GREEN DIAMOND RESOURCE COMPANY

Contemporary Forest Management and Mass Wasting: Making Significant Progress.

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Abstract

The degree to which timber harvesting and related management practices influence mass wasting has changed dramatically over the last two decades and are now more carefully assessed and mitigated than ever before. As part of a recent mass wasting assessment on industrially managed timberlands in northern California, we reviewed 70 years of historic aerial photographs from 1942-2012 and measured over 2,900 shallow landslides in the field. Although landsliding is influenced by factors that on a decadal scale are stochastic in occurrence, the observations to date strongly indicate the new regulations, habitat conservation plans, and geologic oversight have made significant positive impacts on the degree to which timber management practices have affected regional mass wasting. Our study indicates shallow landslide erosion rates have dropped more than 90% since the peak rates that were observed in the 1970's. Most recent decadal erosion rates are at their lowest (0.16 m³/ha/yr) over the period of photographic record that was reviewed for this study.

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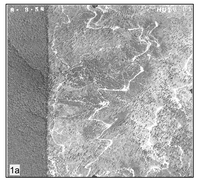
Factors contributing to declining shallow landslide erosion rates on managed timberlands in Northern California:

1. Changes in California State forest regulations.
2. Better Management Practices.
3. Increased Geologic Oversight.

1. Changes in California State forest regulations.

The approval of the California Forest Practice Act in 1973 brought many changes to forestry with the goal to ensure that logging was done in a manner that would preserve and protect fish, wildlife, forests, and streams. More stringent rules included changes to harvest unit sizes, tree retention along streamside slopes and road building standards. All of which have continued to evolve over time and have had significant impacts on management related mass wasting.

Photos 1a & 1b: By 1958 roughly 500 contiguous hectares harvested over a short span of a couple years. By 2009, harvesting shown in photo has spanned 10 years, clearcut blocks are no greater than 16 hectares, no adjacent clearcuts less than 5 years old, habitat retention zones can be seen within harvest blocks, & seasonal roads are decommissioned after use.


1a


1b

Key dates in changing California State forest regulations that impacted mass wasting prevention:

1973 - California Forest Practice rules established; Harvest plans began protecting fish bearing streams and cut blocks were limited to 49 hectares in size.

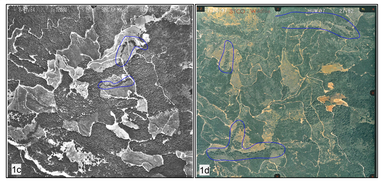
1983 - Watercourse and Lake Protection Zone (WLPZ) rules implemented, criteria for determining WLPZ added to forest practice rules increasing streamside tree retention.

1994 - Changes to silviculture and sustained yield plan resulting in smaller harvest blocks and reduced harvest rates.

2000 - Implementation of the Threatened and Impaired (T&I) Watershed rules which impacted WLPZs nearly doubling the size of these protection zones.

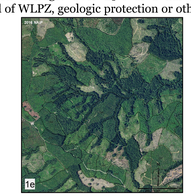
2010 - Anadromous Salmonid Protection (ASP) rule package was implemented adding increased protection to the WLPZ especially on lower order non fish bearing streams.

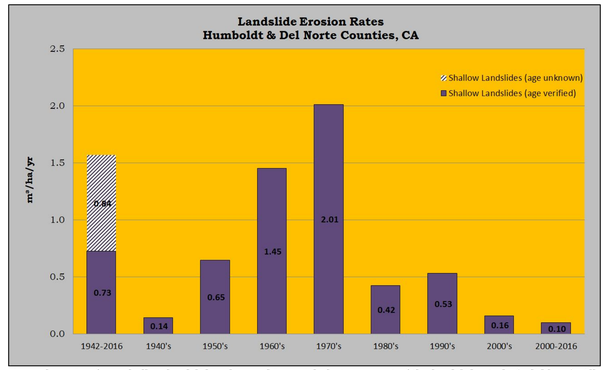
Photos 1c & 1d: By the 1980's harvest blocks were considerably smaller than in the past although retention areas were not yet a common occurrence and were much smaller in width than those of the late 1990's. By 2000, riparian zones had doubled in size. WLPZs are highlighted in blue.


1c

1d

Photo 1e: Today clearcut blocks are still limited to 16 hectares, however contiguous opening size is less than 6 hectares on average. Over 25% of a harvest block is composed of WLPZ, geologic protection or other retention areas.


1e



Annual erosion from shallow landslides observed in aerial photos as part of the landslide study (solid bars). All landslides included in decadal rates were field verified. The resulting data show a decreasing trend in erosion rates over time. Additional landslides were observed in the field but were not seen in photos. Landslides not seen in photos roughly equaled the volume of the slides observed in the aerial photos (striped bar). These additional slides roughly double the long term, 1942-2016, annual rate to 1.57 m³/ha/yr. Volumes from the non photo verified landslides are not incorporated with decadal rates as temporal estimates could not be made.

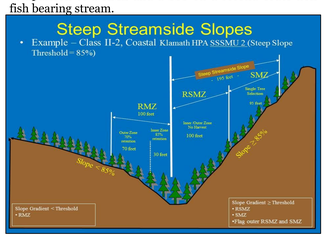
References

1. Green Diamond Resource Company. 2006. Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances. Volume 1–2, Final report. Prepared for the National Marine Fisheries Service and U.S. Fish and Wildlife Service. October 2006. 568 pp.
2. Woodward J., House, M., Lamphear, D., 2017. Development of Preventative Streamside Landslide Buffers on Managed Timberlands. USDA Forest Service PSW-GTR 258, Proceedings of the Coast Redwood Sciences Symposium, September 2016: Past Successes and Future Directions, pp 163-173.

2. Better management practices.

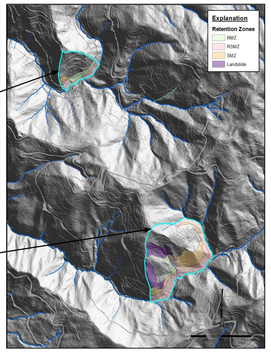
Management practices have evolved and improved over time. Examples include: A self imposed AHCP in 2007 that includes development and implementation of preventative landslide buffers; lower impact ground-based harvest methods; innovative Riparian Management Zones (RMZ) that protect aquatic habitat (note RMZs are analogous to a California forest practice rule WLPZ mentioned earlier, semantics…)

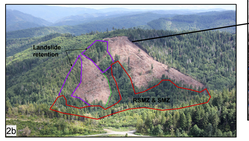
Below: The purpose of our initial landslide study was to develop preventative landslide buffers (Woodward, J. House, M., Lamphear, D., in press) which we defined as Steep Streamside Slopes (SSS). These buffers are similar to an RMZ but have elevated tree retention standards. Each SSS is further broken into a Riparian Stability Management Zone (RSMZ) and depending on slope steepness a Stability Management Zone (SMZ). Below is a comparison of a RMZ and a SSS on a second order non fish bearing stream.



Photos 2a & 2b: Photos of SSS zones implemented in THPs. These areas were logged using cable yarding methods. Lineations seen within clearcut blocks are cable yarding corridors leading to landings at top.
Map to the Right: A GIS depiction of the same harvest units are shown on a 1-meter LiDAR DEM. Historical skid trails are evident throughout the area.


2a

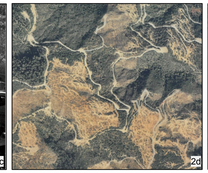




2b

Photos 2c & 2d: Historical ground-based logging included skidders and bulldozers that cut skid trails throughout a harvest block resulting in significant ground disturbance and exposed bare mineral soil. This method of logging began in the 1950's and was prevalent into the early 2000's.

2c

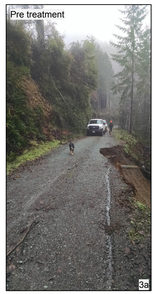

2d

Photos 2e & 2f: Modern ground-based logging transitioned from tractor to "shovel" logging in 2000. Shovel logging utilizes track-mounted machines that operate on top of the slash without the need for cutting skid trails, significantly reducing the amount of bare soil exposed compared with historical ground-based operations.


2e


2f

3. Increased Geologic Oversight.



3a

Geologic oversight began with the passing of the Forest Practice Act. As the Forest Practice Act developed geologic review of harvest plans gradually increased. Today, licensed Geologists from the California Geologic Survey review all submitted Timber Harvesting Plans (THP) and most plans with complex geologic issues receive input from consulting licensed geologists. Over the last few years our geology staff has reviewed around 50 harvest plans per year. As part of our work we review published mapping as well as our in house LiDAR and geologic mapping. Most plans receive some level of field review and roughly 20 percent receive either a modified geologic map or a geologic report that is submitted with the THP.
Photos 3a, 3b, & 3c: Improved road building and repair practices that include disconnecting road drainage systems from streams and input from licensed geologists as needed. Photos show debris slide repair on haul road.

3b

3c

Photos 3d & 3e: Landslides identified during field reconnaissance of harvest block layout, note split stump and back-tilted tree. **Photo 3f** landslide adjacent to haul road and watercourse is mitigated with rock buttress, seed and mulch. **Photo 3g:** Geologist assess landslide identified during plan layout and plan mitigation.

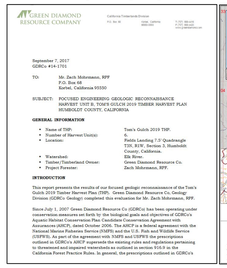

3d


3f


3e

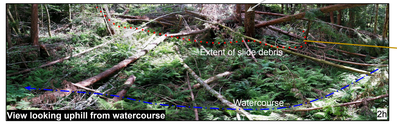

3g

Below: Excerpt from geologic report submitted with a Timber Harvest Plan.



Photos 2g, 2h, & 2i: Tree retention related to Riparian Management Zones (RMZ) provides root strength and evapotranspiration for slope stability and if a landslide occurs they provide wood for recruitment to streams for aquatic habitat and minimize the delivery of fine sediment.

2g



2h

2i