Digitization of Disturbance History for Swanton Pacific Ranch from 1989 to 2015

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Introduction

To understand how forests change over time, we must look at the disturbances and how these interact with forests over time. Disturbances such as fires, landslides, windthrow, and disease along with more anthropogenic disturbances such as logging start the ecological succession process. It is through disturbance ecology that these relationships are studied (Rogers, 1996), and are used to better understand natural processes, disturbance regimes and help determine methods and timing of management of forests.

Redwood (*Sequoia sempervirens*) forests are a unique plant community found growing in a restricted geographic band up the coast of California through the southern edge of Oregon. These forests are often in the “fog belt”, where frequent fog during summer months provides redwoods with adequate moisture (Burgess & Dawson, 2004), providing a near year round source of effective precipitation in an otherwise arid climate. These forests have adapted over the millennia to be a niche community with other distinct flora and fauna dominated with epiphytic lichens, bryophytes, ferns and other vascular plants (Williams & Sillet, 2007) due to unusual characteristics in these forests, such as histosol soils forming on large lateral branches, hundreds of feet in the air (Enloe, 2006). The management of this forest type is important because it not only provides a sanctuary for these endemic species and communities, but it also provides aesthetic, recreational, and economic benefits to humans.

Redwoods are adapted to disturbances such as periodic flooding and fire (Stephens, 2005). The trees are tolerant of shade but prefer full sun if ample moisture is available and can grow quite rapidly if they have favorable conditions (Boe, 1975). They can be extremely long lived trees, with individuals recorded being over 2,200 years old, and can attain heights of 200-300 feet (Koch et al., 2004). Using genetic sequencing, it was found that 32% of redwood stems in second growth forests are genetically distinct, suggesting they are, or are the sole clone of a tree which germinated from seed (Douhovnikoff et al., 2004), while the rest of the stems are represented as an assortment of genetic clones. This is because redwoods coppice readily which has been the primary form of regeneration for silvicultural prescriptions of this forest type (Boe, 1975). This results in rapidly regenerating even aged stands, after harvest.

The southern extent of the Redwood forests is in the Santa Cruz Mountains. The forests here were logged in the latter half of the 19th century, with widespread clearcutting in the early 20th century as a response to the increase in demand for timber by San Francisco after the 1906 earthquake (Noss, 2000). The resulting second growth forests started to be harvested in the mid-1900s, continuing to present. Under California Forest Practice rules specific to the Southern Subdistrict of the Coast District, clearcutting has been outlawed since 1970, and single-tree selection has been the only silvicultural practice allowed in the Southern Subdistrict (Berlage, 2012). This silvicultural practice has resulted in the even aged transitioning to uneven age structure we now see in the managed forest lands of Swanton.

One area in the Santa Cruz Mountains with some of these second growth, managed redwood forests is Swanton Valley. In this area Swanton Pacific Ranch (SPR) is found, Cal Poly San Luis Obispo's living, learning laboratory. Redwood and Douglas-fir (*Pseudotsuga menziesii*) forests represent 1435 acres of the ranch, and provide a unique opportunity for forestry students fostering the 'learn by doing' philosophy as stated in the SPR mission statement.

Before European arrival, redwood forests historically burned frequently at a low intensity (Ramage, 2010). However, since the early 20th century, fire suppression has been the primary form of fire management in western North America, which lead to the accumulation of fuels, overcrowding of the understory, and a reduction in nutrient because of the hotter, higher fueled, fires volatilizing more organic material than low intensity fires. The result of this can be seen in the large fires such as the Lockheed Fire that burned over 7,800 acres in 2009.

The recent disturbance history of Swanton Pacific Ranch is not currently documented for the public but instead accessible only through oral communication and in historic timber harvest plans. There has been a need for a consolidated collection of disturbance history for the forests at Swanton Pacific Ranch to better understand the ecological dynamics and more effectively provide appropriate management.

Methods

Data collection

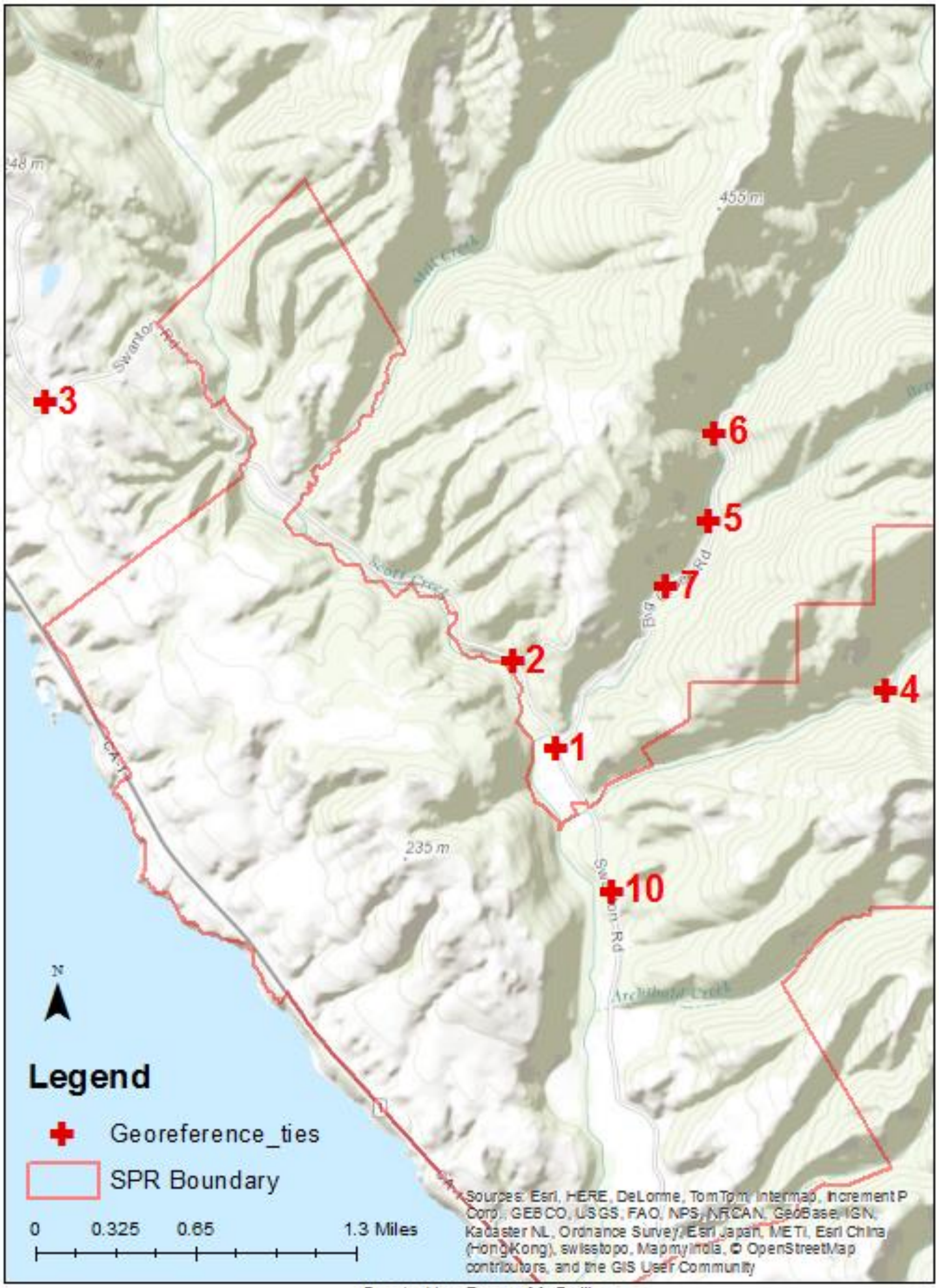
Past information for harvested areas was acquired from the current operations manager of SPR, Steve Auten, in the form of PDF maps included as attachments for past Timber Harvest Plans in addition to oral history. The original GIS data for vegetation burn severity of the 2009 Lockheed fire was obtained as raster layers from Cal Poly Research Guide, Russ White which was created by an aerial survey conducted within a year of the fire. All geospatial work and analysis of this data was completed using ArcMap 10.2.2. The 1991 FMP contained maps used to map the stand boundaries logged for the Pioneer harvest, which occurred in 1989 as the first group selection harvest under Cal Poly stewardship and occurred on the south slopes of the Little Creek watershed. A map titled Past Projects Map was obtained from Steve and contained the harvest boundaries for the Tranquility harvest, which occurred along the drainage of Little Creek in 1994 as a group selection harvest. The 2004 Lower Little Creek THP contained the maps outlining the associated harvest, which occurred as a group selection harvest in Little Creek and Archibald Creek. The 2008 NTMP had the maps which contained harvest boundaries used for the North Fork harvest of 2009 which was a group selection harvest along the north fork of Little Creek and the South Fork harvest of 2011, which was a group selection harvest along the south fork of Little Creek. The map which contained the emergency harvest boundaries, “Emergency Notice Map with Volume Estimates”, was obtained from Steve Auten and was carried out in 2009 as group selection harvests in multiple plots across Little Creek and Archibald Creek.

Timber harvest disturbance

To compile the data into an easily retrievable and usable format, three to four points of reference that were identifiable on past and present maps were used to correct distortion between maps. This is to account for differences in scale, and distortion across the different datums used between the maps. The points of reference were identified by locating buildings or permanent structures or road intersections that had not undergone relocation between the creation of the historic and current maps. Multiple georeferenced points of reference had to be selected, so that depending on which part of SPR the past maps were focused on, there would be sufficient reference points to correct distortion.

There were seven ties in total used for correcting distortion from past maps (Figure 1). Out of the seven points of reference used, two were road intersections and on the figure are labeled #1 and #2, two were structures labeled as #6 and #7, and one was a surveying benchmark labeled as #10. Two more points of reference were used that were stream confluences labeled as #4 and #5.

Once the past maps were aligned to the current topographic maps and layers, the harvest boundaries were traced, recorded and saved in a common database file for future access. Maps were then created to display the results.



Created by: Danny McQuillan
November 08, 2014

Figure 1. Location of study site, outlining Swanton Pacific Ranch and including reference locations used for georeferencing past maps to create updated disturbance boundaries in GIS.

Fire disturbance

Data were already available as a raster mapping burn severity for the 2009 Lockheed Fire from the LiDAR survey conducted by Cal Poly in 2010 (White, 2015). Data were then cropped to the SPR boundary and saved in the same database file as the timber harvest data. The files created were placed in a folder and were provided to Russ White, a Cal Poly Research Guide, and uploaded to the department servers. Maps were created using these layers, and are presented separately in the appendix. Information about estimated yields are recorded for the emergency harvest of 2009 in the layers created.

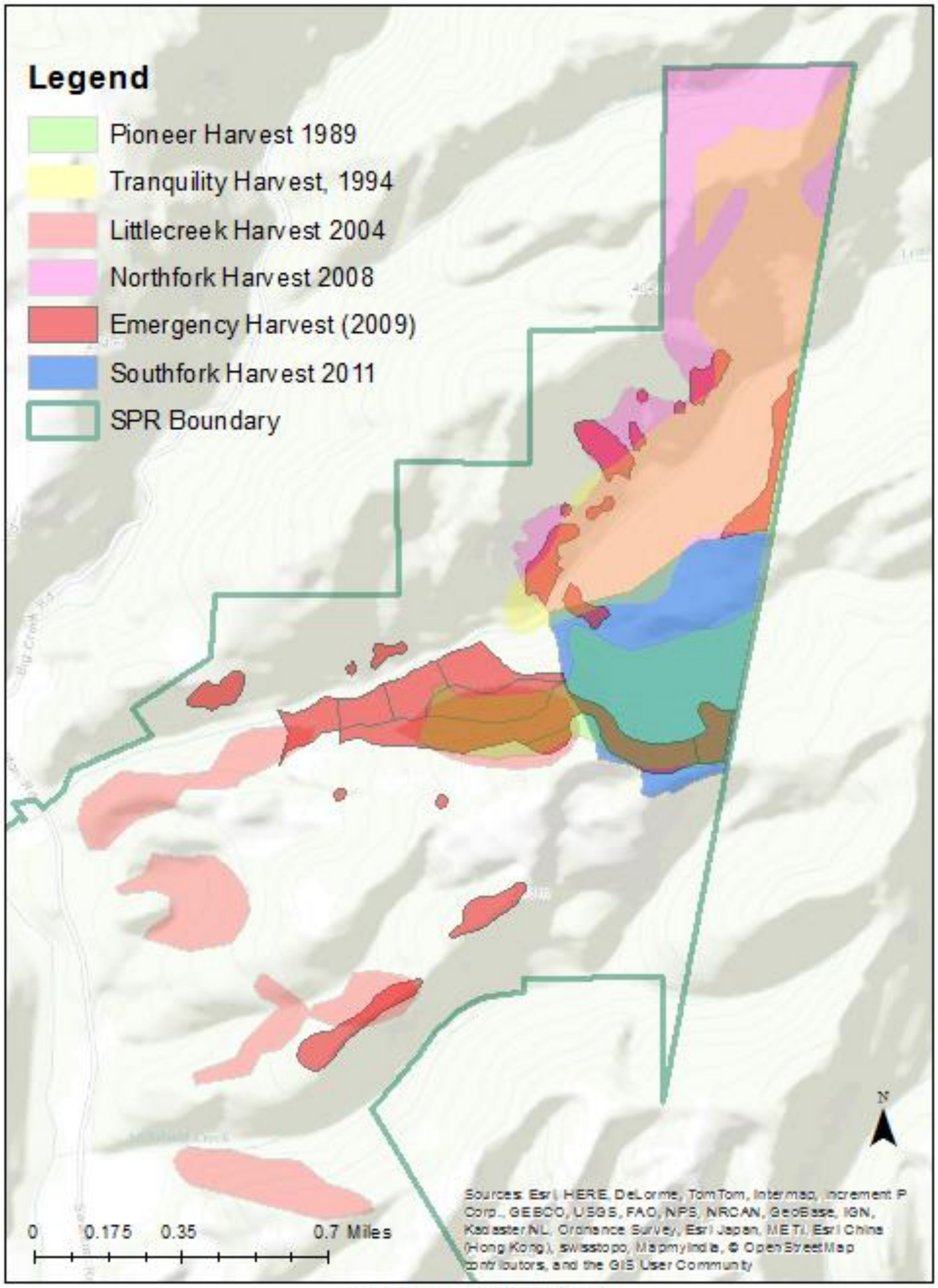
Results and Discussion

Once the disturbances became comparable, it displayed the concentration of disturbances in the Little Creek watershed. Particularly along the north fork and south of the confluence of the north and south forks of Little Creek. The total area effected by the disturbances is shown in Table 1. For the logging entries, harvest boundaries signify the areas where an economically profitable thinning silvicultural practice occurred, shifting the stand age class from an even aged distribution to a more uneven aged distribution within the harvest boundaries.

Table 1. Areas effected by recorded disturbances 1989-2014

Year	Name	Acres
1989	Pioneer	70.4
1994	Tranquility	147.7
2004	Little Creek	101.6
2008	Northfork	206.4
2011	Southfork	83.8
2009	Lockheed fire	1136.4
2009	Emergency harvest	92.1

The disturbance concentration is highest in the Little Creek watershed, with some areas falling into 3 harvest areas as shown in Figure 2. The burn severity shows a mosaic pattern, with more vegetation loss along ridge tops and less severe vegetation loss in the valleys which are dominated by the redwoods. This added more complexity to the forest structure, especially when coupled with the multiple harvest entries in the watershed.



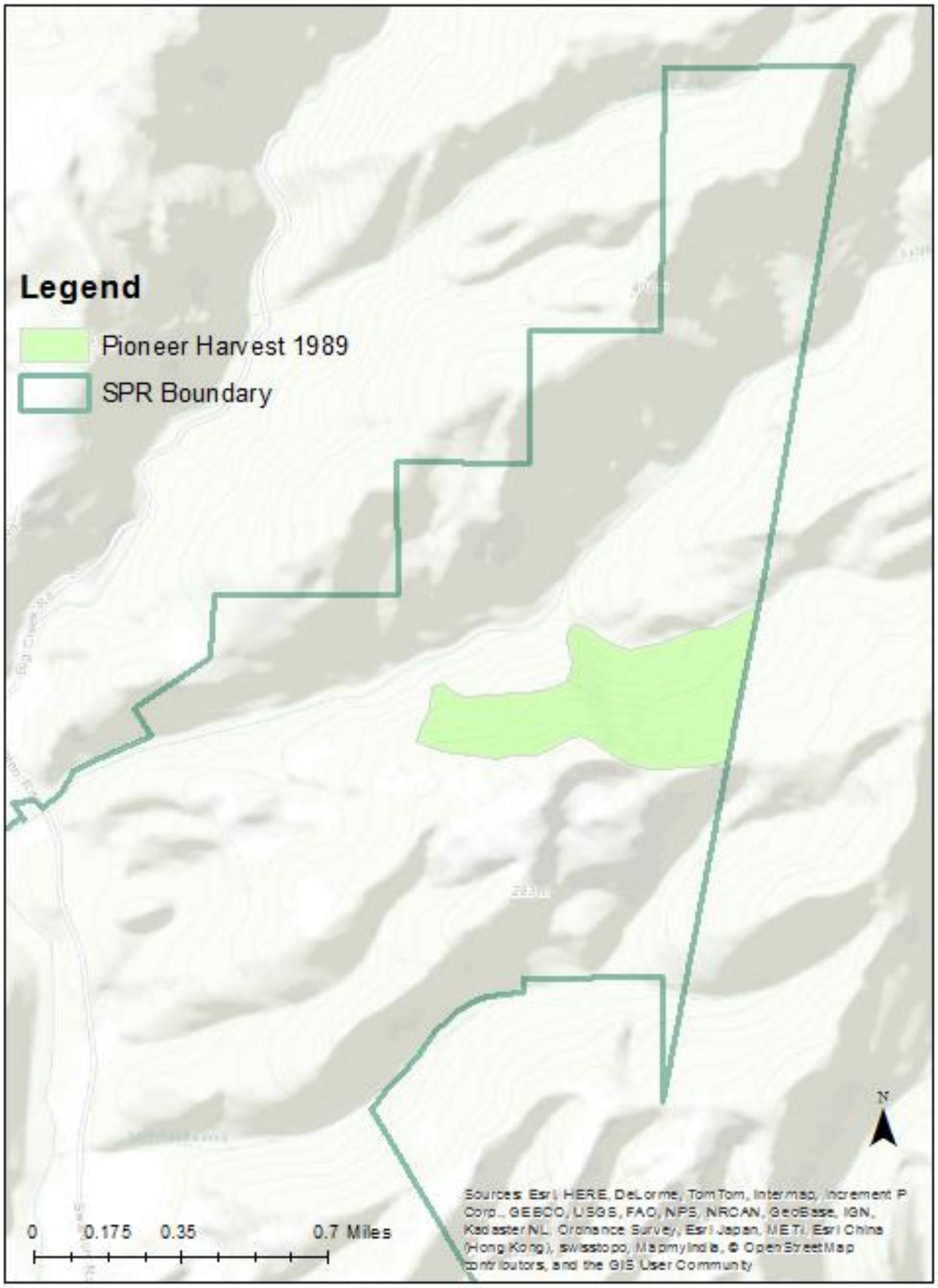
Created by: Danny McQuillan
May 21, 2015

Figure 2. Boundaries of all harvests from 1989 to 2011 at Swanton Pacific Ranch.

Conclusion

This project is a start in updating the resources Cal Poly has to work with, to continue to provide a learning environment for students and land managers. It will provide a framework for future work, which might include other disturbance events such as windthrow, flooding or extend before the first logging harvest Cal Poly was involved with in 1989. This data will prove valuable to further research, by facilitating informed site selection, in addition to deepening the understanding and to continue the history of stewardship for the land Cal Poly continues to inspire.

Appendix



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May 21, 2015

Figure 3. 1989 Pioneer harvest map for SPR

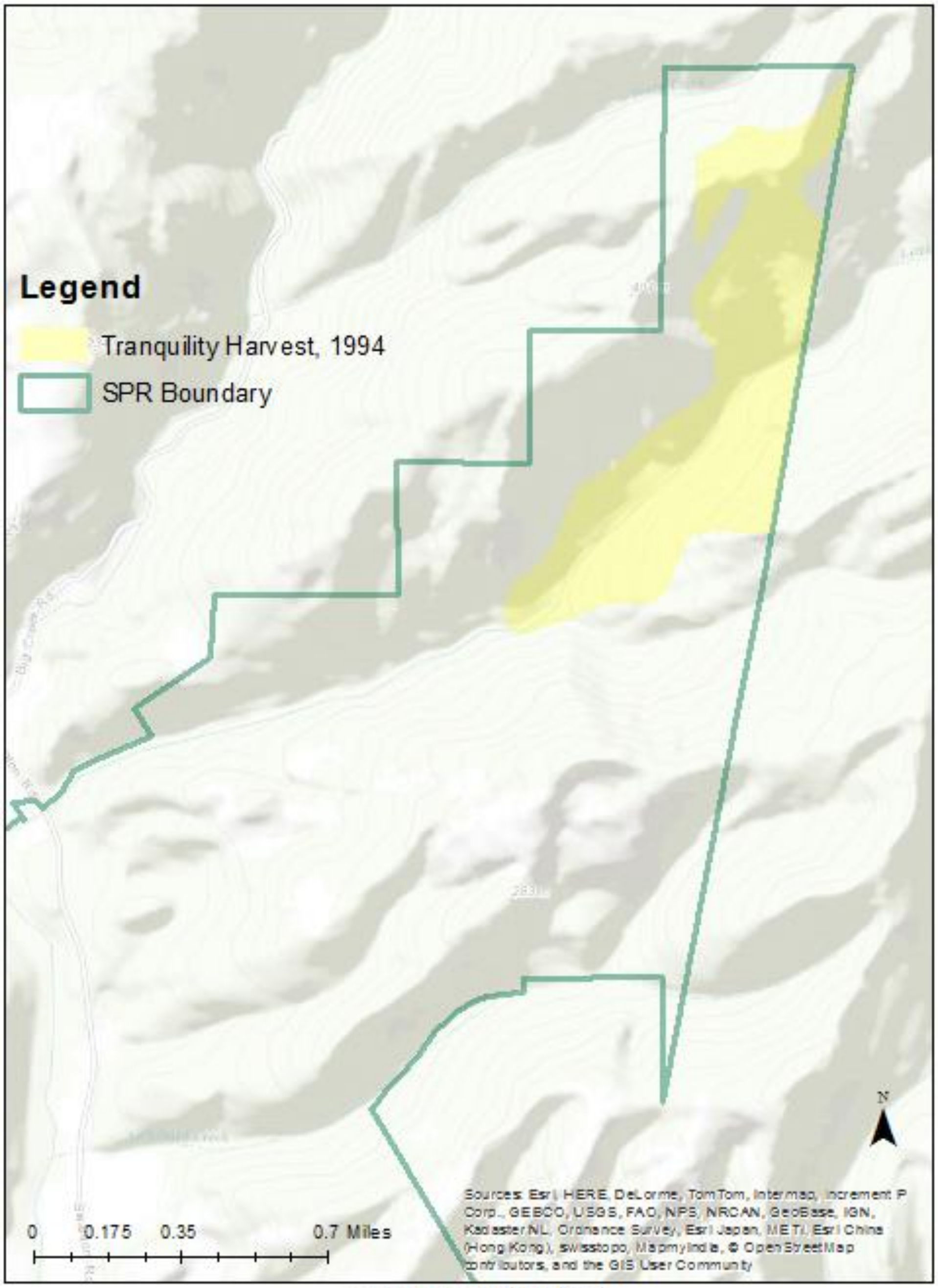

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Figure 4. 1994 Tranquility harvest map for SPR

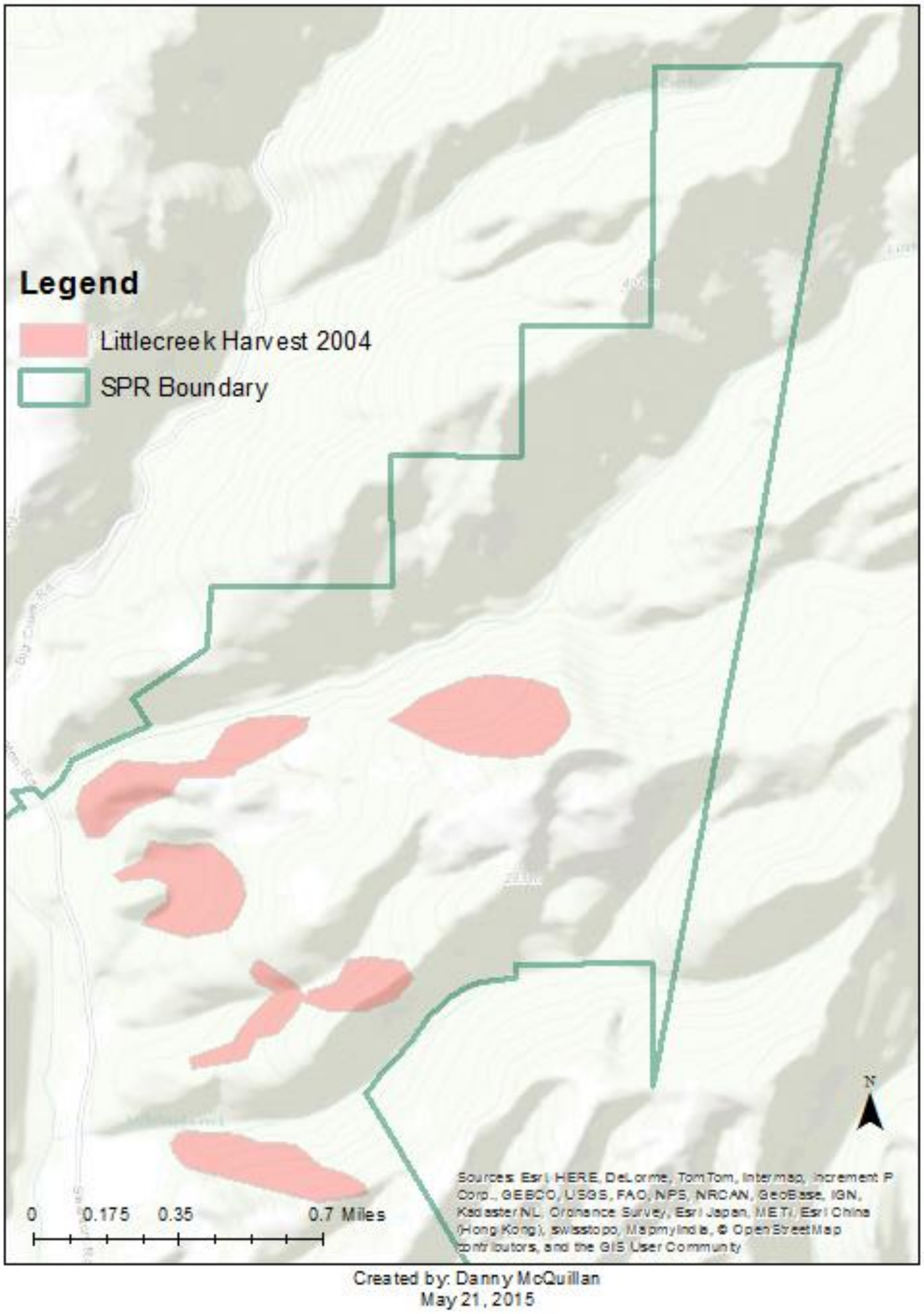

Figure 5. 2004 Little Creek harvest map for SPR

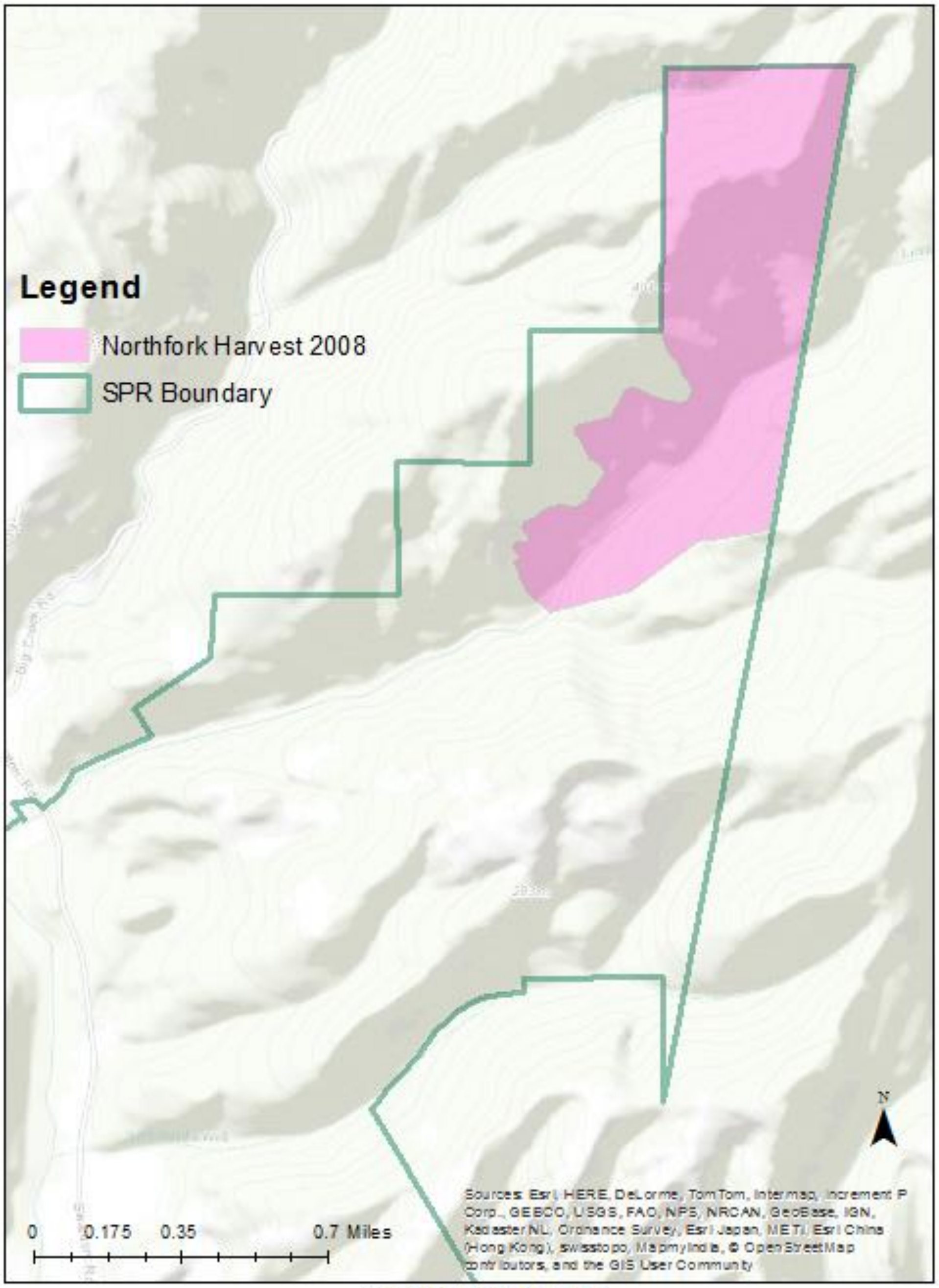

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Figure 6. 2008 Northfork harvest map for SPR

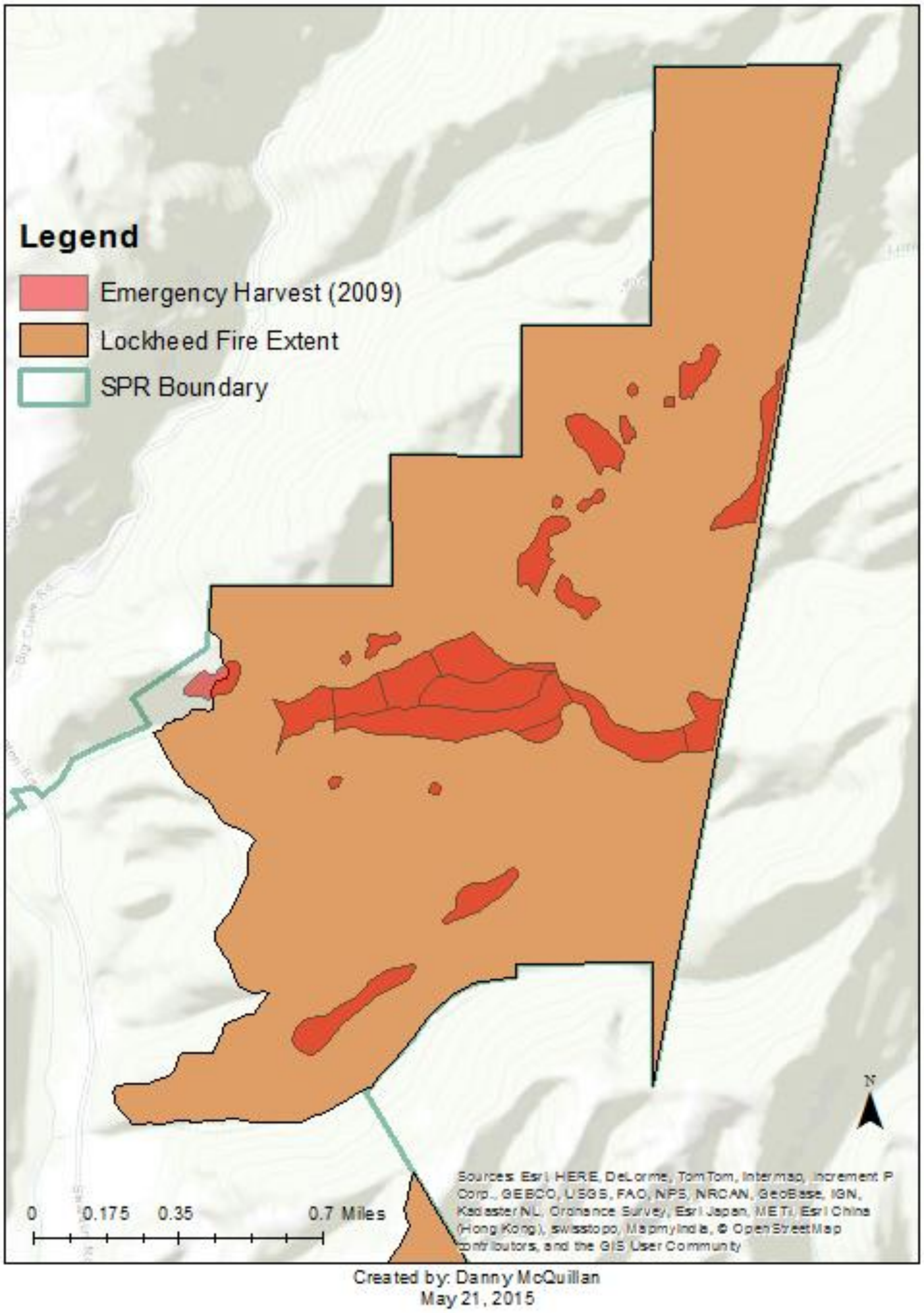

Figure 7. 2009 Emergency harvest map for SPR

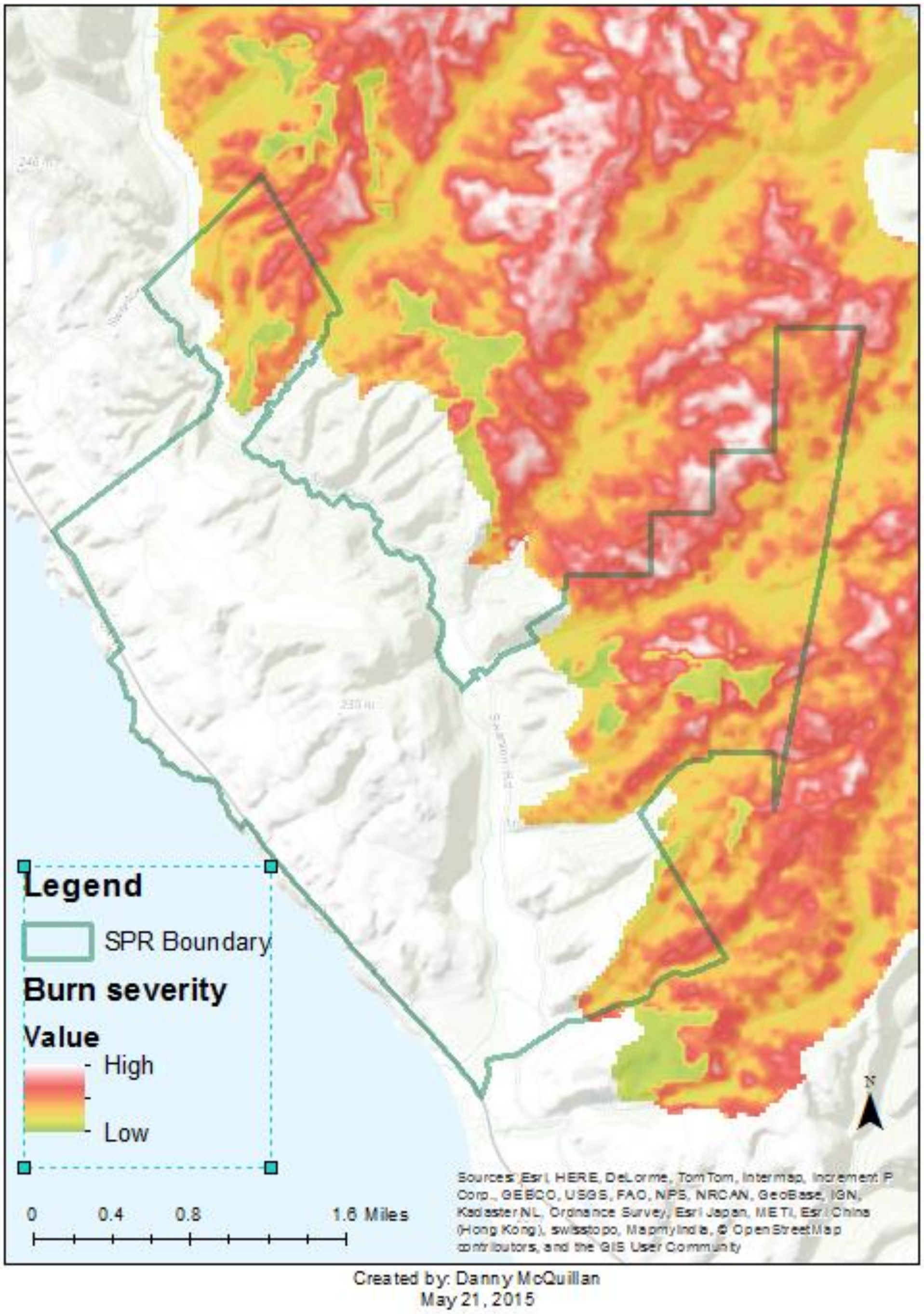

Figure 8. 2009 Lockheed fire burn severity map for SPR

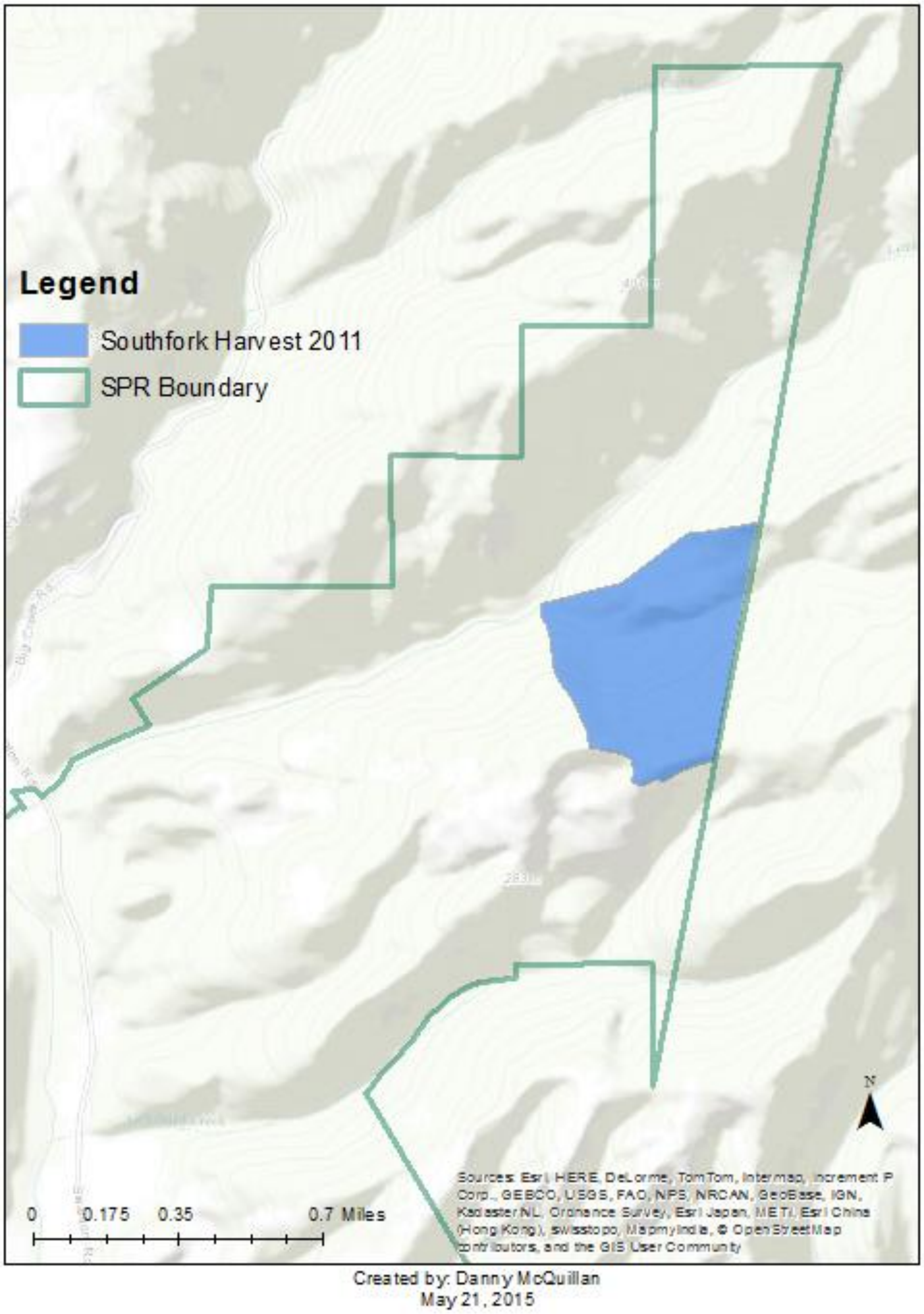

Figure 9. Southfork harvest map for SPR

Acknowledgements

I would like to thank Steve Auten, and Dr. Doug Piirto for sharing time in their busy schedules to answer my questions and pass along information they had in their memories, and sharing the necessary documents which provided the basis of this research; David Yun and Russ White for providing solutions to my numerous questions in GIS; Sarah Bisbing for her continued and persistent encouragement in this research and sharing time out of her busy schedule helping me create something I am proud of.

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