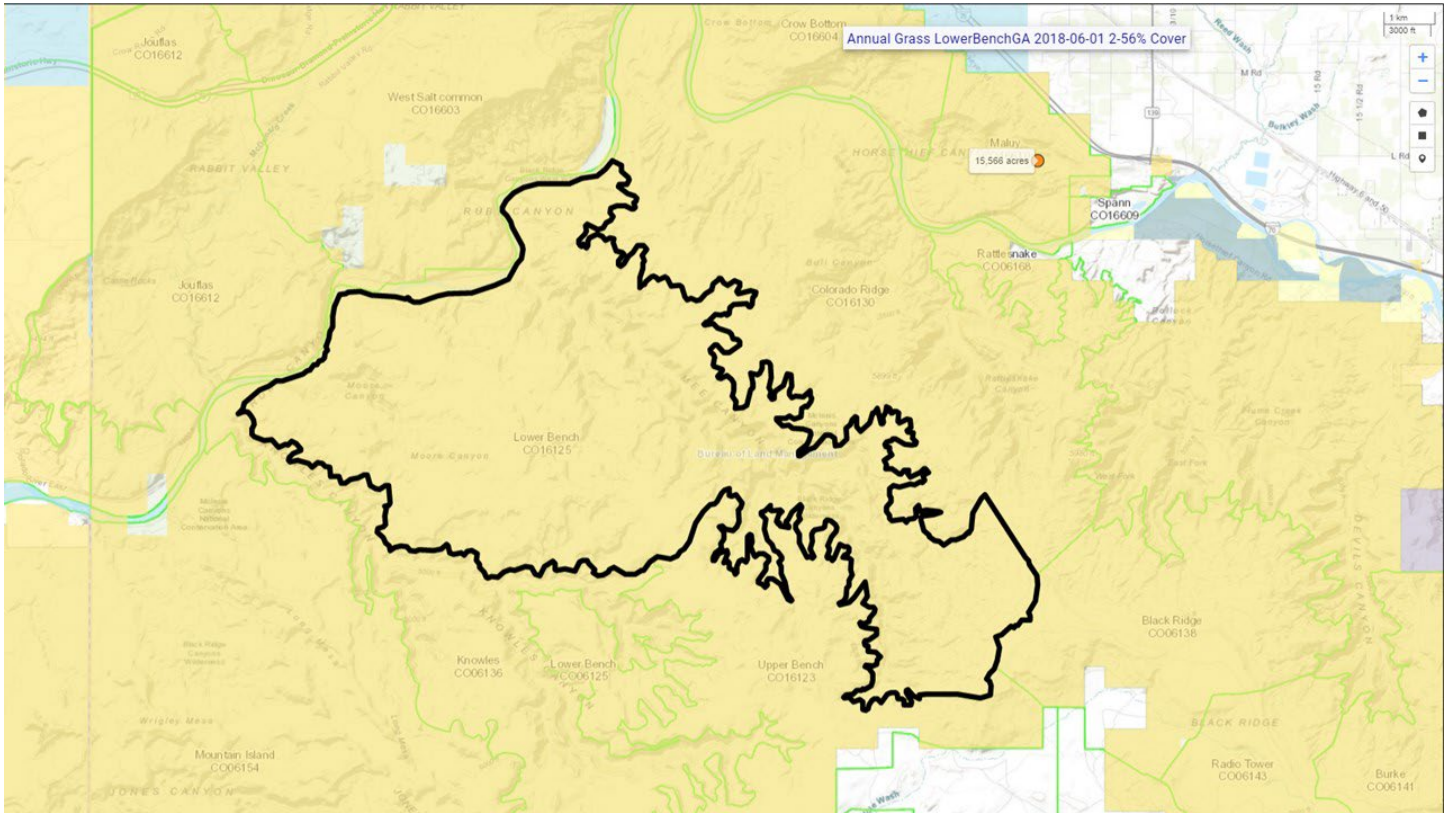


Figure 1b. LandCART Spatial Compare Tool Lower Bench Grazing Allotment boundary (black line), grazing allotments (green lines), and Surface Management Area (SMA) data (BLM managed land is yellow) displayed over the default topo base map. A LandCART user can define the area of interest (AOI)/boundary by uploading a shapefile, using the current map extent, or drawing a rectangle or polygon using the drawing tools on-screen.

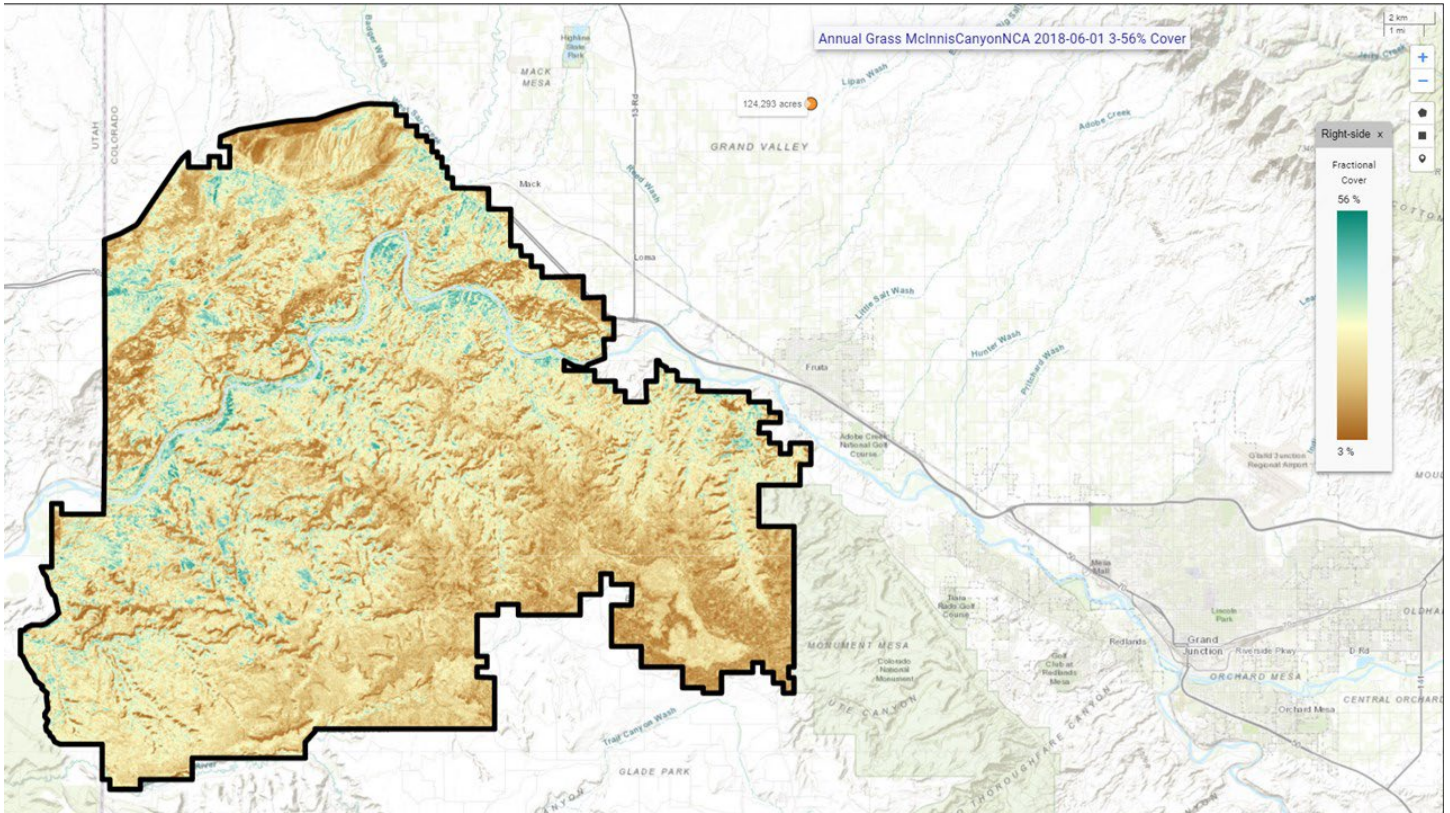


Figure 2a. LandCART Spatial Compare Tool McInnis Canyons NCA boundary (black line) with predicted Annual Grass fractional cover from 2018-06-01 to 2018-09-01 displayed over the default topo base map. Percent Annual Grass cover ranges from 3% to 56%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Spatial Compare Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

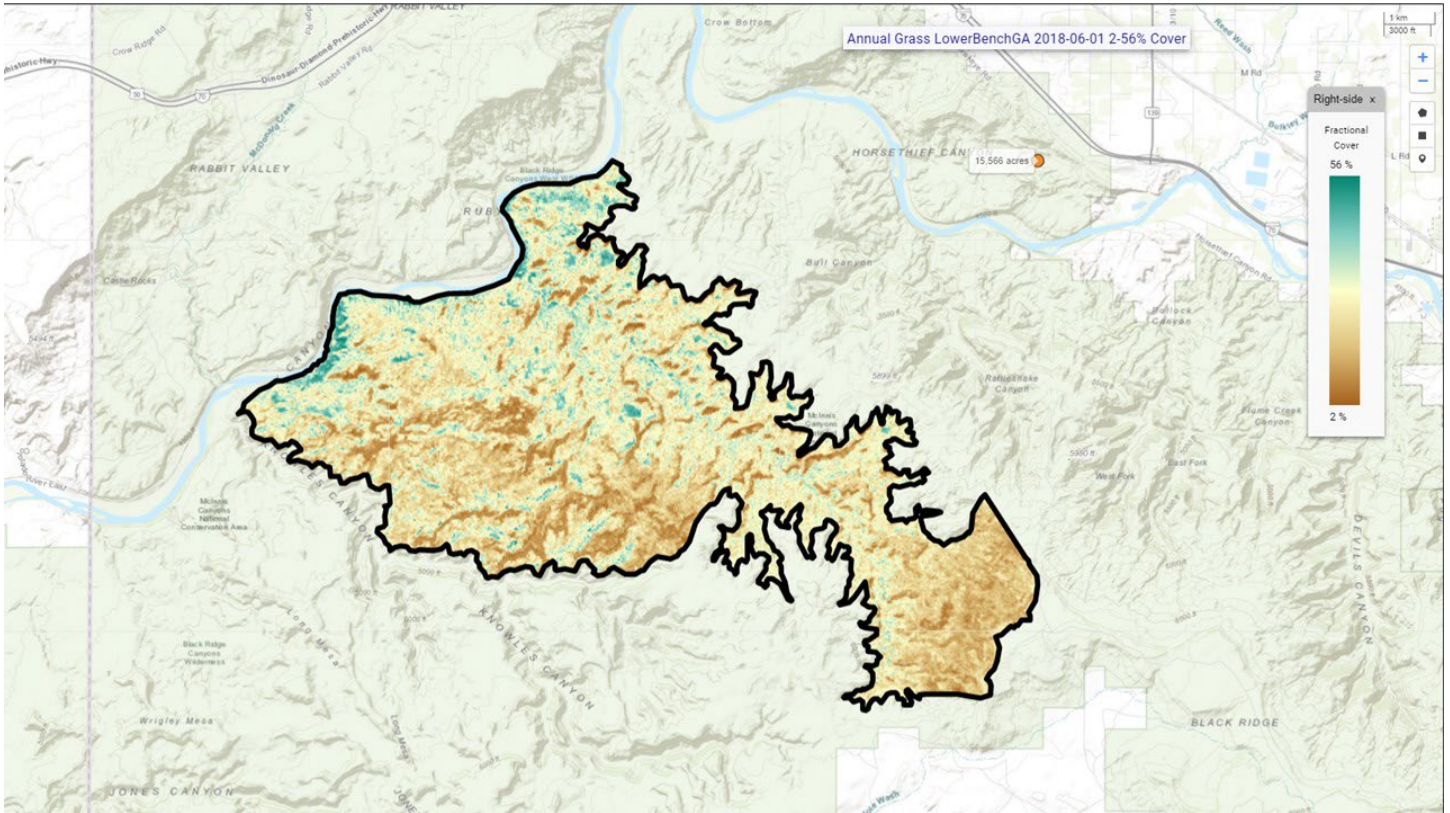


Figure 2b. LandCART Spatial Compare Tool Lower Bench Grazing Allotment boundary (black line) with predicted Annual Grass fractional cover from 2018-06-01 to 2018-09-01 displayed over the default topo base map. Percent Annual Grass cover ranges from 2 % to 56%. A LandCART user can choose their desired indicator and time frame from dropdown lists on the Start Panel in the Spatial Compare Tool. Predictions can be made from 1984 to approximately 2 weeks before present. Currently, 19 AIM indicators are available for prediction using LandCART. The user can choose to download the predicted image along with associated FGDC-compliant metadata. The indicator displayed here, Annual Grass, is defined as: The any hit cover of annual grasses in the plot. This indicator is derived from the Line Point Intercept method (typically 150 points on three transects per plot). See [AIM metadata](#) and/or the [LandCART User Guide](#) for more information.

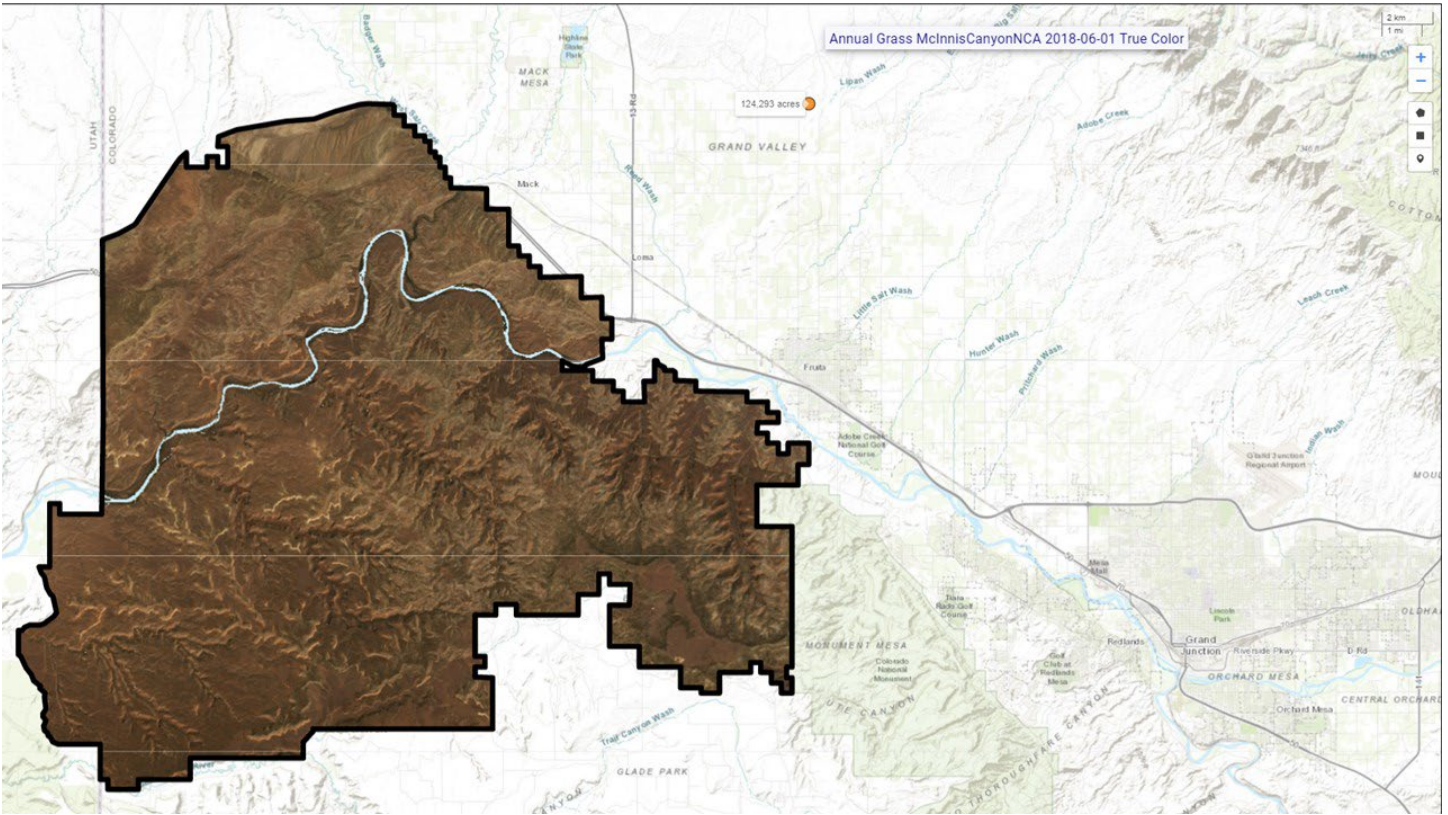


Figure 3a. LandCART Spatial Compare Tool McInnis Canyons NCA boundary (black line) with true color Landsat imagery composite from 2018-06-01 to 2018-09-01 displayed over the default topo base map. The LandCART Spatial Compare Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_035033_20180602, LC08_035033_20180618, LC08_035033_20180704, LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829, LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804, LE07_036033_20180820.

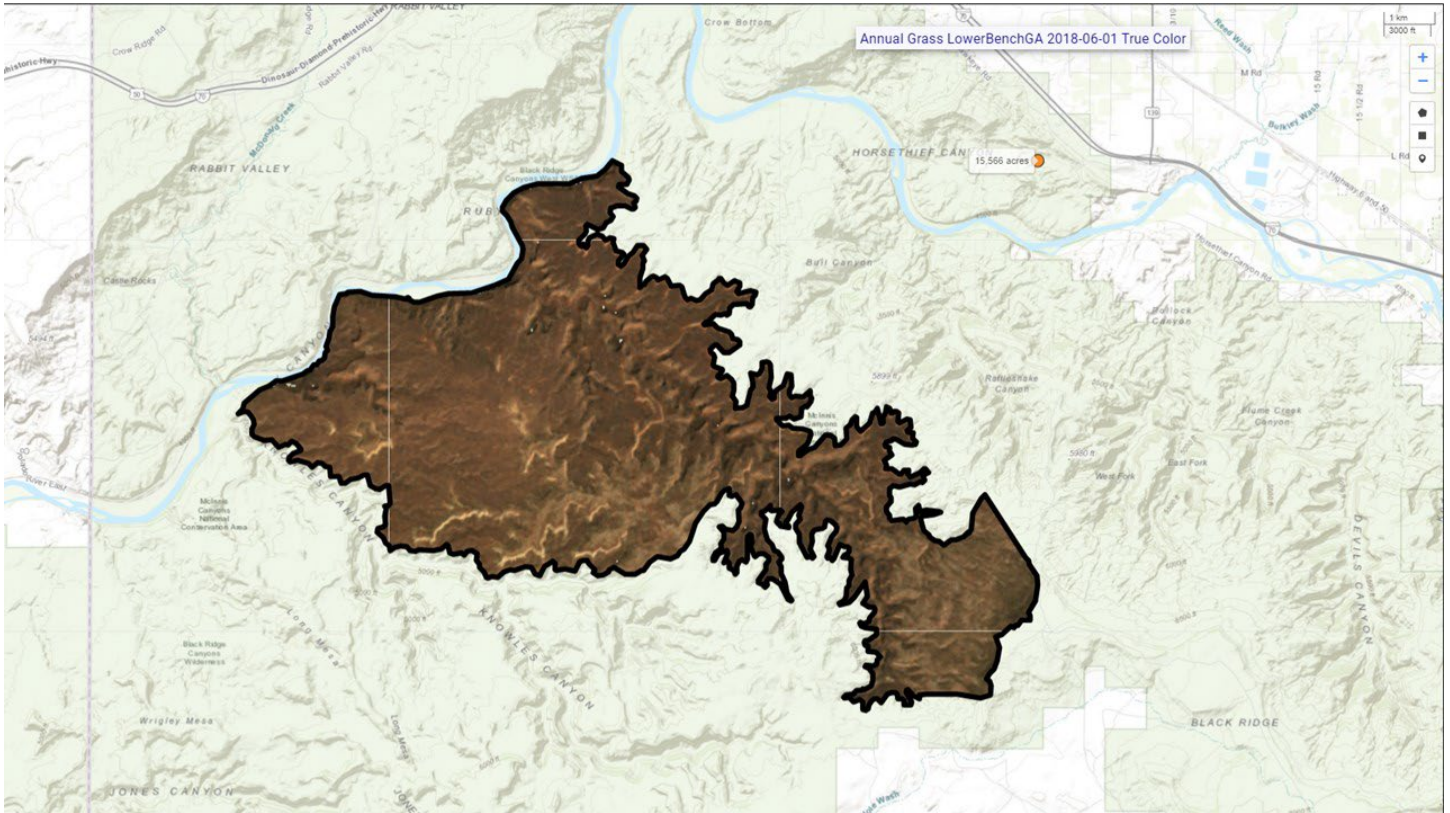


Figure 3b. LandCART Spatial Compare Tool Lower Bench Grazing Allotment boundary (black line) with true color Landsat imagery composite from 2018-06-01 to 2018-09-01 displayed over the default topo base map. The LandCART Spatial Compare Tool acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This true color image is displayed in the red, green, and blue bands. The following Landsat images were used for predicting Annual Grass cover in Lower Bench Grazing Allotment: LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829, LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804, LE07_036033_20180820.

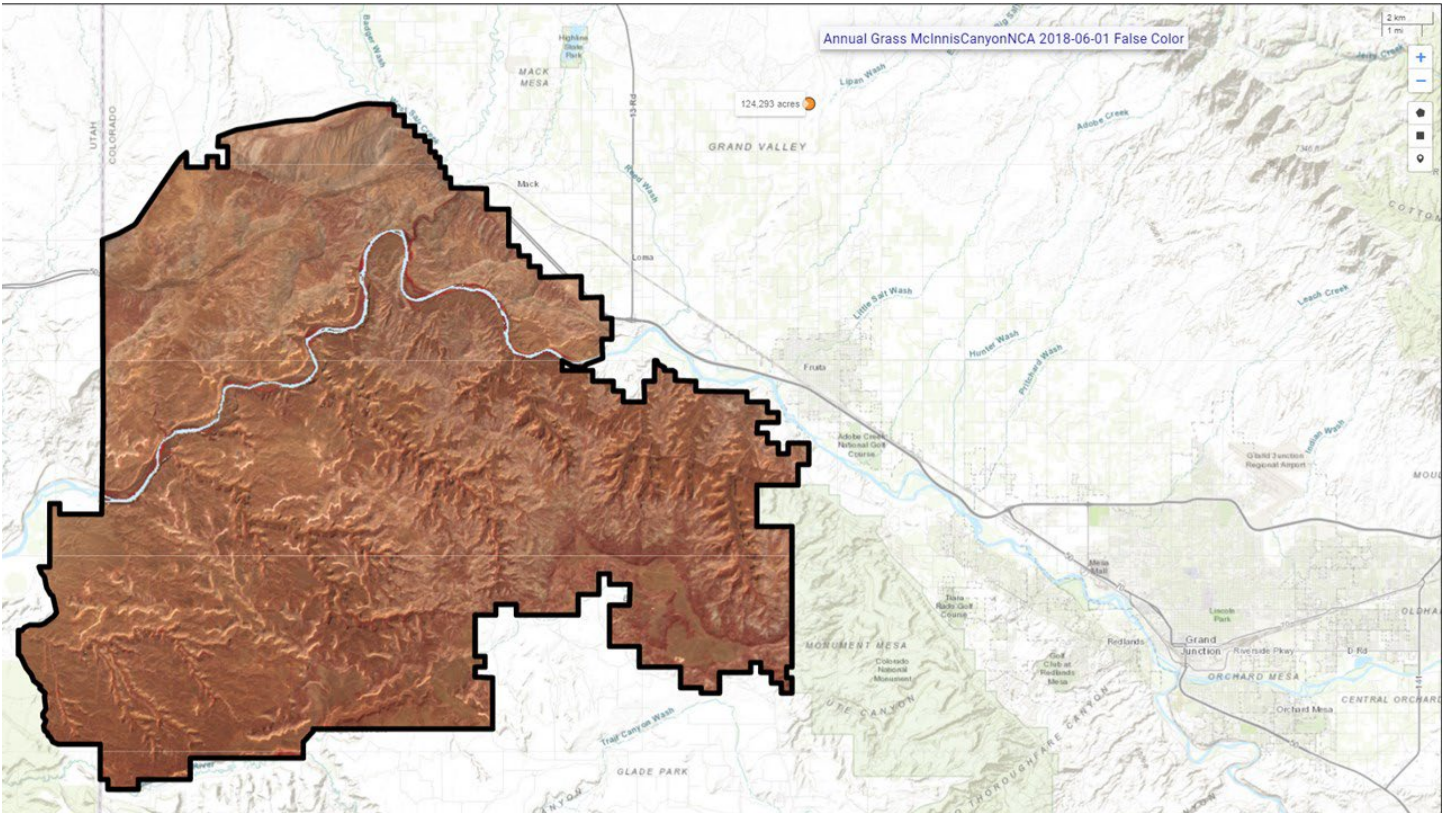


Figure 4a. *LandCART Spatial Compare Tool* McInnis Canyons NCA boundary (black line) and false color Landsat imagery composite from 2018-06-01 to 2018-09-01 displayed over the default topo base map. The *LandCART Spatial Compare Tool* acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in McInnis Canyons NCA: LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_035033_20180602, LC08_035033_20180618, LC08_035033_20180704, LC08_036033_20180609, LC08_036033_20180625, LC08_036033_20180711, LC08_036033_20180727, LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829, LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804, LE07_036033_20180820.

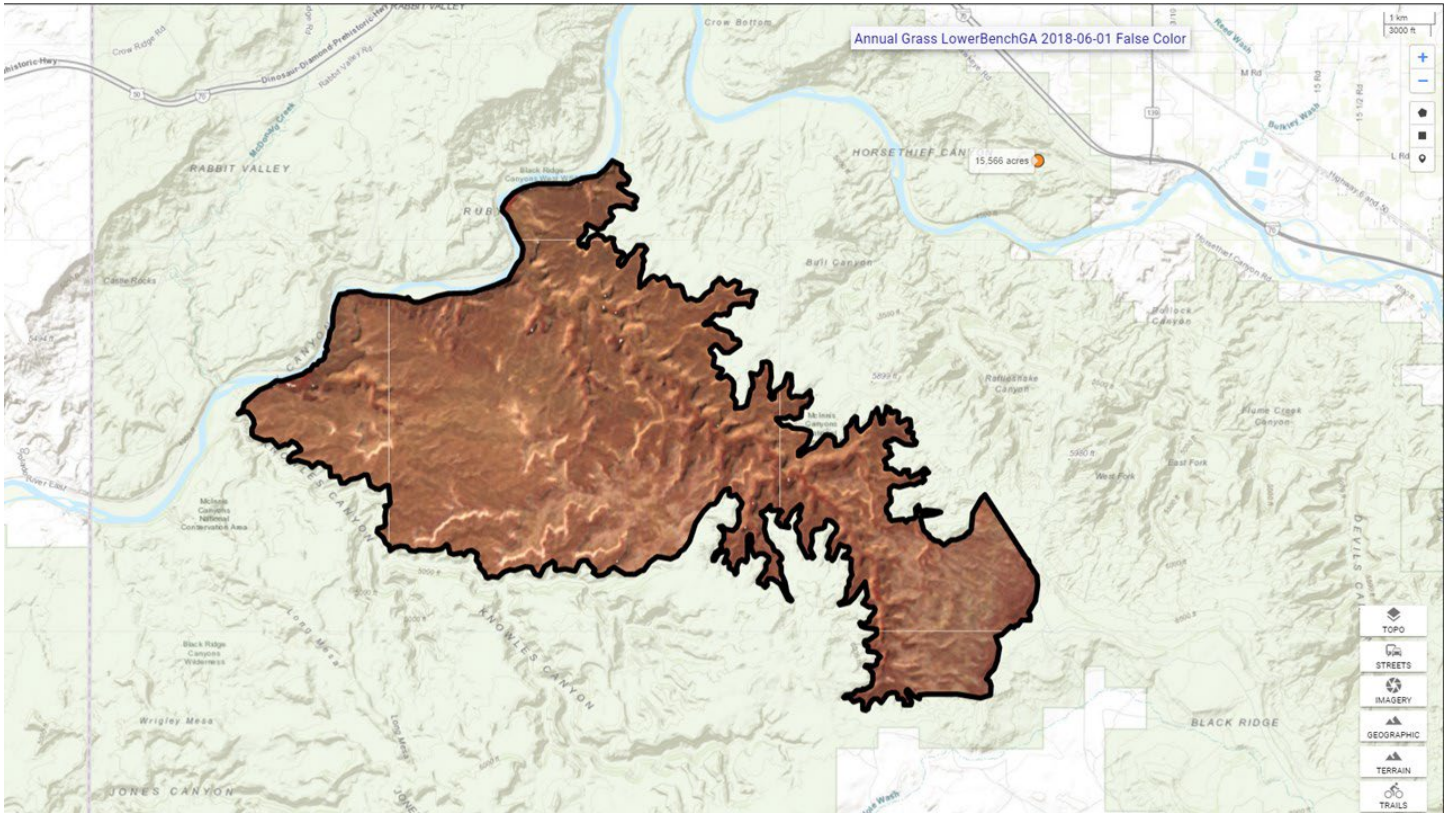


Figure 4b. *LandCART Spatial Compare Tool* Lower Bench Grazing Allotment boundary (black line) and false color Landsat imagery composite from 2018-06-01 to 2018-09-01 displayed over the default topo base map. The *LandCART Spatial Compare Tool* acquires, pre-processes, and mosaics multiple Landsat images for the user's chosen area of interest, time frame of interest, and indicator of interest. This false color composite image is displayed in the near-infrared, red, and green bands. False color composite images allow a user to view healthy green vegetation as deep red. The following Landsat images were used for predicting Annual Grass cover in Lower Bench Grazing Allotment: LC08_036033_20180812, LC08_036033_20180828, LE07_035033_20180610, LE07_035033_20180626, LE07_035033_20180813, LE07_035033_20180829, LE07_036033_20180601, LE07_036033_20180719, LE07_036033_20180804, LE07_036033_20180820.

Annual Grass LowerBenchGA 2018-06-01

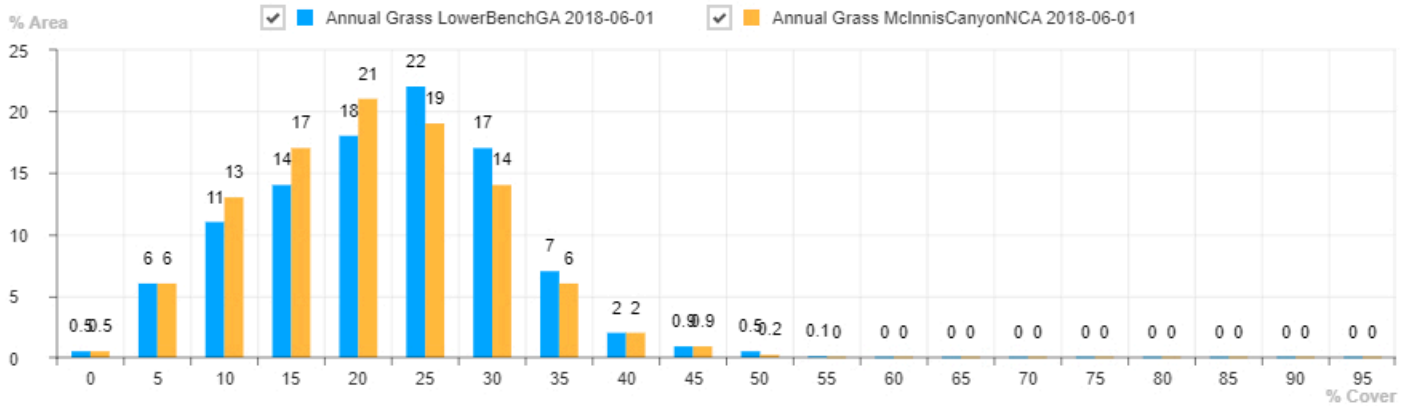


Figure 5. Histogram of LandCART Spatial Compare Tool Annual Grass percent cover for McInnis Canyons NCA and Lower Bench Grazing Allotment from 2018-06-01 to 2018-09-01 by percent area. Percent cover is displayed in 5% bins, i.e., 0-5%, 5-10%, ...,90-95%, 95-100%.

Table 1. Histogram values of LandCART Spatial Compare Tool Annual Grass percent cover for McInnis Canyons NCA and Lower Bench Grazing Allotment from 2018-06-01 to 2018-09-01 by percent area. Values are binned in increments of 5%, i.e., 0-5%, 5-10%, ..., 90-95%, 95-100%.

Annual Grass McInnis Canyons NCA		Annual Grass Lower Bench Grazing Allotment	
%Cover	%Area	%Cover	%Area
0	0.5	0	0.5
5	6	5	6
10	13	10	11
15	17	15	14
20	21	20	18
25	19	25	22
30	14	30	17
35	6	35	7
40	2	40	2
45	0.9	45	0.9
50	0.2	50	0.5
55	0	55	0.1
60	0	60	0
65	0	65	0
70	0	70	0
75	0	75	0
80	0	80	0
85	0	85	0
90	0	90	0
95	0	95	0

Table 2. LandCART Spatial Compare Tool summary statistics for Annual Grass percent cover for McInnis Canyons NCA and Lower Bench Grazing Allotment from 2018-06-01 to 2018-09-01.

<u>Annual Grass McInnisCanyonNCA 2018-06-01</u>	<u>Annual Grass LowerBenchGA 2018-06-01</u>
Mean: 23%	Mean: 24%
Standard Deviation: 8%	Standard Deviation: 9%
5th percentile: 9%	5th percentile: 9%
10th percentile: 11%	10th percentile: 11%
50th percentile: 23%	50th percentile: 25%
90th percentile: 34%	90th percentile: 35%
95th percentile: 38%	95th percentile: 38%

References

- Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ####. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.
- Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.
- Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.
- Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.
- Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

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NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

ACCESS CONSTRAINT

None, these data are considered public domain.

USE CONSTRAINT

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APPENDIX I – FREQUENTLY ASKED QUESTIONS

Q: WHO DO I CONTACT FOR HELP WITH LANDCART?

A: For help contact BLM_OC_LandCART@blm.gov.

Q: WHAT IS THE RESOLUTION OF LANDCART MAP PRODUCTS?

A: Spatial resolution: 30-m spatial resolution

Temporal resolution: approximately every 16 days from 1984 to present

Pixel values: fractional vegetation cover range from 0% to 100%; heights in cm

Q: AT WHAT SCALE WOULD IT BE APPROPRIATE TO MAKE INFERENCES USING THESE DATA BASED ON THE RESOLUTION? HOW BIG IS THE LARGEST/SMALLEST AREA WE THAT CAN RUN PREDICTIONS ON?

A. We have not yet found a consistent limit to area of interest (AOI) size - either minimum or maximum. GEE is optimized for very large datasets. We have successfully run predictions on 1,000 acres and 2 million acres. Our recommendation is to upload your area of interest as a shapefile (or draw it on the map) and test a prediction or two for that area. We also recommend that you don't attempt to predict an area as large as a state – a safe bet is to predict areas less than 10 million acres – more specifically, AOIs at ecoregion- or watershed-scale down to grazing allotment- and pasture-scale. The minimum recommended AOI size is approximately 100 acres or 40 ha. Please do not attempt to predict fractional cover for a smaller area – we cannot be confident in the accuracy of the results. When/if we identify a specific maximum or minimum size, we will include it in the user guide, online documentation, and in these FAQ answers.

Q: WHAT IS THE ACCURACY OF LANDCART TOOLS?

A: Current accuracies as of 2/11/2021 are listed below. However, we found some incorrect calculations in our indicators and recently redeveloped the Random Forest models for all 19 indicators. We are running accuracy assessments as we speak. All indications point to higher accuracies with the new data and models. We will report the final accuracies when they are all complete.

AIM 2.0 Indicator	R ²	MAE	RMSE
Annual Forb	0.37	6.61	9.75
Annual Grass	0.43	9.74	14.5
Annual Herbaceous	0.47	12.69	16.31
Bare Ground	0.65	10.07	13.02
Bare Soil	0.56	8.85	11.98
Canopy Gaps greater than 25cm	0.57	14.1	17.87
Canopy Gaps greater than 100 cm	0.58	12.55	16.84
Canopy Gaps greater than 200 cm	0.57	9.95	14.58
Herbaceous	0.65	11.58	14.77
Perennial Forb	0.31	10.32	14.07
Perennial Grass	0.31	10.22	13.99
Perennial Herbaceous	0.37	8.96	12.43
Sagebrush	0.38	6.77	8.87
Shrubs	0.33	8.08	10.38
Shrubsucculent	0.33	7.97	10.26
Succulent	0.11	0.3	0.95
Total Foliar	0.66	10.42	13.19
Trees	0.5	3.53	7.74

Woody	0.45	8.59	11.22
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Q: WHAT INDICATORS DOES LANDCART CALCULATE?

A: AIM 2.0 Indicators available in LandCART are

- Annual Forb
- Annual Grass
- Annual Herbaceous
- Bare Ground
- Bare Soil
- Canopy Gaps greater than 25cm
- Canopy Gaps greater than 100 cm
- Canopy Gaps greater than 200 cm
- Herbaceous
- Perennial Forb
- Perennial Grass
- Perennial Herbaceous
- Sagebrush
- Shrubs
- Shrubsucculent
- Succulent
- Total Foliar
- Trees
- Woody

Q: WHAT IS THE DIFFERENCE BETWEEN BARE GROUND AND BARE SOIL INDICATORS?

A: Bare Ground: The basal cover of soil, rocks, and deposited soil (all first hit) in the plot, not including ground with cover above it. Bare Soil: The basal cover of soil in the plot, not including soil that has cover above it.

Q: WHAT SATELLITE IMAGERY IS USED FOR LANDCART CALCULATIONS?

A: Landsat Satellite Imagery hosted as Google Earth Engine assets:

Thematic Mapper (TM, Landsat 5, 1984 - 2011)

Enhanced Thematic Mapper Plus (ETM+, Landsat 7, 1999 - present)

Operational Land Imager (OLI, Landsat 8, 2013 - present)

Landsat 9 was launched into orbit in September 2021 and is a carbon copy of Landsat 8. These data will be incorporated into the LandCART process when the imagery is published by USGS.

<https://www.usgs.gov/media/images/landsat-missions-timeline>

<https://developers.google.com/earth-engine/datasets/catalog/landsat>

Q: HOW DO I CITE USING LANDCART TOOLS?

FORMAL CITATION

Zhou, B., Okin, G.S. and Zhang, J. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sens. Environ.* 2020, 236, 111521.

Bureau of Land Management (BLM). BLM Landscape Approach Data Portal - AIM Downloadable Data. <https://landscape.blm.gov/geoportal/catalog/AIM/AIM.page>. Published October 25, 2011. Accessed INSERT DATE HERE.

Okin, G., Zhou, B., Duniway, M., Cole, C., Savage, S., Litschert, S., and Liddle, J. Landscape Cover Analysis and Reporting Tools V1.0. <https://landcart.org> Published February 16, 2022. Accessed INSERT DATE HERE.

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Q: ARE THERE ANY JOURNAL PAPERS OR OTHER REPORTS AND DOCUMENTS THAT I CAN CITE WHEN I USE LANDCART? IS THERE A REPORT OR TECH REF FROM BLM?

A: CURRENT REFERENCES

Savage, S., and Slyder, J. In Press. Fractional Cover Evaluation. BLM Tech Note ###. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.

Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.

Toevs, G.R., Karl, J.W., Taylor, J.J., Spurrier, C.S., Bobo, M.R. and Herrick, J.E., 2011. Consistent indicators and methods and a scalable sample design to meet assessment, inventory, and monitoring information needs across scales. *Rangelands*, 33(4), pp.14-20.

Webb, N.P., McCord, S.E., Edwards, B.L., Herrick, J.E., Kachergis, E., Okin, G.S. and Van Zee, J.W., 2021. Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management. *Rangeland Ecology & Management*, 76, pp.78-83.

Zhang, J., Okin, G.S. and Zhou, B., 2019. Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning. *Remote Sensing of Environment*, 233, p.111382.

Zhou, B., Okin, G.S. and Zhang, J., 2020. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sensing of Environment*, 236, p.111521.

ADDITIONAL INFORMATION

Landscape Cover Analysis and Reporting Tools (LandCART) is a NASA-funded collaboration between the BLM, UCLA, and the USGS (see grant information, below). LandCART tools generate continuous fractional cover maps representing AIM 2.0 indicators in the Western Lower 48 using AIM 2.0 data, Google Earth Engine, and machine learning prediction methods. For more information and to use LandCART click here: (landcart.org).

NASA Science Mission Directorate
Research Opportunities in Space and Earth Science – 2016
NNH16ZDA001N-ECO4CAST
A.46 Earth Science Applications: Ecological Forecasting
16-ECO4CAST-0025

[LandCART User Guide](#)

FORMAL CITATION

Zhou, B., Okin, G.S. and Zhang, J. Leveraging Google Earth Engine (GEE) and machine learning algorithms to incorporate in situ measurement from different times for rangelands monitoring. *Remote Sens. Environ.* 2020, 236, 111521.

Bureau of Land Management (BLM). BLM Landscape Approach Data Portal - AIM Downloadable Data. <https://landscape.blm.gov/geoportal/catalog/AIM/AIM.page>. Published October 25, 2011. Accessed INSERT DATE HERE.

Okin, G., Zhou, B., Duniway, M, Cole, C., Savage, S., Litschert, S., and Liddle, J. Landscape Cover Analysis and Reporting Tools V1.0. <https://landcart.org> Published February 16, 2022. Accessed INSERT DATE HERE.

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Q: WHAT PROJECTIONS ARE LANDCART DATA DOWNLOADS IN?

A: Projection: Geographic (Lat/Long); Datum: WGS 84; EPSG Code: 4326
Spatial Resolution: 30-m pixels

Q: WILL LANDCART CONTINUE TO BE SUPPORTED AFTER THE INITIAL APP CREATION?

A: The NASA ROSES grant ends on February 15, 2022. We intend to continue to support LandCART out of the Geospatial Imaging Section at the NOC and through a cooperative agreement with UCLA. Any questions, requests, bugs, ideas, etc. can continue to be directed to BLM_OC_LandCART@blm.gov for the foreseeable future. The more you use LandCART, the more support we will provide.

Q: CAN I GENERATE REFERENCE CONDITIONS IN LANDCART?

A: Yes. In LandCART you can predict any of the 19 available indicators for any dates from 1984 to present (minus 2 weeks or so). For instance, if you want to see the distribution of Total Foliar before and after a fire or a vegetation treatment, you can use the LandCART Cover Change Compare Tool to predict before and after maps and a difference map indicating the direction and magnitude of change from one date to another.

Q: IS THERE AN EASY WAY TO ANALYZE MULTIPLE INDICATORS FOR AN AREA OF INTEREST AT THE SAME TIME? (E.G., ANNUAL HERBACEOUS, SHRUBS, SAGEBRUSH, TREES)?

A: Currently there is no option to run multiple indicator predictions at the same time. That code is complex and unwieldy and has not been pursued by the development team. Meanwhile, we suggest that you run the tool multiple times using the same AOI and TOI while changing the indicators as needed. Be sure to enable the download option. Then you can download each indicator prediction and work with the data in your software of choice. You can do this either in the same session (browser tab) or in multiple sessions (tabs) (especially if you have a shapefile for the AOI) at the same time. This request has popped up a few times. We will endeavor to write up a How To for analyzing multiple indicators through other means.

Q: DOES IT REQUIRE A SINGLE CONNECTED POLYGON FOR THE SHAPEFILE UPLOAD, OR COULD YOU UPLOAD A SET OF MULTIPART/DISCONNECTED (POTENTIALLY DISSOLVED) POLYGONS? SEEMS LIKE THAT WOULD BE A PARTICULARLY IMPORTANT FEATURE IF YOU WANTED TO APPLY TO A PARTICULAR ECOTYPE WITHIN AN AREA.

A: Disconnected polygons are supported if they are defined as one multipolygon or a multipart feature. If there are multiple (singlepart) polygon features in the shapefile, LandCART currently will randomly select one of the polygons to set as your AOI.

Q: SINCE THE K-S TEST IS NONPARAMETRIC WHAT IS THE VALUE OF THE 1 SAMPLE TEST? DOES IT TEST FOR NORMALITY?

A: The one-tailed test answers the question "What is the probability that this collection of samples could have been drawn from that probability distribution?" or, the two tailed test, "What is the probability that these two sets of samples were drawn from the same (but unknown) probability distribution?" https://en.wikipedia.org/wiki/Kolmogorov%E2%80%93Smirnov_test

Q: COULD A TOOL BE IMPLEMENTED THAT WOULD IDENTIFY COORDINATES FOR A CHOSEN LOCATION? LIKE "IDENTIFY" IN ARCMAP.

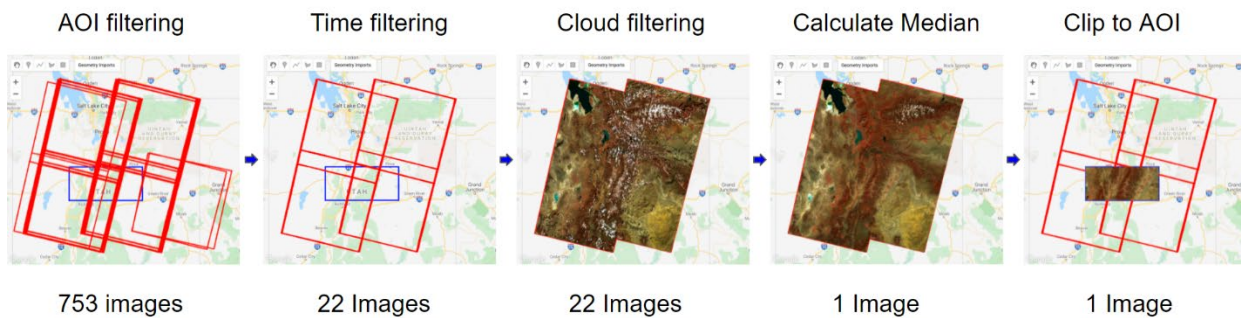
A: Perhaps. The tool currently has an "Identify" button to determine the predicted fractional cover for the location where you click. We might be able to add the X,Y coordinates to the output. This might appear in an update of the app. Stay tuned.

Q: WHY DOES THE TOOL REQUIRE A SPECIFIC DATE (INCLUDING DAY) FOR THE TIME SERIES?

A: We wish to run the trend analysis on the time series for the same season/time of year. We allow you to specify a date/season so you can analyze the time series for your precise time of year. For instance, the growing season in southern New Mexico likely starts earlier in the year than the growing season in eastern Oregon. Remember, these predictions are happening on-the-fly, so the images are not static or pre-defined. We give you as much control over the data that are calculated as we can. We might reduce the choice down to specific month without the day of the month. Stay tuned.

Q: IN THE TIME SERIES TOOL, WHY DOES IT ASK FOR DURATION AS WELL AS A START AND END TIME?

A: Each tool in LandCART asks for a duration of time in which to acquire images for predictions. Landsat satellites image the same location on Earth every 8 to 16 days. This means that trying to find a clear, complete image for a specified area of interest for one day of the year is nearly impossible. Even if you happen to randomly select a date when an image was acquired, you can't be certain that that image is free of clouds/smoke or data gaps (see information on the Landsat 7 Scan Line Corrector failure: <https://www.usgs.gov/landsat-missions/landsat-7> and <https://www.usgs.gov/media/images/a-landsat-7-slc-scene-example>). We suggest a 3-month duration so that multiple images can be composited to create one Landsat image for your area of interest that has no missing data. You can certainly try a 1-month duration, but we strongly recommend nothing shorter. Below are the steps the LandCART program takes to generate the final composite image on which the indicators can be predicted:



6. Filter image collection by AOI (area of interest) – 753 images intersect the defined AOI
7. Filter image collection by time range of interest (TOI) (We need multiple pixels (think layers of images stacked on top of one another) at any location in case of cloud/smoke/SLC-off holes) – 22 images fall within the defined time duration
8. On an image-by-image basis mask out all the pixels covered by cloud, cloud shadow, smoke, smoke shadow, or SLC-off gaps – all 22 images are masked for holes
9. Calculate the median value for every pixel in the image stack (We don't use mean because we want actual vs derived reflectance values. Other aggregation methods like max could also be used for certain applications, e.g., to detect peak greenness) – the median value of the 22 images at each pixel is calculated and saved to 1 new composite image
10. Clip to the user defined region of interest – 1 composite image of the defined AOI and TOI is now ready to run indicator prediction models

Q: WOULD YOU PUT IN 12 MONTHS FOR THE DURATION IF YOU WANTED THE AVERAGE FOR A YEAR?

A: You could calculate an annual average using a 12-month duration, but you would want to exclude months that are likely to have any snow cover as these would bias the calculation. Those months are also unlikely to have AIM/LMF data.

Q: WHY DOES ONLY THE WEST SIDE OF MY AREA OF INTEREST GET PREDICTED? I'VE CHOSEN 1 MONTH STARTING MAY 1, 2010.

A: It appears that your time range is not long enough and the available images from May 1 to May 31, 2010, are too cloudy and/or have data holes. Depending on your location, May could be a very rainy part of the year. We suggest using 3 months, minimum, for your date range. If you must focus only on early spring, try shifting your start date forward or backward and possibly try 1.5 months instead of 1.

Q: WHEN WE CHOOSE A TIME RANGE HOW IS LANDCART DECIDING WHICH PIXEL TO USE AT EACH LOCATION IF MULTIPLE DATES OF OBSERVATIONS ARE AVAILABLE?

A: In general, we use the median of all the available pixel values for the following reasons: a) minimum and maximum aggregation may include image artifacts that will propagate into the final map, b) mean aggregation will generate an average statistic which will be different from any of the actual observations and is considered a pseudo observation which might be undesirable in certain application scenarios, c) median aggregation will be very similar to mean aggregation in terms of the final aggregated values when plenty observations are provided, but it will represent an actual observed value on a certain date which can be reported as well. Thus, we chose median aggregation as our final method to determine the pixel values used at each location if more than one observation is available.

Q: CAN YOU GIVE SOME EXAMPLES OF THE TYPES OF MANAGEMENT QUESTIONS THAT CAN BE ANSWERED WITH LANDCART?

- What is the amount and distribution of perennial grass in the AOI? (Use the Cover Tool)
- How has the amount and distribution of annual grass changed from May 2000 to May 2020 in the AOI? (Use the Cover Change Compare Tool)
- How does the change in Shrub growth trend over time between 1990 and 2020 in my AOI? (Use the Time Series Tool for trend)
- Has the amount and distribution of bare soil increased or decreased in the area treated for postfire restoration when compared to the control area? (Use the Spatial Compare Tool for two areas)