# Southwest Climate Science Center – Final Project Report

1. **USGS GRANT/COOP AGREEMENT:** G13AC003322, Subaward 131697
2. **PROJECT TITLE:** Preliminary assessment of the landscape of climate relevant resource management decisions in the southwest.

3. **PRINCIPAL INVESTIGATOR EMAIL**: mwschwartz@ucdavis.edu
4. **CO-PRINCIPAL INVESTIGATOR EMAIL: none**
5. **PERSONNEL**
    a. Principal Investigator: **Mark W. Schwartz, UC Davis**
    b. Co-Investigators (Name(s) and institution(s)): Gwen Arnold, UC Davis, (gbarnold@ucdavs.edu)
    c. Undergraduate Students (Names and institutions). none
    d. Graduate Students – MS or MA (Names and institutions).
    e. Graduate Students – Ph.D. (Names and institutions). Matt Williamson, UC Davis
    f. Postdoctoral Researchers (Name(s) and institution(s)).
    g. Other (please specify): research technician: Andrew Holguin (ajholguin@ucdavis.edu); Christine Albano (calbano@ucdavis.edu)

6. **PROJECT START DATE: 9 Sept 2013**
7. **END DATE: 8 Sept 2015**

8. **PURPOSE AND OBJECTIVES:** Our objective was to quantitatively characterize the landscape of climate-relevant resource decisions in the southwestern United States. We worked with stakeholders to determine actual uses of climate-relevant information used in natural resource decisions. We used content analysis of federal register records of decisions and stakeholder consultative groups to develop a survey of decision makers querying the use of climate information in decisions. We sought to create a classification of decisions attributes, information needs, and decision processes that rely on climate science. We sought to engage stakeholder consultative groups to define mechanisms for best filtering, delivering and interpreting what has become a dizzying array of climate assessments.
9. **ORGANIZATION AND APPROACH:** We began with a content analysis of federal register decisions to determine keywords and phrases associated with climate in natural resource decisions. We then engaged with consultative groups in four locations to assess how they view climate information as relevant to decisions in which they have participated. We defined a decision as a legally documented decision that appears as a record of decision, a NEPA document and / or is published in the Federal Register. These consultative groups were geographical (Sacramento, Tucson, Salt Lake, Reno). We had intended to organize these groups around conceptual issues (data needs, classifying climate relevant decisions, knowledge sharing). Structuring these groups on a conceptual basis was not, in the end logistically feasible. Following the consultative groups, we developed an online survey and distributed this survey to 4965 potential participants across the Bureau of Land Management, Fish and Wildlife Service, Forest Service, and National Park Service (Figure 1). Our total survey response rate was 13.8% based on 685 responses being marked complete by the SurveyGizmo platform. However, the total response pool consisted of 1069 total responses. This is due to the fact that the internal logic structure of our survey resulted in differing sample sizes for each section based on the answers provided in

previous sections. As such, response rate is a conservative estimate of the number of survey participants.

10. **RESULTS:**

Responses to our survey indicate that respondents rarely found information or resources to constrain their ability to make a decision. That is, decisions must be made, regardless of whether or not respondents felt more information or resources would be beneficial. Respondents also indicated that when constraints were significant, lack of information was the least significant of these constraints (Figure 1).

Despite the fact that lack of information or resources does not prevent decisions from being made, it does appear to affect what information is used, especially in the case of the types of products the Southwest Climate Science Center produces. In the following sections, we describe the results of our analysis of the use of climatic information and attempt to identify the aspects of decisions that may predict the likelihood of a natural resource professional using this information. We used boosted regression trees (implemented within the gbm package in R) to identify important variables for predicting climate use.

In a nutshell, these results point to the following conclusions:

1. Climate information is most used when it reports (a) current and near future climate; (b) historical climate; and (c) projected future seasonal averages. Interpolated surfaces of future projected climate is reported as the least used climate information.
2. Decision makers are clear that they make decisions based on available data and are comfortable making decisions lacking future climate data, if relevant studies do not currently exist.
3. Decision makers are least comfortable, or least prepared, to process data or interpret climate information to make de novo conclusions about resource outcomes.
4. Decision makers report "consultation with experts" to be the far most useful avenue for seeking climate relevant information and rate "personal observations" on par with peer reviewed literature or data products or even monitoring data when establishing desired future conditions or identifying the most appropriate actions and where to deploy these actions.

**When is climate information actually relevant?**

Throughout our consultative group meetings, many participants stressed the fact that not all decisions required climate information. As such, we sought to identify the characteristics of decisions where respondents felt that climate was relevant. Our analysis suggests that the objectives of the decision (as characterized by the raupward multivariate decision classification; Figure 1) are the most important determinants of whether climate information was relevant. Other contributors included: whether the emissions of the project were analyzed, the type of plan being developed, the size of the landscape considered, and the agency overseeing the decision (Figure 2). Examination of the trace plots for the boosted regression model (Figure 3) suggest that mineral development and travel/recreation management decisions tend to be those that respondents felt did not need climate information. In contrast, water management decisions and vegetation management decisions tend to be those that respondents could utilize climate information the most. Climate information was also deemed relevant when the emissions impacts of a project were actually analyzed. Agency also plays a role in the relevance of climate information with the USFWS and various state agencies tending to be highly associated with climate relevance. Finally, larger-scale projects tended to be most closely associated with the perceived relevance of climate information with a threshold around the ~30,000 acre project size.

**When climate is relevant, what determines whether the information gets used?**

For this analysis, we considered a decision that utilized any climatic information (e.g., historical projections, PRISM, projected extremes, forecasts, and climate summaries) to be one that "used" climate data. Results of this gradient boosted regression again indicates that the decision class is the most important predictor of the use of climatic information (Figure 4). The agency making the decision; however, is less important in determining whether information gets used. Rather, the degree to which climate change implications are analyzed in the decision becomes a more important factor. As before, mineral and energy development projects tend not to use climate information of any kind while vegetation management projects tend to use climate information more often (Figure 5). Interestingly, the relationship between the size of the project and the actual use of information changes somewhat with the larger projects being very unlikely to actually use climate information despite its perceived relevance.

**What prevents the use of climate information?**

Many of our respondents agreed that climate information (in the forms we specified) was very useful (Figure 6). Indeed, historical weather observations are used quite frequently. However, very few projects actually incorporated these information sources into the formal decision. Our results suggest that for projections and interpolated data, the primary constraint is often expertise (Figure 7). This is especially true for model-derived data (e.g., interpolated surfaces and projections). This is not entirely surprising, given that most respondents suggest that the majority of information they use during the various phases of the NEPA decision-making process comes via consultation with experts rather than through traditional channels of peer review or use of the analysis products themselves (Figure 8).

11. **NEXT STEPS:** We are in the process of coding over 20,000 agency decisions to determine how frequently the various types of decisions are made as a means of characterizing "market demand" for new climate data products. In addition, we are working bring these results to publication. We are also in the process of further interpretation of the decision objectives multivariate analysis to give depth and meaning to these multivariate explanatory attributes.

12. **OUTPUTS***

*a. Papers published*

Theobald, D.M., D. Harrison-Atlas, W.B. Monahan, **C.M. Albano**. 2015. Ecologically-relevant maps of landforms and physiographic diversity for climate adaptation planning. PLoS ONE 10(12): e0143619.

Lawler, J., D. Ackerly, **C.M. Albano**, M. Anderson, S. Dobrowski, J. Gill, N. Heller, B. Pressey E. Sanderson, S. Weiss. 2015. The theory behind, and the challenges of, conserving nature's stage in a time of rapid change. Conservation Biology. 29: 618–629.

Anderson, M., P. Comer, P. Beier, J. Lawler, C. Schloss, S. Buttrick, **C.M. Albano**, D. Faith. 2015. Case studies of conservation plans that incorporate geodiversity. Conservation Biology. 29: 680–691.

**Albano, C.M**. 2015. Identification of geophysically diverse locations that may facilitate species' persistence and adaptation to climate change. Landscape Ecology. 30(6) 1023-1037.

Dickson, B.G., L. Zachmann, **C.M. Albano**. 2014. Identifying new conservation priority areas on roadless BLM lands in the western United States. Biological Conservation. 178: 117-127

**Albano, C.M**., C. Angelo, R. Strauch, and L. Thurman. 2013. Potential Effects of Climate Warming on Visitor Use in Three Alaskan National Parks. Park Science. 30(1) p. 36-43.

Davis, C.R., R.T. Belote, **M. A. Williamson**, and A.J. Larson. 2016. A rapid forest assessment method for multiparty monitoring across landscapes. Journal of Forestry. 114: 125-133.

Ganjurjav, H., Q. Gao, **M.W. Schwartz**, W. Zhu, L. Y. Li, Y. Wan, X. Cao, **M.A. Williamson**, W. Jiangcun, H. Guo, and E. Lin. 2016. Complex responses of spring vegetation growth to climate in a moisture-limited alpine meadow. Scientific Reports 6: 23356.

** - for outputs, outreach and engagement we counted all activities Christine Albano and Matt Williamson as they were principally supported by this work. We counted only those activities of Arnold and Schwartz when they were directly and specifically relevant to this project.*

13. **OUTREACH AND ENGAGEMENT*:** Describe all project-related outreach opportunities to date.

*a. Please list any **presentations, seminars, webinars, or workshops** made to stakeholders, the public at large, or any other group outside the research community.*

**Albano, C.M**., M.A. Williamson, M.W. Schwartz, G.B. Arnold. 2015. Assessment of Climate Information Use within the National Environmental Policy Act (NEPA) Planning Process in the Southwestern US. Southwest Climate Summit. Sacramento, CA. Nov. 11-13.

**Albano, C.M.** 2015. Identification of geophysically diverse locations that may facilitate species' persistence and adaptation to climate change. International Congress for Conservation Biology. Montpelier, France. Aug. 2-6.

**Albano, C.M.** 2015. ARkStorm@Tahoe: Exploring vulnerabilities to extreme winter storms in the Greater Lake Tahoe region. Invited presentation. Geography Colloquium. University of Nevada, Reno. Reno, NV. Feb 4.

Dickson, B.G., K. Rait, L.J. Zachmann, **C.M. Albano,** L.A. Duncan. 2014. Systematic identification of potential conservation priority areas on roadless BLM lands in the western United States. National Workshop on Large Landscape Conservation. Washington D.C. Oct. 23-24.

**Albano, C.M.,** M.D. Dettinger, M.I. McCarthy, D.A. Cox, T.L. Welborn. 2014. ARkStorm@Tahoe: Addressing social and ecological resilience to extreme winter storm events in the Sierra Nevada. Ecological Society of America Conference. Aug. 10-15.

**Albano, C.M**., B.G. Dickson, L.J. Zachmann. 2013. Identifying new conservation priority areas and opportunities on unprotected roadless lands in the western U.S.: a Great Basin case study. Great Basin Consortium conference. Dec. 9-10.

**Williamson, M. A., C.M. Albano, M.W. Schwartz, G. B. Arnold**. 2015. Preliminary assessment of opportunities and obstacles for climate information use in resource management decisions in the Southwest. 100$^{th}$ meeting of the Ecological Society of America. Baltimore, MD. August 2015.

**Williamson, M.A.**, 2016. Integrating climate information into land management decisions: opportunities in collaborative forest restoration. Collaborative Restoration Workshop: Working Toward Resilient Landscapes and Communities. Denver, CO. April 2016.

*b.* **Communications with decision-makers**, *including their name and agency and the date(s) and frequency of your communications. Information on whether the decision-makers were involved in the design of the project plan or if the research has been tailored to address a specifically stated management need is also helpful.*

## Workshops Attended

- Mapping the future of the SWCSC – Oct 2015 in Sacramento
- Climate-Smart Conservation training, National Conservation Training Center. Sacramento, CA. March 4-6, 2014.
- Advances in Conservation Impact Evaluation and Causal Inference, Society for Conservation Biology Conference. Missoula, MT. July 11-12, 2014
- Great Basin Climate Forum – April 10 2014

**Conferences**

- Society for Conservation Biology - 2014 (Missoula), 2015 (Montpelier)
- Ecological Society of America – 2014 (Sacramento), 2015 (Baltimore)
- SW Climate Summit 2015 – The project team played a major coordinating role in developing and hosting the Climate Summit, in addition to attending and presenting information on this project.
- Great Basin Consortium Conference Dec 9-10 2014

**Other organized stakeholder outreach**

Co-organized six stakeholder meetings and one tabletop emergency response exercise for the ARkStorm@Tahoe project – a project focused on assisting the greater Lake Tahoe/Reno/Carson communities identify vulnerabilities and increase preparedness for extreme winter storm events. Meetings were held in Incline Village, NV (Water supply; Sept 2013), South Lake Tahoe, CA (business, emergency response, natural resources; Oct 2013), Carson City, NV (interagency coordination between state/fed govt; Nov 2013), Reno, NV (2 meetings: Water managers, Tribal entities; Dec 2013), South Lake Tahoe, CA (Natural resources; Jan 2013), Reno, NV (emergency response tabletop exercise, all audiences mentioned above; March 2014). Over 350 participants in total from wide variety of sectors.

Co-organized three consultative group meetings involving ~35 natural resource managers to assist in identifying opportunities for climate science use in natural resource planning and decision making. Participants included planners, line officers, and resource specialists from NPS, DOD, FWS, BLM, USFS, BIA, etc. Sacramento, CA: April 8;  Reno, NV: April 28; Tucson, AZ: May 22 2014.

BLM briefing on Identifying new conservation priority areas and opportunities on unprotected roadless lands in the western U.S. NV BLM State Office, April 21, 2014. Ten BLM state office employees.

c. *Are you aware of any* ***resource management decisions*** *that have come out of this project?  If so, please provide a brief description.*

As a consequence of this project, we were invited to assist the USFWS Humboldt Bay Wildlife Refuge in developing their climate adaptation plan and provided expert input on appropriate climate adaptation strategies for their targeted objectives.

Submitted by:

Mark Schwartz, PI 3/31/16

Stephen T. Jackson,

Reviewed by:

Jonathan T. Overpeck, Award PI
University of Arizona ____________________________ __/__/__/16

Stephen T. Jackson,
SWCSC Director, USGS ____________________________ __/__/__/16

Forwarded to: (USGS Person)    /  /  /16

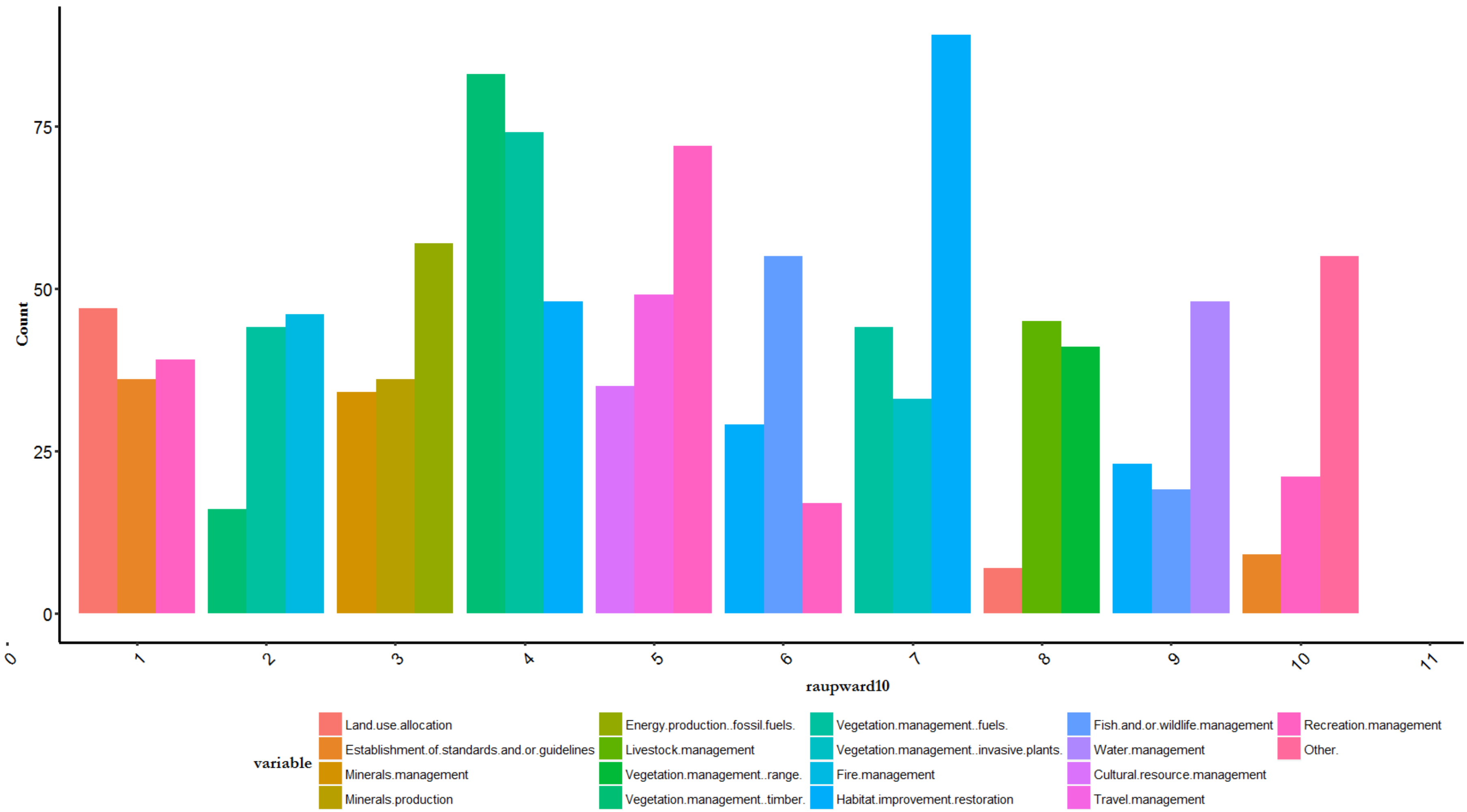


*Figure 1. Raup-Ward classification of the various decisions based on their multiple objectives. The three most objectives most frequently included in the cluster used to help identify the "decision type".*

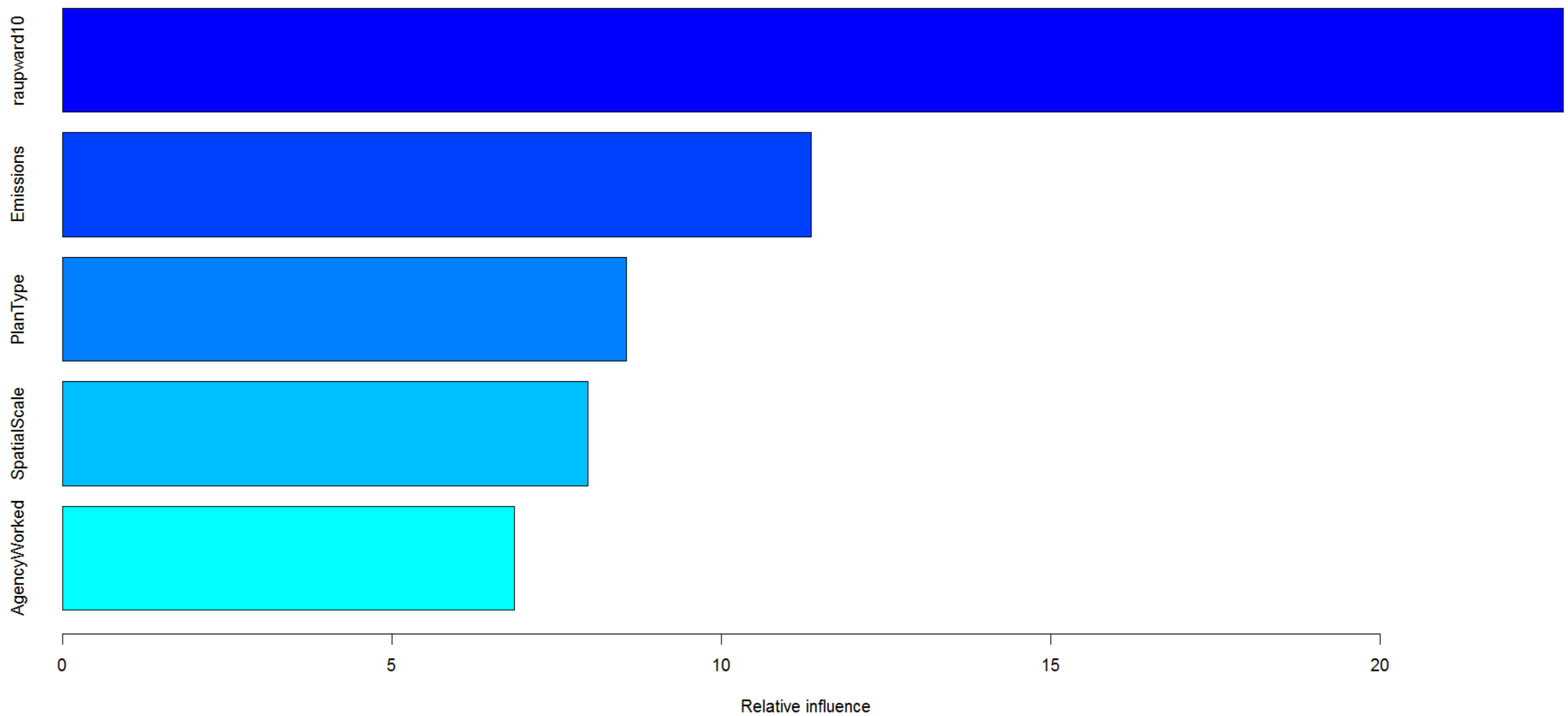


*Figure 2. The five most influential variables in a gradient-boosted model predicting the likelihood that a respondent would characterize climatic information as being relevant to that decision. Model fitting routines are outlined in Appendix B*

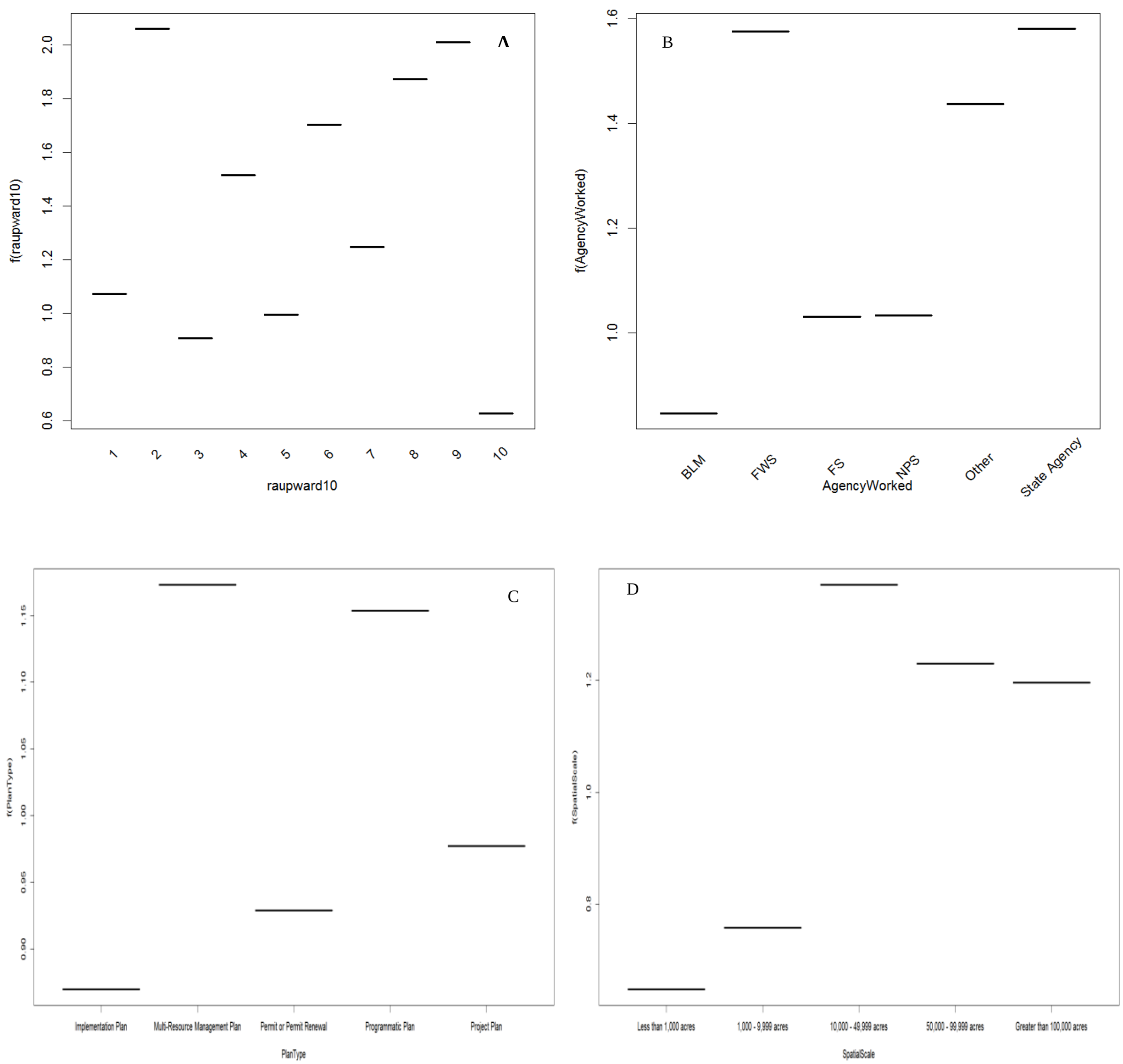


*Figure 3. Trace plots for selected variables included in the gradient boosted model of climate relevance (Figure 2). Trace plots indicate the relationship between decision class (A), agency (B), plan type (C), and spatial scale (D).*

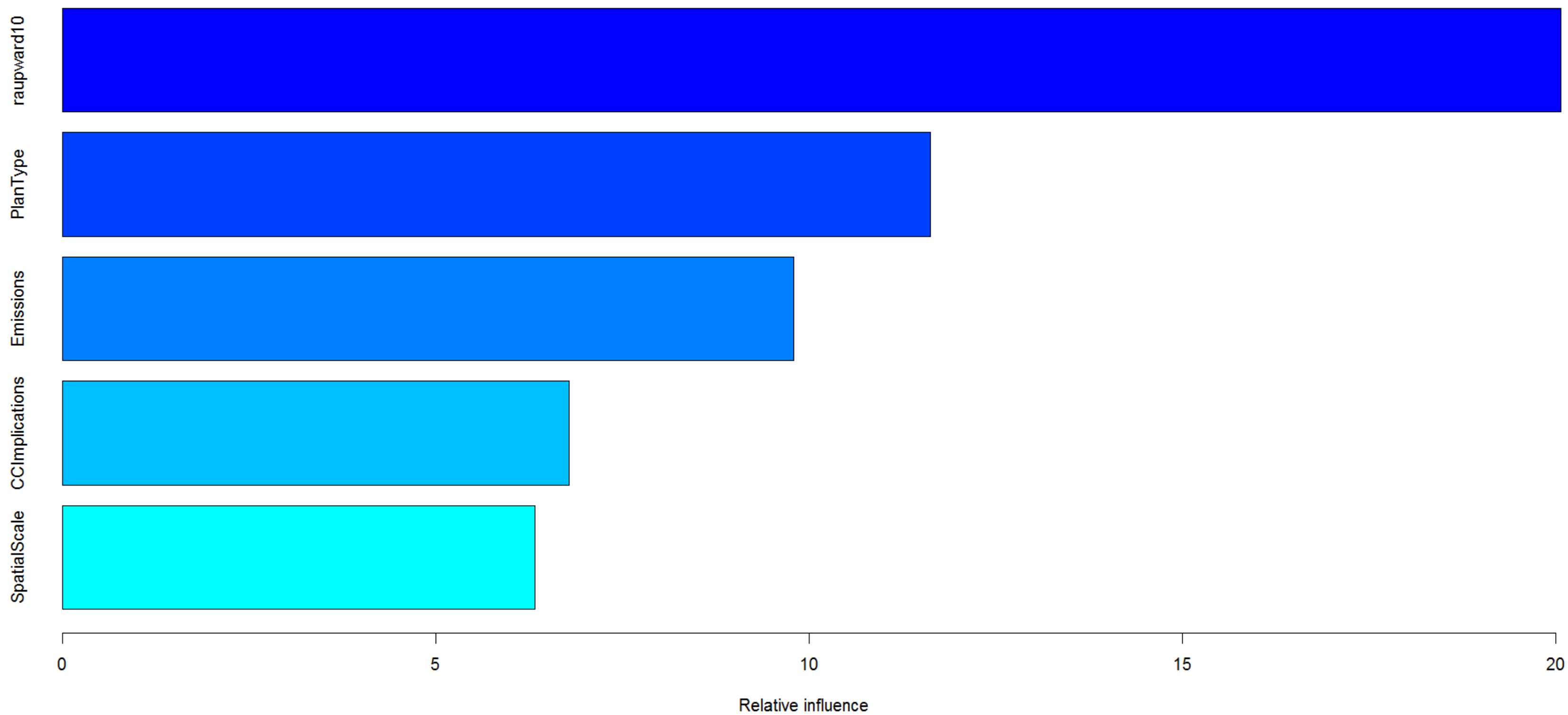


*Figure 4. Relative influence of the five most important predictors in a gradient boosted model predicting whether or not any form of climatic information was used to make the decision. Model fitting routines are included in Appendix B.*

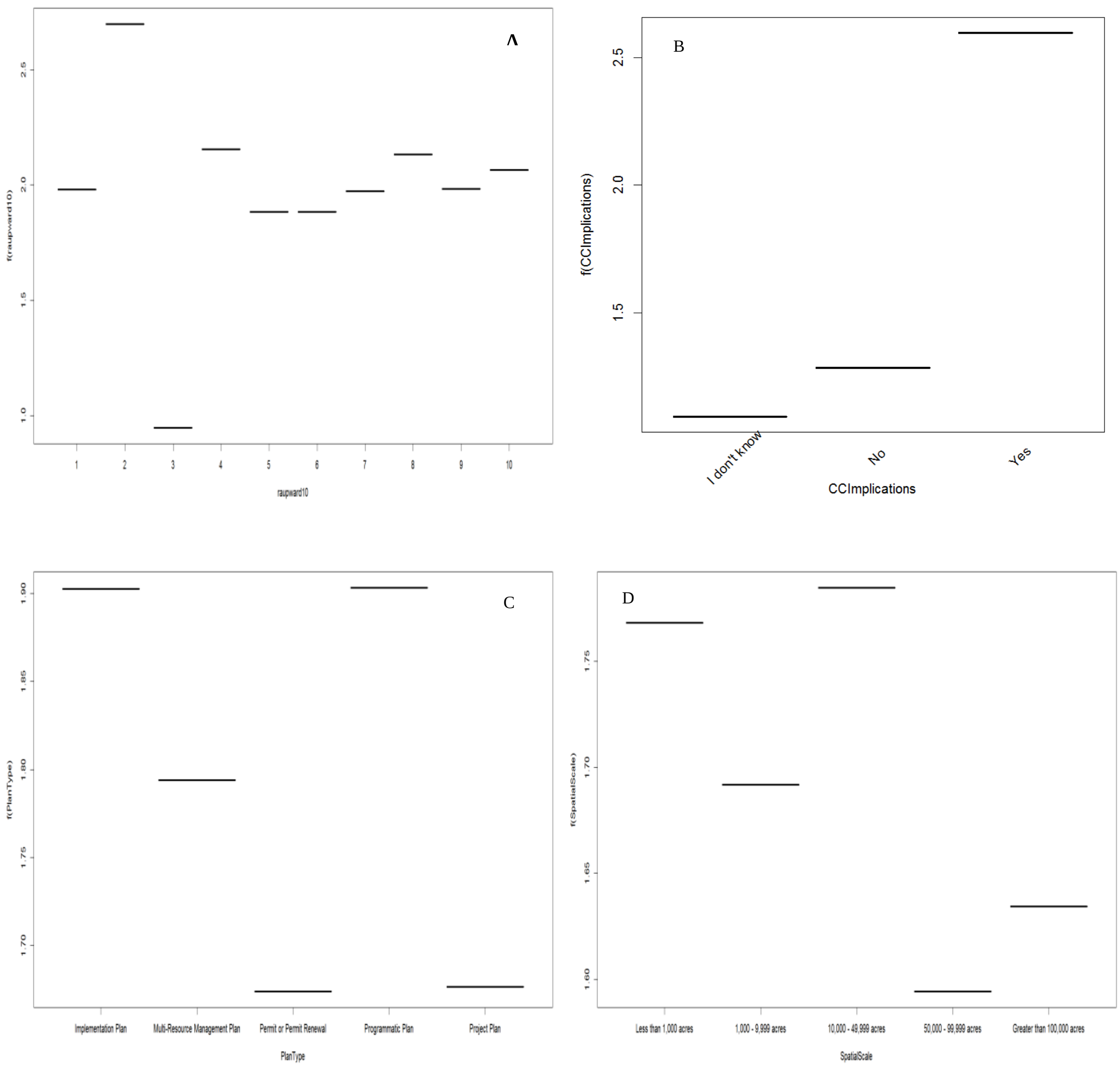


*Figure 5. Trace plots for selected variables included in the gradient boosted model of climate relevance (Figure 2). Trace plots indicate the relationship between decision class (A), whether the implications of climate change were analyzed (B), plan type (C), and spatial scale (D).*

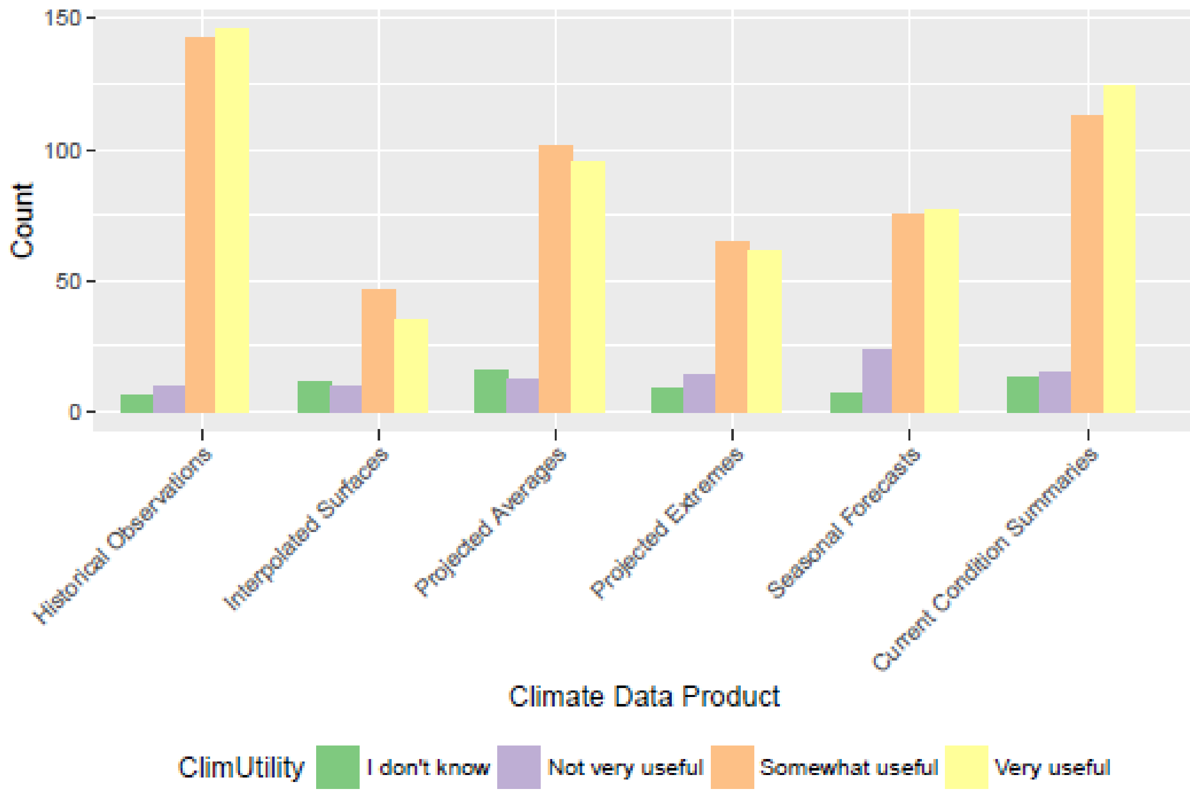


*Figure 6. Perceived utility of various categories of climate products currently available.*

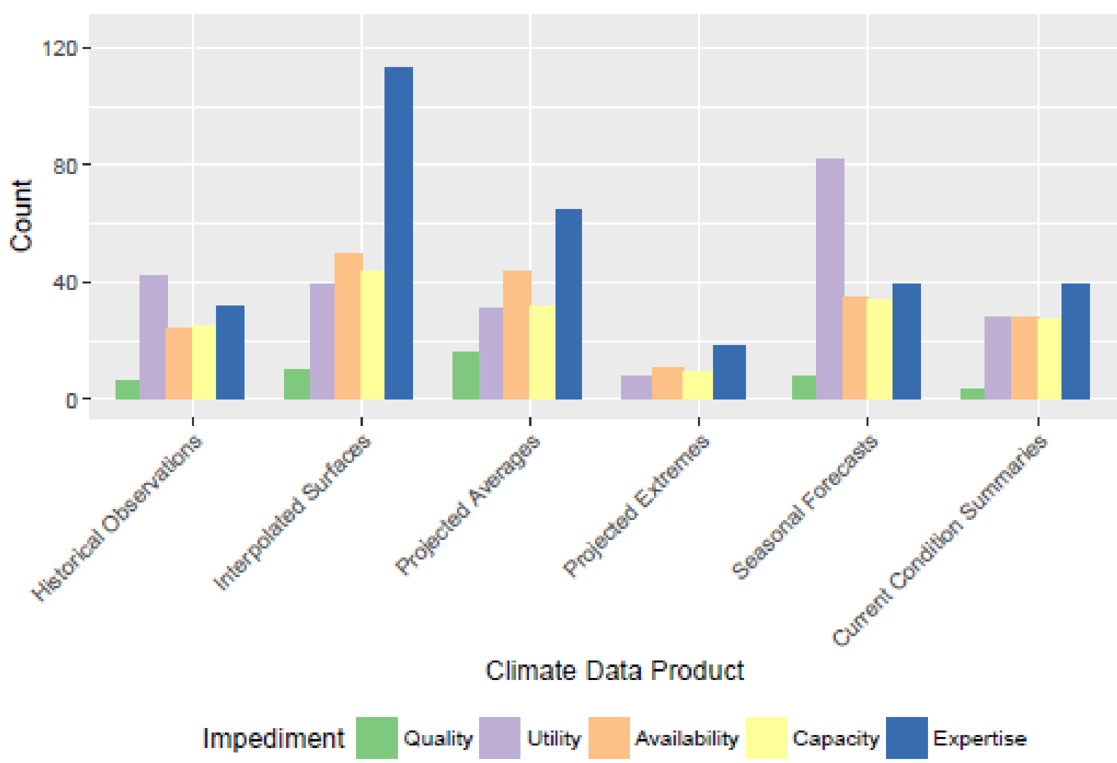


*Figure 7. Key constraints affecting the respondents decision to use a particular class of climate information. In this case, the respondent suggested that climate was relevant and that they might have used this dataset if not for the constraints identified.*

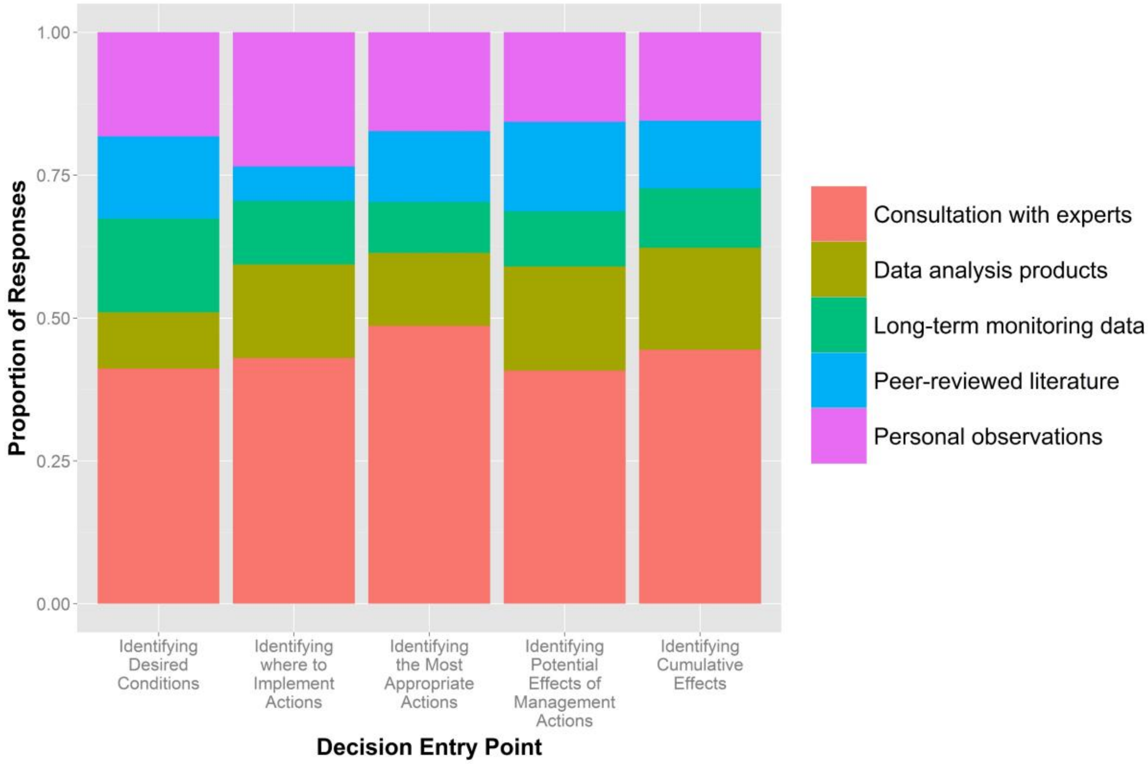


*Figure 8. Primary sources of information used for each phase of decision-making.*