**Methods**

Impacts were modeled using the Comprehensive Air Quality Model with Extensions v6.1 (CAMx) to simulate chemical transport and transformation. Inputs to CAMx include a full year of meteorological modeling input data and emissions inventories, both representing conditions as they occurred in 2011. Inputs for the modeling platform were developed by the Intermountain West Data Warehouse (IWDW), including the 2011 Three State Air Quality Study (3SAQS) emission inventory (Adelman and Baek, 2015). Details of meteorological modeling, emissions inventory development and model performance are available on the IWDW website (IWDW-WAQGS, 2016, UNC and ENVIRON, 2014). This modeling platform has been utilized in numerous policy applications, which has led to a high level of model performance evaluation and scrutiny. Such scrutiny increases the acceptance of model results, performance and conclusions, specifically for the Western US.

In general, this study focuses on emissions associated with oil and gas production and to some extent, processing sources (i.e., it excludes downstream oil and gas distribution or refining activities). Historically, U.S. oil and gas production was considered a small well-dispersed area source of air pollution. This has changed significantly as oil and gas development has grown significantly (EIA, 2014a), and is now the largest source of emissions of other pollutants known to contribute to air quality concerns including nitrogen oxides (NOx), sulfur dioxide (SO2), particulate matter (PM) and air toxics (Adelman et al., 2014).

**Ozone** is known to cause negative human health impacts and damage to sensitive vegetation and ecosystems. For this reason, two O3 metrics were assessed, the W126 and the NAAPS.

**Visibility** is an important resource worthy of conservation and protection in NPS areas, as established under the NPS Organic Act and the Clean Air Act (CAA) of 1977.

**Nitrogen deposition** is a powerful fertilizer and in excess, can cause changes in soil and water chemistry, acidification of soils and surface water and result in changes in community structure, biodiversity, reproduction, and decomposition (Pomfret et al., 1993). Many lands in the western US are evolved with low levels of nitrogen deposition and are sensitive to small increase in nitrogen deposition (Sharma, 2006). In this study, nitrogen deposition is assessed using critical load thresholds, defined as "the quantile estimate of the exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to precise knowledge" (Nilsson and Grennfelt, 1988).

**Results & Discussion**

**Nitrogen Deposition Results:**

- There are 26 units where the modeled contribution of O&G emissions to nitrogen deposition exceeds the total modeled nitrogen deposition from below the CL to above the CL. As shown in Figure 5, the four corners region shows up as a hotspot for oil and gas contributions to total nitrogen deposition.

**Modeled contribution of emissions associated with oil and gas production to annual average nitrogen deposition in NPS areas, as established under the NPS Organic Act and the Clean Air Act (CAA) of 1977.**