



## Human Systems of FIRO Study: Study Summary

Forecast-Informed Reservoir Operations (FIRO) is an emerging, innovative concept in water resources management and is characterized by multi-agency collaboration. The FIRO project at Lake Mendocino is the most established of several ongoing FIRO projects, and is characterized by a steering committee composed of members from various agencies from local, state, and federal governments. This document summarizes a study of the Forecast-Informed Reservoir Operations (FIRO) project's implementation at Lake Mendocino from a social science perspective. The social science perspective complements the Lake Mendocino Final Viability Assessment (FVA), which describes the technical portions of the FIRO effort. These findings explore how the collaboration formed, estimates the disposition of project leadership toward relationships built over the course of the project, and identify internal steering committee processes related to relationship building and maintenance.

The study used semi-structured interviews with 17 key project participants and coded the transcripts to reveal themes concerning connectedness, belongingness, and other relationship descriptors. Major themes were identified from the interview transcripts using the constant comparative method and topic modeling. In addition, sentiment analysis was used to evaluate sentiment polarity (positive, negative, and neutral) as well as eight other basic emotions in survey participants' descriptions of this successful project. These insights can provide guidance for implementing similar projects at new locations. Herein we present that measurement frameworks that quantify relationship quality, qualitative lessons learned, and potential points of intervention in future FIRO projects.

Initial interview participants were selected from speakers at the 7<sup>th</sup> Annual Forecast Informed Reservoir Operations Workshop and expanded during the interview process. Researchers administered single-session, semi-structured interviews that consisted of one question capturing professional experience and authority in the water resources domain and six questions to characterize connectedness and dynamic relationship qualities, such as frequency of contact, changes in level of formality, and conflict resolution.

In both the human-coded analysis of interview transcripts and the automated text analysis techniques, researchers aggregated themes relevant to project relationships. For the human-coded analysis, researchers first identified how often each theme is mentioned. Then themes were summarized and aggregated ("aggregated thematic groups") to maximize the salience of the thematic groups. See Table 1. From the full set of thematic groups, the groups relevant to characterizing the relationships within the project were identified ("relational thematic groups"). Automated topic modeling broadly agreed with human coding of the transcripts.

We also performed a sentiment analysis and found that the statements made by study participants are overwhelmingly classified as containing positive sentiment. In addition to overall positive sentiment, *trust* and *anticipation* are both identified frequently. There were only two negative statements within the thematic groups related to relationships, such as, "early on also the Corps was very hesitant, and suspicious." Note that this apparently negative and subjective statement implies a significant change from skepticism to a current-day role of strong support that is reflected in the majority of other comments made about USACE.

Table 1. Aggregated themes, the counts for theme mentions, and the number of participants who mentioned the theme.

Aggregated Theme	Theme	Ct.	No.	Aggregated Theme	Theme	Ct.	No.
Knowledge of others' concerns and constraints	Knowledge of collaborators' concerns and constraints	29	11	Place-based attachment	Place specialness	3	3
	Knowledge of stakeholder concerns and constraints	13	8		Concern about possible mismanagement of natural world	8	5
					Personal connection to nature	5	4
Closeness with frequent collaborators	Social attachment to collaborators	21	11	Personal morale and being valued	Statements about personal morale and being valued	11	5
	Comfort with collaborators	18	12		Enthusiastic participation	12	11
	Collaboration	15	10		Behaviors showing investment in FIRO activities	5	4
Leadership and connections to other water resources groups	Leadership	17	8	Identity ties to a natural resource	Identity as a water resources professional	4	3
	Transparency between committee members	4	3		Length of experience in water resources field	7	7
		Connections to other water resources groups	6	4			

In viewing the various themes, we can conclude that identity and personal attachment to a specific place are not essential for innovation of this type. Instead, the features of this successful project include excellent qualifications, decision-making authority, and some pre-existing strong relationships within the ranks of project leadership. Study participants broadly described a process of listening to their counterparts at other agencies, observing, and communicating frankly with one another what they are and are not empowered to do in their various roles. In some cases, mental models of others' responsibilities already existed, in others, they had to be built over time, and potentially required high effort. Participants also reported that internal steering committee processes related to relationship building and maintenance included establishing ground rules for communication, using a trained facilitator, and built-in time for informal bonding.

Assuming these results can be generalized, if a FIRO project is underway at a new location, and participants indicate high positive sentiment but relatively low trust, this is not necessarily cause for alarm. The Lake Mendocino FIRO project built mutual trust between the study participants over time from initial attitudes that ranged from skeptical to enthusiastic. Therefore, low trust can simply indicate growing (rather than deficient) trust, provided sentiment is generally positive. In particular, low trust scores suggest that additional effort is needed to cultivate the necessary collaborative attitude.

Major concerns would therefore be 1) lack of positive sentiment in a new FIRO project, and 2) the presence of non-collaborative behaviors. Such deficiencies are best addressed rapidly and thoroughly, since goodwill is so important to project success. Additionally, because goodwill is difficult to restore, it is likely most effective to follow Lake Mendocino's example and prioritize prevention of behaviors that erode social capital while supporting ongoing relationship maintenance. The trust and anticipation expressed by participants are reflective of interpersonal features of the FIRO process. In turn, these interpersonal features helped participants be receptive to the challenges of a multi-organization pilot project, namely assuming voluntary risk for uncertain benefits.