EFFECTIVENESS MONITORING COMMITTEE PROJECT CONCEPT PROPOSAL - September 1, 2017

**Proposed Project**: REPEAT LIDAR SURVEYS TO DETECT STORM-TRIGGERED LANDSLIDES. This project is related to Project Proposal EMC-2016-3 Conceptual Design and Implementation Planning for Evaluation of Effectiveness of FPR's for Unstable Areas.

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**Introduction, Background and Justification**:

**Introduction**

For FY 2017, we propose acquisition of new LiDAR data for one or more areas in order to develop and test specifications and analytical methods regarding temporal comparison of LiDAR (LiDAR differencing). This effort would improve our technical understanding of the requirements, limitations, and advantages of comparing a time series of LiDAR data and serve as an important remote sensing tool used in landscape-scale effectiveness monitoring studies.

We intend to test the process of LiDAR differencing in a timberland that has recently experienced a broad range of storm damage and landslide activities in order to determine upper and lower detection limits, accuracy, and reliability. The lower detection limits are of special interest as they may provide an early warning system for hazards to the public and public resources. To test the method, we need a site which has the following characteristics.

1. Recent LiDAR data that predates a candidate storm event. Candidate storms are any that arose interest for this study and will be evaluated against a variety of criteria.
2. Ready access to ground locations which may be restricted in the case of private land or remote sites
3. Close proximity to staff offices and bases of operations to facilitate field verification and mapping
4. Cold water fisheries and aquatic habitat
5. Timberland that has experienced a range of management (e.g. timber harvest practices covered by BOF rules) prior to the candidate storm
6. A susceptibility to shallow and deep-seated landslides and surface erosion
7. Additional support from other stakeholders, especially land managers and owners. This may come in the form of cost-sharing.
8. Public benefit to the degree that public funds are required

In this document, we describe two areas of interest that we have selected as meeting our criteria to varying degrees. We then provide basic descriptions of the technologies and how we intend to use them.

**Background**

California Geological Survey (CGS), CALFIRE, and Matt O'Connor (members of Board of Forestry's Effectiveness Monitoring committee) are engaged in developing a study plan to determine the effectiveness of the California Forest Practice Rules at reducing or minimizing sediment impacts derived from management-related mass wasting resulting from threshold storm events. Core elements of the

FPRs focus on protecting resources at risk (i.e., cold water fisheries, aquatic habitat, riparian and channel migration zones) and maintaining water quality standards as outlined in Regional Basin Plan objectives. Although the full scope of Post-Mortem Effectiveness Monitoring project is still under development we seek to implement a pilot phase that focuses on identifying and mapping landslides and unstable areas/soils at a landscape scale in an effort to correlate the relation between forest practices and storm-induced mass wasting. This pilot phase will evaluate the most appropriate methodologies to adopt that promote accurate identification of watershed-wide landscape changes. LiDAR differencing is an advanced method for change detection and is a candidate method for post-storm monitoring.

The goal of this pilot phase is to document the mass wasting response to a stressing event such as a storm and its interaction across a range of current and historic land uses. The analysis will stratify by land use, climate, and geologic variables to investigate controlling factors on the frequency and magnitude of mass wasting.

Automated procedures exist (e.g. those developed and used by Oregon Department of Geology and Mineral Industries (e.g. Protocol for deep landslide susceptibility mapping, Oregon Department of Geology and Mineral Industries, Special Paper 48 and Automated quantification of distributed landslide movement using circular tree trunks extracted from terrestrial laser scan data, Connor and Olsen, 2014)) to extract and classify features from DEMs and will be tested for suitability for this project. Suitability will be judged by use of visual inspection by geologists. If deemed suitable the automated process may be employed across larger regions to assist in the identification of mass wasting features.

**LiDAR Basics**

LiDAR data consists of an array of return times for reflected light pulses that are mapped with very precise latitude and longitude coordinates. The return times correlate to the elevation of the reflecting surface. Thus, each reflection (e.g. return) is represented as a precise point with latitude (x), longitude (y), and elevation (z) coordinates. The array of points is referred to as a point cloud which consists of all the reflections of the survey. The most distinct returns in the cloud are the first returns which may have reflected off of tree tops, water, or the ground. In forested areas, the first returns compose the canopy surface. Last returns typically are reflections off the ground unless blocked, which may occur in thick forest settings where the only remedy is to survey at a very high laser pulse rate to ensure a minimal number of ground returns.

**Digital Elevation Models (DEM)**

LiDAR vendors process the point cloud data to select first and last returns to produce canopy surface models and “bare earth” models, respectively. These products are digital elevation models (DEM) which are a raster table of precisely mapped elevations at sub-meter scales that can be displayed as a map. A process known as “map algebra” allows for simple mathematical comparisons between multiple DEMs. For example, tree height is determined by subtracting the last return from the first return. In cases, where two DEMs represent different surveys, such as a baseline survey and a post-event survey, subtraction of the two yields a “difference model” in which negative values reflect decreases in elevation and positive values reflect elevation increases. In the case of comparing of two acquisitions of bare earth models, elevation changes represent changes in the ground surface. Alternatively, comparison of two canopy surface models over a period of time may represent canopy growth or loss or slope deformation.

**Justification**:

LiDAR provides a very effective way to identify unstable landforms and capture the occurrence of mass wasting over broad regions rapidly. LiDAR facilitates more accurate and detailed identification and mapping of mass wasting features than any other method. Comparable data cannot be obtained by on-the-ground or conventional aerial photography, and that LiDAR is extremely cost effective for these purposes.

Identification and mapping of mass wasting features based upon a single LiDAR survey cannot reveal landscape changes over time that are necessary to determine which features were triggered or reactivated by a particular stressing event. A minimum of two surveys are required in order to allow comparisons before and after an event(s). The timing of surveys relative to the event(s) and the duration of time between the pre-event and post-event surveys are the primary controls regarding the validity of before-and-after comparisons. The potential of including mass wasting features that are unrelated to the stressing event(s) presents a potential problem. The potential of this confounding factor is reduced when the timing between surveys and the event(s) are tightly constrained. Field verification and use of aerial photographs will aid in determining which features are linked to a specific event. Specifically, for this project, we propose to compare canopy surface and bare earth models for both pre- and post-event acquisitions resulting in watershed-wide comparative analysis of mass wasting hazards as a forensic tool used to monitor effectiveness of FPRs and management practices. Anomalous distortions of the canopy surface in forested areas would be detected and may indicate ground movement. Because canopy models are based on first returns, signal loss is minimal and the resolution is highest.

- Within a single acquisition, a bare earth model can vary in quality depending on the density of ground returns and thickness of duff and litter cover and stand density.
- Distortions as revealed in the bare earth models would be detected and may indicate mass wasting. While the difference models could detect change, they need to be visually inspected for the identification and mapping of mass wasting features. Visual (on-site and remote-sensed) and computer-assisted inspection may be required to distinguish false detections due to potential quality or alignment differences between DEMs.

**Goal**

The goal of this proposed pilot phase is to compare two LiDAR acquisitions that bracket the stressing event(s) (e.g. storms capable of stimulating slope movement) to determine the activity of mass wasting features (e.g. unstable areas and unstable soils) related to land use, climate, and geologic factors. Our overarching goal is to test how well the FPRs are working in green tree harvest areas to reduce sediment impacts to water quality, fish habitat, and promote WLPZ function. LiDAR from this pilot phase is the remote sensing tool used to evaluate effectiveness of FPRs related to mass wasting.To succeed in this project, both technical and administrative challenges must be addressed. The most demanding of the technical challenges is that LiDAR surveys require specialized equipment and processes that are deployed from aircraft. This requires reliance on experienced vendors. Each vendor uses proprietary processes to produce the LiDAR products. Comparisons of LiDAR acquisitions between different vendors may result in difficulties due to the potential uniqueness of the combination of equipment, settings, and processing. Therefore, it is preferable to use to the same vendor if possible. If not, it may be important to be able to provide a vendor the original raw LiDAR for both surveys for their processing. Existing LiDAR acquisitions may have use restrictions depending on the original contracts.

Logistically, there are substantial administrative constraints in obtaining pre- and post-event LiDAR. First, predicting the location and timing of a candidate event(s) is difficult and uncertain at best. Timely and effective mobilization is imperative to conduct event-driven surveys. These surveys require that budgetary funds and vendor contracts are secured and that favorable weather and ground conditions (e.g. roads are open, etc.) are present. Currently several factors and strategies exist that address these administrative constraints.

- During Spring 2017, an extensive LiDAR survey over a region of nearly 1,000 square miles of coastal watershed in southern Mendocino countyas been conducted. Because the broad region encompassed in that survey, the chances are increased that a stressing event in the next few years may occur over part of that region in which case, that survey would provide a useful pre-event reference for comparisons.
  - Per that contract, the state will receive the raw data and products with unfettered use.
  - Use of the same vendor for post-event acquisitions would allow for optimal data preparation for comparisons. Contract requirements could impose quality metrics on the vendor to guarantee delivery of suitable products such as spatially aligned pre- and post- data.
- Earmarked monies can be set aside for post-event surveys.
- Contract relationships with LiDAR vendors can be established prior to candidate events.

**Relationship to Strategic Plan Themes and Critical Questions**:

If this proposal is funded, a detailed study plan will be developed and include specific critical questions and working hypotheses. Below are critical questions within the EMC's Strategic Plan.

<u>Theme 4. Mass Wasting</u>.

This proposal is most directly related to EMC Strategic Plan Theme 4-Mass Wasting Sediment (directly quoted below): To limit mass wasting sediment from anthropogenic sources, the FPRs require that timber operations be planned and conducted to provide mitigation measures to minimize sediment delivery from unstable geologic features (14 CCR § 923 [943, 953]). While considerable past monitoring efforts have addressed implementation and short-term effectiveness of FPRs designed to limit sediment delivery from surface erosion processes, less documentation has occurred on a statewide basis for success of the FPRs in preventing sediment delivery from management-related mass wasting. This is particularly important in the California Coast Ranges and Klamath Mountains, where landslide features can be the primary sediment delivery mechanism. Achieving this goal is consistent with the goals of FGCom and/or FGCom and Board (Joint) policies, including the Endangered and Threatened Species, Salmon, Water, and Joint Pacific Salmon and Anadromous Trout Policies. In addition, these FPRs will also contribute toward meeting Basin Plan objectives. The critical questions regarding this theme address specific mass wasting related topics to determine if the current rules and regulations are effective in avoiding and reducing management-induced mass wasting.

Critical Questions: Are the FPRs and associated regulations effective in minimizing sediment delivery from…

(a) existing chronic unstable geologic features to maintain water quality?

(b) mass wasting during episodic rare events and/or large storms to maintain water quality (see Section 4.2.2)?

(c) mass wasting from high risk geologic features?

Landslides that do occur have the potential to deliver large wood and sediment to streams, and may cause substantial change in riparian and aquatic habitat. "Rare or large events" that trigger a large number of landslides in a region or watershed provide the opportunity to observe the degree to which WLPZ designs:

- mitigate sediment delivery to streams from landslide,
- mitigate triggering of near-stream landslides,
- provide LWD for recruitment to stream channels[i] ().

Following are excerpts from the EMC Strategic Plan Themes that are interrelated with this proposed study;

Theme 1: WLPZ Riparian Function

The FPRs have been developed to ensure that timber operations do not potentially cause significant adverse site-specific and cumulative adverse impacts to the beneficial uses of water, native aquatic and riparian-associated species, functions of riparian zones or result in an unauthorized take of listed aquatic species (14 CCR § 916 [936, 956]). The primary objective of the WLPZ FPRs is to maintain or restore riparian and aquatic functions in classified watercourses. This can occur with both passive and active management approaches that may incorporate options ranging from protection (passive no touch) to active manipulation of stand structure and include timber harvest (14 CCR § 916.9 [936.9, 956.9](v)). Key functions of riparian zones include large wood recruitment, watercourse shading, sediment filtration, nutrient input, microclimate control, streambank/hillslope stability, and habitat for terrestrial wildlife species.

Critical Questions: Are the FPRs and associated regulations effective in …

(d) retaining predominant conifers in WLPZs. (Implementation and Compliance) and large woody debris input to watercourse channels?

(e) filtering sediment that reaches WLPZs?

Theme 2: Watercourse Channel Sediment.

Since the implementation of the modern FPRs in 1975, a primary goal of these regulations has been to limit the delivery of management-related sediment to watercourse channels in California. The amount of hillslope erosion and sediment delivery that occurs following timber operations depends on numerous factors, including the site conditions present (e.g. slope, soil type, vegetative cover), soil disturbance, level of proper FPR implementation, and intensity and number of large storm events following the completion of logging. The FPRs have been upgraded numerous times in the past 40 years to reduce management related sediment delivery. Specifically, current silviculture practice regulations (14 CCR § 913 [933, 953]), harvesting practices and erosion control measures (14 CCR § 914 [934, 954]), watercourse and lake protection (14 CCR § 923 [943, 953]) and logging roads, landings and logging road watercourse crossings rules (14 CCR § 923 [943, 953]) provide measures to ensure timber operations meet the goals and intent of the FPRs by limiting sediment delivery to stream channels. These FPRs can contribute toward meeting goals of FGCom and/or FGCom and Board (Joint) policies that address protection of water quality and fish habitat, including the Endangered and Threatened Species, Salmon, Water, and Joint Pacific Salmon and Anadromous Trout Policies. In addition, these FPRs may also contribute toward meeting Basin Plan objectives.

Critical Questions: for Theme 2 address erosion and sediment monitoring at both the watershed (or sub-watershed) scale and Plan scale. Critical Questions:

(f) Are the FPRs and associated regulations effective in minimizing management related sediment delivery from forest management activities to watercourse channels?

<u>Theme 3: Road and WLPZ Sediment</u>

Similar to Theme 2, the Road and WLPZ Sediment theme has been developed to answer critical questions regarding management-related hillslope erosion and sediment delivery to watercourse channels in forested watersheds. Theme 3 focuses on critical questions related to the effectiveness of FPR requirements included in the recently implemented Road Rules 2013 requirements (14 CCR § 923 [943, 953]). These FPRs also contribute toward meeting goals of FGCom and/or FGCom and Board (Joint) policies that address protection of water quality and fish habitat listed above. In addition, these FPRs may also contribute toward meeting Basin Plan objectives.

Critical Questions: Are the FPRs and associated regulations effective in …

(g) reducing or minimizing management-related generation of sediment and delivery to watercourse channels?

(h) reducing generation and sediment delivery to watercourse channels when timber operations implement the Road Rules 2013 measures?

(i) reducing the effects of large storms on landslides as related to roads, watercourse crossings and landings?

(j) maintaining or improving fish passage through watercourse crossing structures? (see Section 4.2 for discussion of appropriate scale(s))

Theme 5: Fish Habitat

Numerous FPR regulations relate to the protection of fish habitat features in forested watersheds, particularly those found in the WLPZ rule section [14 CCR § 916 (936, 956)]. Specifically, these FPRs require that timber operations shall be planned and conducted to provide protection for water temperature control, streambed and flow modifications by large woody debris, filtration of organic and inorganic material, upslope stability, bank and channel stabilization, and spawning and rearing habitat for salmonids [14 CCR § 916.4 (936.4, 956.4) (b)]. As stated above for the other themes, these rule requirements contribute toward meeting the goals of Fish and Game Commission and/or Fish and Game Commission and Board (Joint) policies, including: Endangered and Threatened Species Policy, Salmon Policy, Water Policy, and Joint Pacific Salmon and Anadromous Trout Policy. In addition, these FPRs may also contribute toward meeting Basin Plan objectives. The critical questions included under this theme relate to maintaining and/or restoring the quality and connectivity of foraging, rearing, and spawning habitat.

Critical Questions: Are FPRs and associated regulations effective in …

(b) maintaining and restoring the distribution of foraging, rearing and spawning habitat for anadromous salmonids? (Note: Monitoring may also be appropriate for the AB1492 Working Groups).

As demonstrated by the emphasized elements of Themes 1, 2, 3 and 5, this proposed project would be expected to contribute substantially to evaluation of FPR effectiveness in terms of those themes and their critical questions. If this proposal is funded, a detailed study plan will be developed and include specific critical questions and working hypotheses.

Finally, this proposed pilot phase could contribute to understanding potential long-range effects of climate change, drought, forest health and increased wildfire severity by including these factors as potential stressors that may influence accelerated mass wasting rates across managed timberlands. In particular, the effects of declining forest health expressed by tree mortality or reduced vigor in response to drought, disease, and insect infestation would be expected to increase the potential for slope instability due to a reduction in root reinforcement and reduced evapotranspiration. As a result, elevated soil moisture may increase the likelihood of a triggering event. Similarly, wildfire is expected to increase the potential for landslides. Landscape response to wildfire would also provide an opportunity to evaluate the effectiveness of site-specific protection measures implemented within fire-scarred WLPZs and logging areas to promote slope stability, reduce sediment delivery to channels, and promote LWD delivery to channels.

**Geographic Scope: (See attached maps)**

Below we describe two sites (the Bagley Fire burned area and the collective burned area of the Fred's and Power Fires) that meet some or all of the desirable criteria listed above. Each of these sites have experienced wildland fires after which LiDAR data was collected. Each of the sites experienced recent storm damage and a range of land use conditions that may relate to the extent and magnitude of storm damage. Burned areas are preferred over heavily timbered areas as environments to test methods because the accuracy of bare earth DEMs will be optimized without the interference of tall and dense vegetation.

Post-fire erosion is strongly related to the soils and parent rock types. Each of the sites consist of different rock types and related geologic conditions. Evaluating the methods over a suite of rock types and conditions would test the efficacy of LiDAR across a variety of soils and parent rock types.

For both areas of interest (AOI), we provide maps that illustrated property ownership, fire perimeters, recent storm damage on US Forest Service lands, and vegetation types.

**Bagley Fire AOI**

The Bagley Fire AOI consists of mixed rock types that characterize much of the timber producing regions of the following the Klamath Geomorphic ProvincesThe rock types are also representative of the rangelands and oak woodlands located in the foothills of the Sierra Nevada Geomorphic Province.

- Pre-storm QL1 LiDAR exists
- Dates
  - Fire: Aug-Sep 2012 (also a much smaller fire in 2005)
  - LiDAR: Aug-Sep 2013 (LiDAR collected 1 year after 2012 Bagley Fire)
- Types of Movement
  - Based on USFS 2017 storm points: landslides (mode unspecified), rock slide, debris flows, cut slope/fill slope failures
- Potential Causal Mechanisms
  - Excess moisture during 2016-17 storm season
- Watersheds of Interest
  - Iron Cyn Reservoir, Pit Six Reservoir, and Shasta Lake
  - McCloud River, Squaw Valley Creek, Iron Cyn Creek
- Aquatic Habitat
  - Although Class I streams immediately flow into reservoirs where fish habitat is thoroughly altered, the streams are trout fisheries especially Squaw Valley Creek.
- Ownership
  - Mixed public and private timberland, with higher proportion of public land (71%) than Freds/Power AOI
  - Ownership distribution is public on north and south sides, with mixed grid pattern in center
- Public Benefit Elements
  - Water quality, fisheries, and aquatic habitat
  - Site lies immediately upstream of reservoirs and provide limited cold water fisheries and aquatic habitat.
- Public Safety Issues
  - None known

**Freds/Power Fires AOI**

The primary rock type of the Freds/Power Fires AOI is granodiorite that extends throughout the timbered portions of the Sierra Nevada Geomorphic Province.

- Pre-storm QL1 LiDAR exists
- Dates
  <u>North Polygon</u> (Freds Fire, King Fire, and Cleveland Fire)
  - Fires: Freds: Oct-Nov 2004, King: Sep-Oct 2014, Cleveland: Oct 1992
  - LiDAR: 10/2014-11/2014, 05/2015-06/2015 (LiDAR collected 10 to 10.5 years after Freds Fire, 1-8
    months after King Fire, and 22 years after Cleveland Fire)

  <u>South Polygon</u> (Power Fire)
  - Fire: Oct-Nov 2004
  - LiDAR: 11/2014, 04/2015-06/2015 (LiDAR collected 10 to 10.5 years after Power Fire)
- Types of Movement
  - Debris flows, earthflows, rotational slides, cut slope/fill slope failures
- Potential Causal Mechanisms
  - Excess moisture during 2016-17 storm season
- Watersheds of Interest
  - SF American River, Mokelumne River
- Ownership
  - Mixed public and private timberland (more balanced mix, with 61% public and 39% private)
  - Ownership distribution not a regular grid, but has balanced coverage throughout AOI
- Public Benefit Elements
  - Water quality and habitat protection
- Aquatic Habitat
  - Considerable, site includes tens of miles of cold water fisheries and aquatic habitat upstream of nearest reservoirs and dams
- Public Safety Issues
  - US Hwy 50
    - Flooding and landsliding

**LiDAR Summary**

The proposed LiDAR acquisition would advance the goals of the Effectiveness Monitoring Committee (EMC) in developing scientifically sound methods for understanding and monitoring the effects of stressing storms within various forests. The funds expended for this proposal would: 1) enable preparation of technical specifications and requirements, 2) predict future costs and levels of effort for the storm response study, and 3) advance technical expertise that would be available for other EMC studies.

**Potential Collaboration:**

CALFIRE staff at may contribute to data processing and analysis

**Budget Request**:

Acquisition would be arranged for the late summer of 2018 once the areas are free of snow pack.

The costs would range from approximately $50,000 if only one of the proposed areas is funded to $100,000 if both areas are approved.

If approved in concept, a vendor will be contacted in order to provide a detailed cost estimate.

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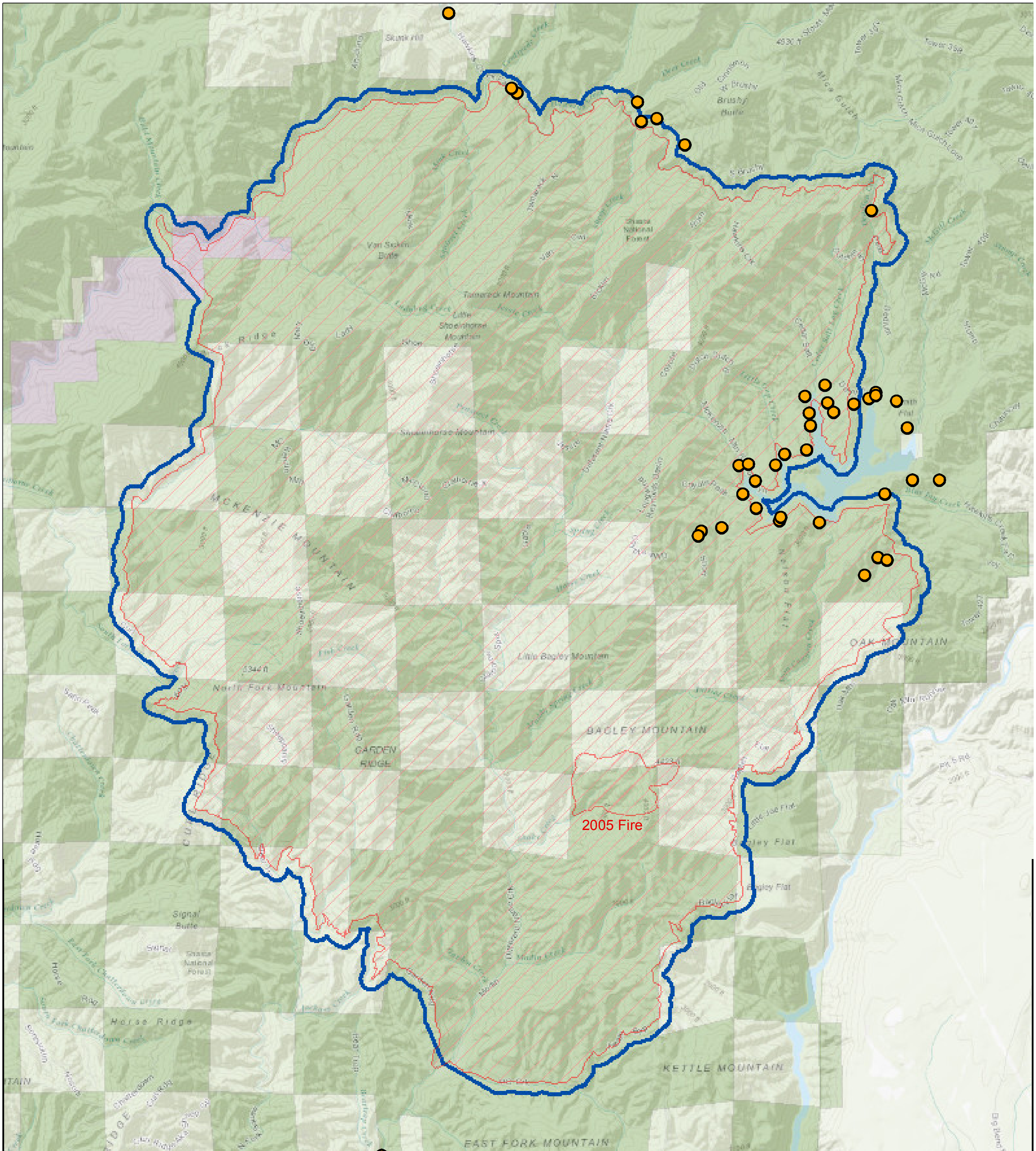
[i] mass wasting is an important process that moves LWD from the terrestrial to the aquatic environment; WLPZ is a critical source area for LWD recruitment to streams, and stream disturbance associated with mass wasting episodes may cause channel shifts and overbank flow that recruits LWD to the aquatic environment

# MAPS AND IMAGERY




S E i HERE D L I i P C GEBCO USGS

# Ownership - Bagley Fire Lidar AOI

| Ownership | Acres | Sq Miles | Percent |
|---|---|---|---|
| Federal (USFS) | 35,193 | 55.0 | 71 |
| Private | 14,280 | 22.3 | 29 |
| NGO/Other (TNC) | 444 | 0.7 | 1 |
| | 49,917 | 78.0 | |

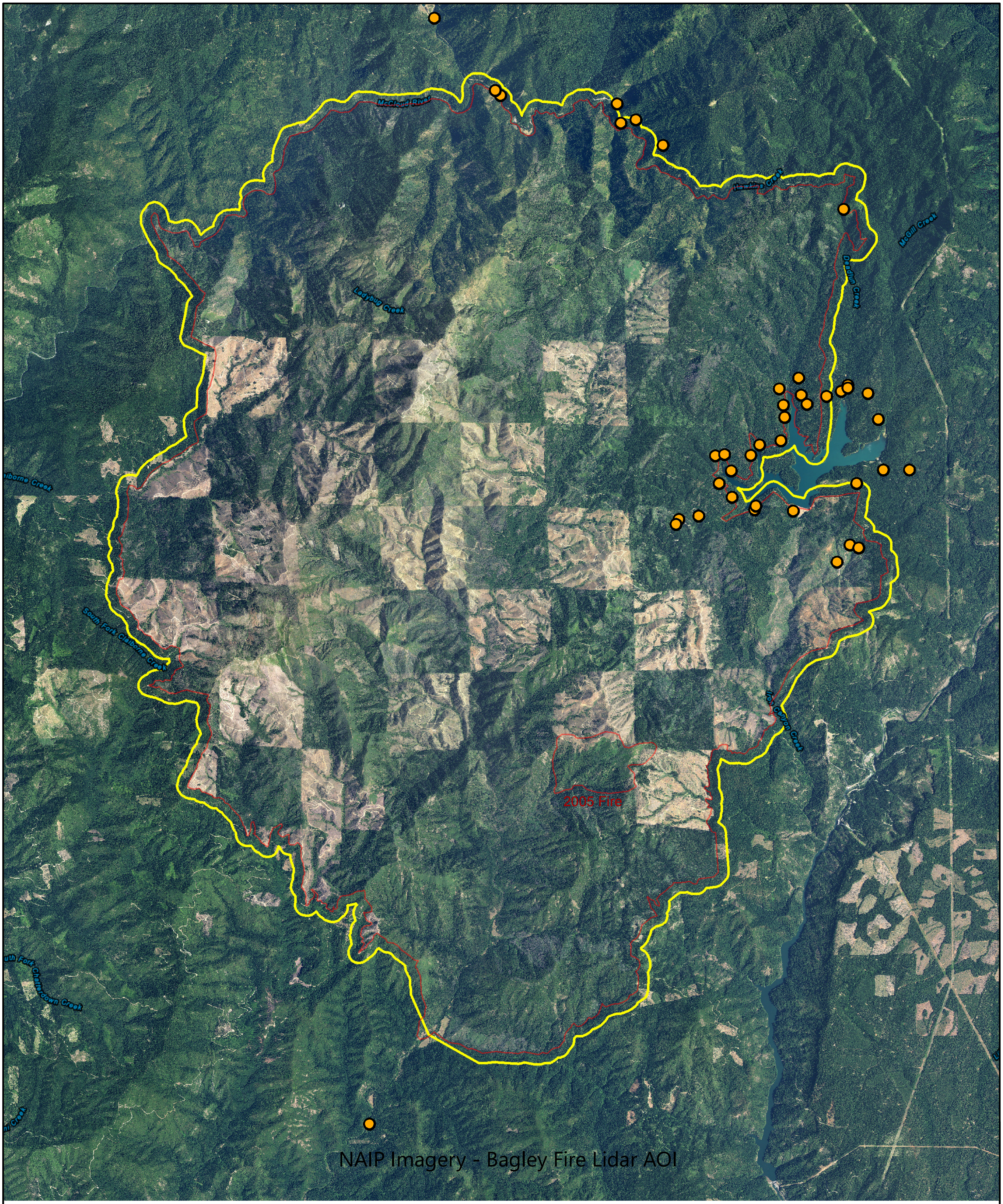
Bagley Fire Lidar AOI (2013 and proposed 2017)

Bagley fire perimeters (2012 and 2005)

USFS 2017 Storm Damage (7/19/17)

0 0.5 1 2 Miles

N




USFS 2017 Storm Damage (7/19/17)

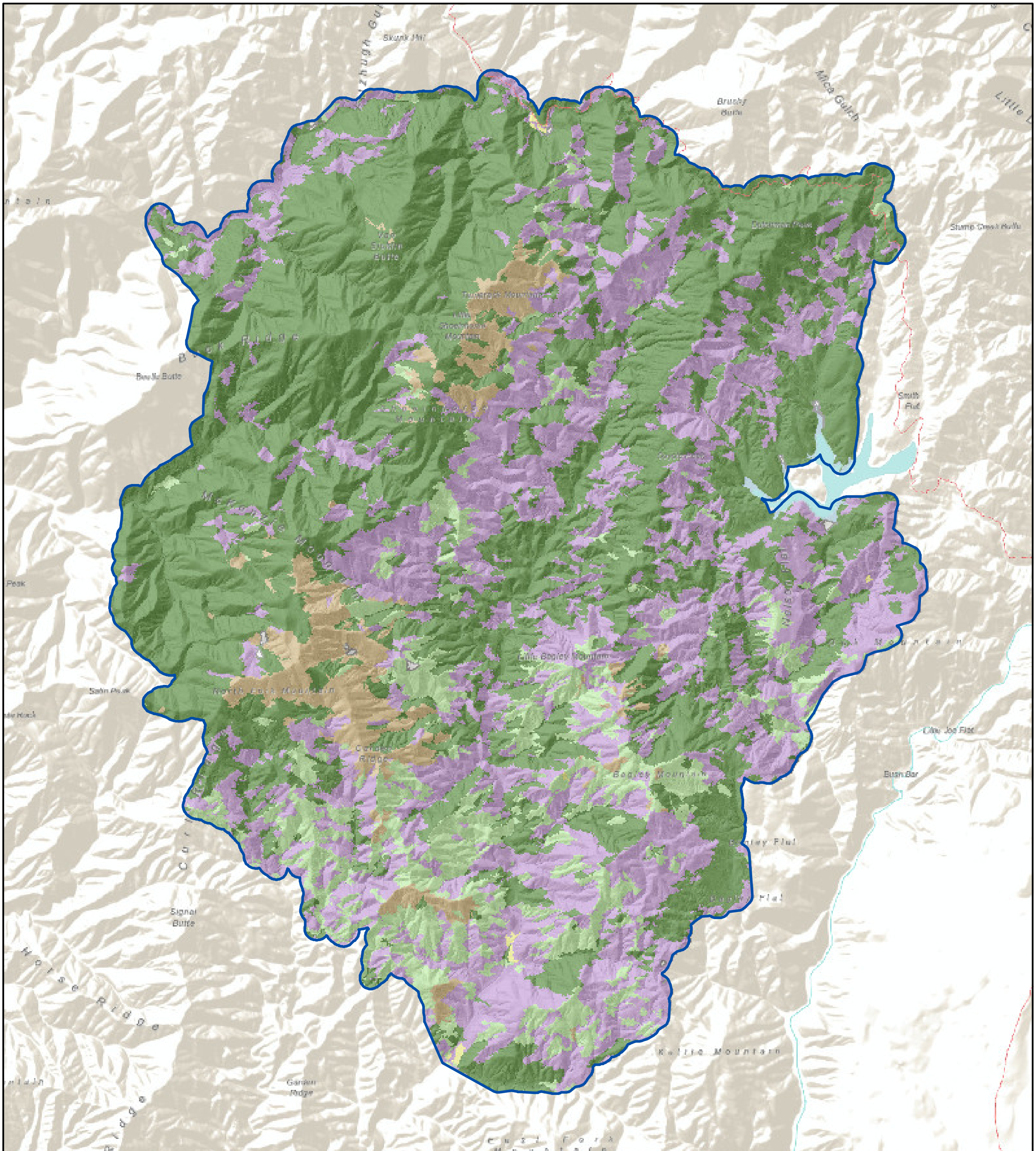
Bagley Fire Lidar AOI (2013 and proposed 2017)

Bagley fire perimeters (2012 and 2005)

2016 NAIP Imagery (source dates between 07/17/16 and 08/11/16)

0 0.5 1 2 Miles

N




USGS Anderson Level II Land Cover

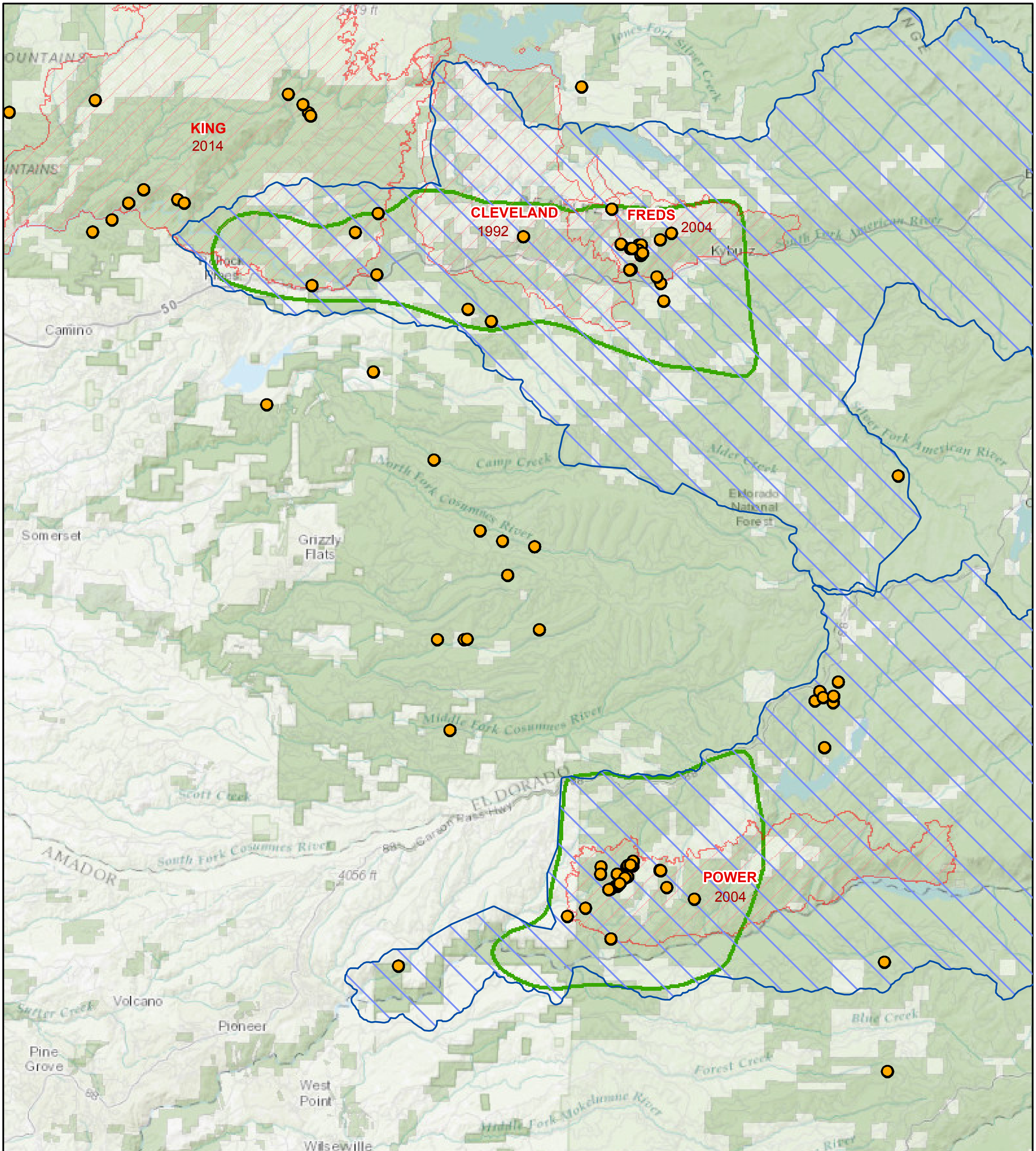
| | Acres | Sq Miles | Percent |
|---|---|---|---|
| Conifer | 26,876 | 42.0 | 54 |
| Mixed conifer hardwood | 15,347 | 24.0 | 31 |
| Hardwood | 5,072 | 7.9 | 10 |
| Shrub and brush rangeland | 2,364 | 3.7 | 5 |
| Intermittent lake or pond | 42 | 0.1 | <1 |

# Vegetation - Bagley Fire Lidar AOI

Bagley Fire Lidar AOI (2013 and proposed 2017)

0 0.5 1 2 Miles

N



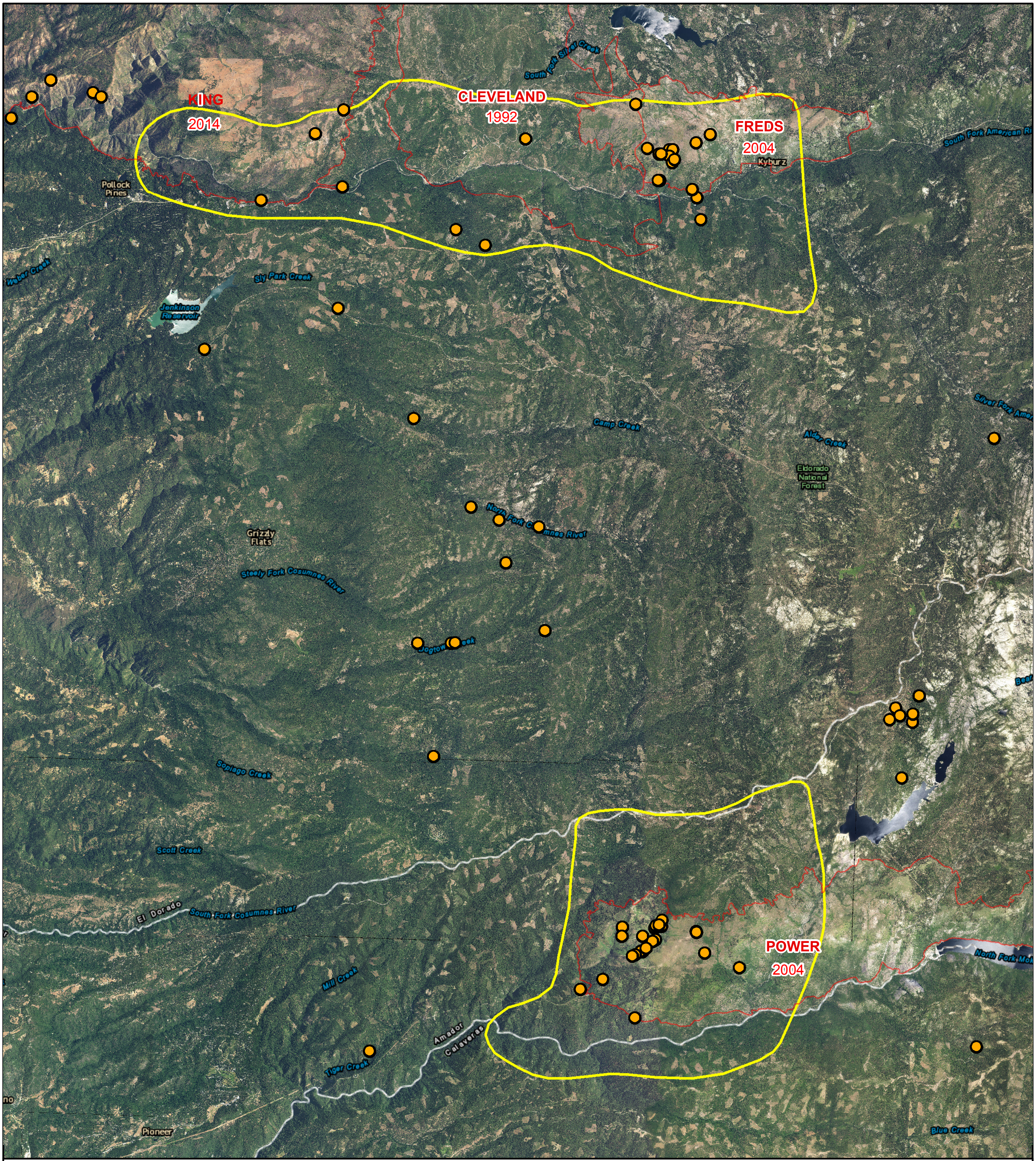

# Ownership - Freds/Power Fires Preliminary Lidar AOI

| Ownership | Acres | Sq Miles | Percent |
|---|---|---|---|
| Federal (USFS) | 38,686 | 60.4 | 61 |
| Private | 25,004 | 39.1 | 39 |
| | 63,690 | 99.5 | |

- Preliminary AOI for Freds and Power Fires 2017 Lidar
- Extents of 2015 Freds and Power Fires Lidar
- Major fire perimeters
- USFS 2017 Storm Damage (7/19/17)

0 1 2 3 4 5 Miles

N




NAIP Imagery - Freds/Power Fires Preliminary Lidar AOI

USFS 2017 Storm Damage (7/19/17)

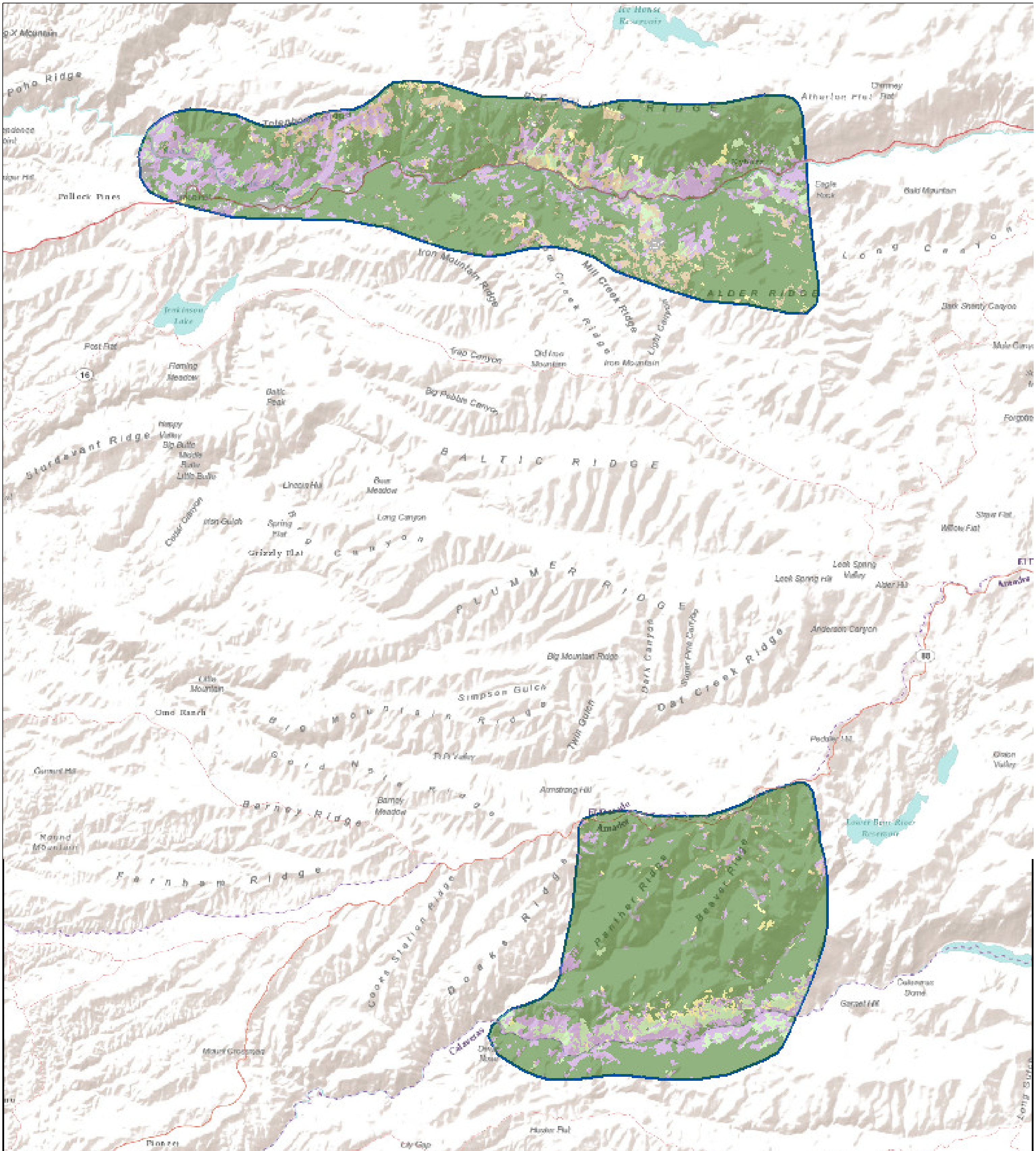
Preliminary AOI for Freds and Power Fires 2017 Lidar

Major fire perimeters

2016 NAIP Imagery (source dates between 06/20/16 and 07/22/16)

0 1 2 3 4 Miles

N




Vegetation - Freds and Power Fires Lidar AOI

USGS Anderson Level II Land Cover

| | Acres | Sq Miles | Percent |
|---|---|---|---|
| Conifer | 46,385 | 72.5 | 73 |
| Mixed conifer hardwood | 9,001 | 14.1 | 14 |
| Shrub and brush rangeland | 3,199 | 5.0 | 5 |
| Hardwood | 2,858 | 4.5 | 5 |
| Herbaceous rangeland | 776 | 1.2 | 1 |

Preliminary AOI for Freds and Power Fires 2017 Lidar

0 1 2 3 4 Miles

N