**Atmospheric Anthropogenic N**

Atmospheric anthropogenic N-deposition is significant in chaparral in southern California (Fenn et al., 2003a; Phoenix et al., 2006). Of gaseous and particulate N pollutants, the majority (85-95%) fall as dry deposition during the summer when **inversion** conditions trap these pollutants near the land surface (Bytnerowicz and Fenn, 1996; Fen et al., 2003a). Atmospheric N inputs can increase total and available N through direct fertilization and enhanced mineralization, reduce soil C:N ratios, enhance soil acidification, and promote losses of N from gaseous efflux and leaching (Fenn et al. 2003b; Meixer and Fenn, 2004; Michalski et al., 1999, Riggan et al., 1985; Vourlitis et al., 2007a, b). In the chaparral of the San Gabriels, annual nitrogen deposition from canopy throughfall and precipitation inputs 23.3 and 8.2 kg N / ha respectively, which are high values relative to other undisturbed ecosystems nation wide (Riggan et al., 1985).

**Burn**

Fires uncouple N mobilization from uptake by destroying plant biomass and increasing nitrification (Hanan, 2017). Nitrogen is particularly susceptible to volitization by heating, such that significant amounts of gaseous N can be lost above 300C (DeBell and Ralston, 1970; Knight, 1966; White el al., 1973). Fire consumes above ground biomass, surface litter, and SOM, which depending on intensity, causes losses in ecosystem N storage (Debano and Conrad, 1978; Debano et al., 1979), while other processes such as leaching, erosion, and/or runoff can cause additional and substantial losses of ecosystem N during the initial stages of chaparral succession (Gray and Schlesinger, 1981; Riggan et al., 1985, 1994). Response of different nutrients to heating indicate that little change is likely to occur more than 4-5 cm below the soil surface, unless a very long very intense duration occurs (Debano et al. 1990). However, nutrient availability of N can increase with depth after a burn because steep temperature gradients are produced in upper soil layers during the combustion of litter and humus on the soil surface where surface temperatures may exceed 1000C, while poor heat conduction results in temperatures of 200C or less at 5cm depth. As a result, some vaporized SOM and ammonium-rich compounds released during combustion are transferred downwards where they condense in cool underlying soil (Debano and others 1976). While large amounts of N is lost during combustion, available NH4-Nitrogen is usually higher in underlying soil following fire (Debano and others 1979). However, the increase in N availability as NH4-Nitrogen observed immediately after fire appears to be related to soil temperature in that under extremely hot fire, most of the N is probably volatized, particularly near the soil surface, while only small amounts are transferred downwards, while in cooler soil heating regimes, substantial NH4-Nitrogen can be found in ash and underlying soil (Debano, 1990).

**Post-Burn**

While to pool of total nitrogen decreases with each fire, the concentration of available N in the form of ammonium and nitrate increases after the burn (Debano et al., 1979). During the first postfire year, soil measurements have shown an increase of ammonium and nitrate concentrations in California Chaparral Ecosystems (Rundel, 1983; Sampson, 1944; Christensen, 1973). After fire, ash deposited from the charred remains of shrubs and litter is rapidly mineralized following fire causing a transient increase in available N, especially NH4 (Carreira et al., 1994; Fenn et al., 1993; Riggan et al., 1985, 1994; Stock and Lewis, 1986). Studies in California chaparral showed that 150 Kg/ha of N were lost by volatization during the fire and an additional 15 kg/ha by erosion after fire (Debano and Conrad 1976, 1978), which represents about 11% of the N in plants, litter and the upper 10 cm of soil before burning. Contributors of post fire chaparral ecosystem nitrogen replacement likely include bulk precipitation, nitrogen fixing bacteria and shrubs (Barro and Conrad, 1991; Debano, 1988). Bulk precipitation is estimated to restore 1.5 kg N / ha annually, which is not sufficient to restore N lost if chaparral burns every 25-35 years (Ellis and others, 1983). N input may be greater in localized areas with large airborne N pollutants present (Debano, 1988). In the chaparral of the San Gabriels, annual nitrogen deposition from canopy throughfall and precipitation inputs 23.3 and 8.2 kg N / ha respectively, which are high values relative to other undisturbed ecosystems nation wide (Riggan et al., 1985). Some plants and shrubs that re-colonize following fire are capable of symbiotic N fixation, which can add an additional 2-40 kg N/ha y {convert to g N/(y m^2)} to recovering chaparral (Ellis and Kummerow, 1989; Poth, 1982) so potential loss of N may be rapidly offset by input via N fixation.

**Other things I need to organize**

While most biological activity shuts down in prolonged dry sesaons in Mediterranean-type ecosystems (Stark ad Firestone 1995), some basal mineralization still occures allowing NH4 to accumulate in soil microsites that remain hydrologically disconnected through the summer (Parker and Schimel 2011). Upon wet-up, NH4 can diffuse to nitrifiers, which respond within hours of rewetting (Placella and Firestone 2013), which means that early autumn storms can generate a flush of nitrate to streams while plants are still relatively dormant (Mooney and Rundel, 1979; James and Richards, 2006; Homyak et al., 2014). Since chaparral fires typically occur during the summer (Keely and Fotheringham, 2001), they can magnify the early wet season N flush by further decoupling N mineralization from uptake (Hanan, 2017).

Predictive modeling done by Hanan (2017) suggests that postburn N loss is greater during both extreme wet and extreme dry years, although the impact of drought is greater.

Dixon et al. (2012) found that, in San Gabriels, low gradient hillslopes (<25dgr), chemical weathering increases with increasing erosion rates, but on high gradient hillslopes (>25dgr), chemical weathering intensities and rates decrease as erosion rates increase (Dixon et al. 2012). (Anthropogenic nitric acid and other acidic N plays a key roll in chemical weathing)

NO2+H2O = HNO3 + H

Nitrogen availability may be the limiting factor for plant growth in California soils (Rundel, 1982). Nitrate-nitrogen is apparently deficient in many chaparral soils in sharp contrasts to it’s comparatively high concentrations after burning (Christensen, 1973).