

## AN ABSTRACT OF THE THESIS OF

Kristel J Fesler for the degree of Master of Science in Geography presented on March 9, 2007.

Title: An Analysis of Water Resource Conflict and Cooperation in Oregon between 1990 and 2004

Abstract approved:

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Julia A. Jones

This research provides details of water resource conflict and cooperation in Oregon between 1990 and 2004 by using an event database methodology. Events were concentrated in four of 18 basins. No basin accounted for more than 25% of the total water rights events, the most evenly distributed issue type. Overall more events were cooperative and very few were of high intensity. High intensity conflict covered one issue type- instream, while cooperative covered five supporting results seen at international scale. The occurrence of water quality events increases as the scale decreases.

Spatial and temporal analysis indicate that surface water supply correlates to overall conflict and cooperation levels better than population density, consumptive use and water quality. However, major conflictive outbreaks or cooperative breakthroughs are correlated to institutional changes in the social system (cooperation in 1991, 1999, and 2004; conflict in 1991, 2001, and 2004), acting as either an instigator or resolution of resource conflict. Water resource conflict was shown to intensify over time, and major conflictive events tend to lead to major cooperative events. Additionally, this process is unique to conflict; cooperative processes are not easily undermined by a conflictive action.

Finally, policy recommendations are presented to increase water resource manager's ability to foster dispute resolution and to engage key stakeholders. Implementation of these techniques should provide water resource managers with the necessary tools to manage conflict, not make it disappear entirely.

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An Analysis of Water Resource Conflict and Cooperation  
in Oregon between 1990 and 2004

by  
Kristel J Fesler

A THESIS

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APPROVED:

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Chair of the Department of Geosciences

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Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Kristel J Fesler, Author

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## An Analysis of Water Resource Conflict and Cooperation in Oregon between 1990 and 2004

### **Introduction**

“Whiskey is for drinking, water is for fighting.” This quote attributed to Mark Twain has been used repeatedly to characterize the state of water management in the western United States. Lengthy litigations and clashes between environmentalists, municipalities, Native American tribes, and agricultural interests have seeped into the psyche of western water management, contributing to social notions that population growth, droughts or other factors lead to conflict over water resources. But what demographic and physical factors are actually correlated with water conflict? Do areas with a higher drought frequency actually have higher rates of conflict over water resources? What about areas of rapid population growth? Basins with over-allocated streams? What of cooperation: does it ever occur over water resources? If so, where and when? Does water resource conflict or cooperation persist through time? Are there any relationships between initial conflict and subsequent cooperation?

The main goal of this study is to examine these questions concerning water resource conflict and cooperation in Oregon between 1990 and 2004. It sets out to systematically test correlations between variables commonly believed to cause water conflict and actual measures of conflict, found using an event database methodology. Another objective is to scrutinize the role institutions play in water resource conflict and cooperation and to examine the duration of water conflict before its resolution.

### ***Hypotheses and Hypotheses Tests***

A conceptual framework for water conflict and cooperation at the state and local scale is hypothesized and tested. First, hydrologic and demographic variables play a role in stakeholder relations and affect overall levels of conflict and cooperation. However, major conflictive outbreaks or cooperative breakthroughs are not correlated to these variations when there is institutional capacity to absorb these shocks to the ecological system. Institutional changes are correlated to major conflictive outbreaks or cooperative breakthroughs, acting as either an instigator or

resolution of resource conflict. It is also hypothesized that water conflict intensifies through time and then is resolved by a cooperative event. This process is unique to conflict; cooperative processes are not easily undermined by a conflictive action. The primary null hypotheses are:

- Water resource actions are not evenly distributed among Oregon's administrative basins.
- Water resource conflict and cooperation does not vary in space in association with consumptive use, population change or water quality.
- Water resource conflict and cooperation does not vary in time in association with surface water availability, water quality or institutional change.
- Water resource conflict and cooperation occur independently in time.

The first hypothesis was analyzed by comparing frequency and per capita distributions of events and issue types. Linear regression, quantitative and qualitative time line comparisons are the methods used for analysis for the second and third hypotheses, following Yoffe et al. (2003) and Wolf et al. (2003). Two metrics of the dependent variables are used in spatial and temporal analysis: frequency of high intensity events and weighted average intensity. Time-lagged relationships between conflict and cooperation were analyzed using a series of scatter plots, plotting points consisting of weighted average intensities in time ( $t = 1$ ) to intensities in subsequent years ( $t = 2, 3, 4$ , and  $5$ ).

### ***Background and justification of research***

A major shift in water management is occurring as new water supply demands are forcing changes in water allocation and management techniques. Historically, water management has been focused on improving water quality, altering flows by creating storage reservoirs, straightening stream banks and improving water quality for municipal consumption (Travis 2003). The main water users in the Western United States, agricultural producers, are experiencing increasing pressure from growing urban populations, increasing species and habitat protections, and swelling recreational demands (Cody and Hughes 2003; Travis 2003). Historical patterns of

water use are also being altered by Native American tribes utilizing previously unclaimed water rights (Snyder and Andersen 1988). These alterations are especially acute in the American West, where water supplies are naturally scarce and populations are rising faster than in other areas of the nation (Cody and Hughes 2003; Travis 2003).

Water conflict in the Western United States and around the world has been attributed to social and demographic changes, especially population growth (Gleick 1993; Cody and Hughes 2003; USBOR 2003). Increases in regional conflict have also been recorded where the needs of agriculture, industry, urban and Native American populations collided (Gleick 1993; Wolf 1998; Cody and Hughes 2003). The Bureau of Reclamation concludes that water scarcity is causing conflict (2003). As these new pressures collide, tensions between federal, state and Native American governments have increased, due to changing jurisdictions over water uses (Cody and Hughes 2003). Additionally, the absence of institutions able to deal with these changes has been linked to conflict over water resources (Yoffe et al. 2003).

An important challenge for this century's water managers will be preventing this water resource competition from escalating into conflict (Postel 2000). However, the processes that link resource management to conflict must be understood before successful dispute resolution policies can be put in place (Humphreys 2005). This is illustrated by a wide range of current recommendations. In the face of growing water demands, some researchers call for increased monitoring, assessment and forecasting of water resource data (Jackson et al. 2001). Others promote increasing institutional capacity for reducing and handling disputes, citing instances of reduced conflict following such efforts. For example, international conflict over dams was less intense between countries with a treaty (Yoffe et al. 2003) and domestic conflict can be decreased by the presence of a water market (Jaeger 2004).

Systematic study of domestic water resource interactions has been extremely limited because it is more complex and understated than at the international scale (Wolf et al. 2001); interactions are less formal, and concerns are often localized. The few domestic studies completed on natural resource issues have focused on voting,

environmental membership patterns, and economic ties (Wikle 1993; Bendix and Liebler 1999; Salka 2001). Water resource issues involve multiple parties, cultural differences, contrasting values, numerous issues, uncertain science, extensive history, and confusing legal requirements; entwining itself into several aspects of social and political life (Walker and Daniels 1997; Postel 2000; Daniels and Walker 2001; Tamas 2003).

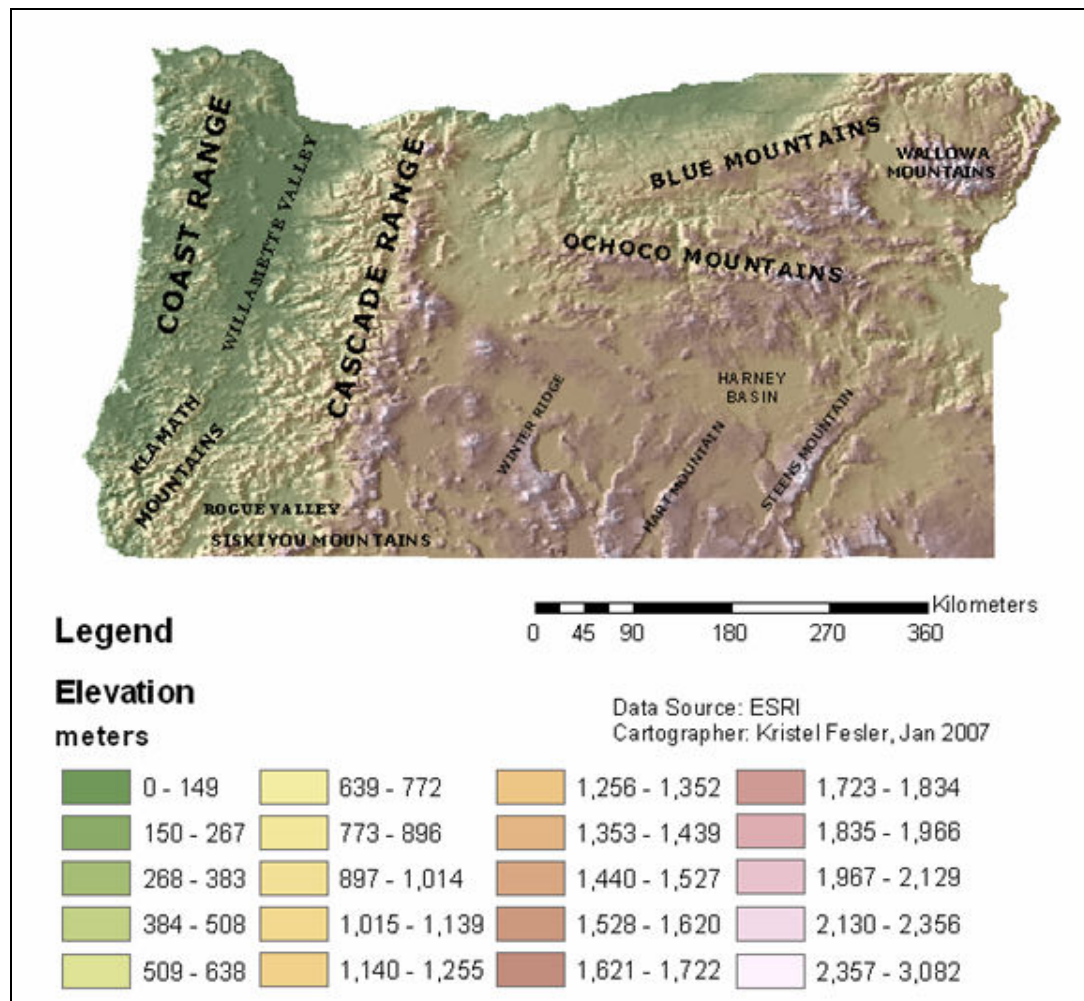
## **A Review of Oregon Geography**

### ***Physical Geography***

#### **Topography**

Mountain ranges, valleys, and “basin and range” formations characterize the variable topography of Oregon (Figure 1). The Cascade Mountain Range divides the state into eastern and western regions and reaches elevations exceeding 3,000 m. Parallel to and west of the Cascades is the older and lower Coast Mountain Range, which has a maximum elevation of about 1,250 m. Between these two mountain ranges at approximately sea level, lies the Willamette Valley, the largest valley in Oregon. To the south, the smaller Rogue Valley lies amongst the Klamath-Siskiyou Mountains. North-eastern Oregon contains the Blue, Wallowa, and Ochoco Mountain Ranges. The Wallowa Mountains border Hells Canyon and are sometimes considered a sub-range of the Blue Mountains. South-east of the Cascades Mountains, basin and range formations predominate as a series of north-south aligned mountains or ridges and neighboring valleys. The Steens Mountain, Hart Mountain and Winter Ridge and their adjacent valleys, the Alvord Desert, Lake Abert and Summer Lake, lie within this high lava plain.





**Figure 1: Oregon's major landforms, characterized by mountain ranges, valleys, and "basin and range" formations. Mountain ranges include the Cascade, Coast, Wallowa, Blue and Ochoco. The Willamette Valley lies between the Cascade and Coast Range Mountains. South-eastern Oregon consists of basin and range formations, a series of north-south aligned mountains and adjacent valleys.**

## Climate

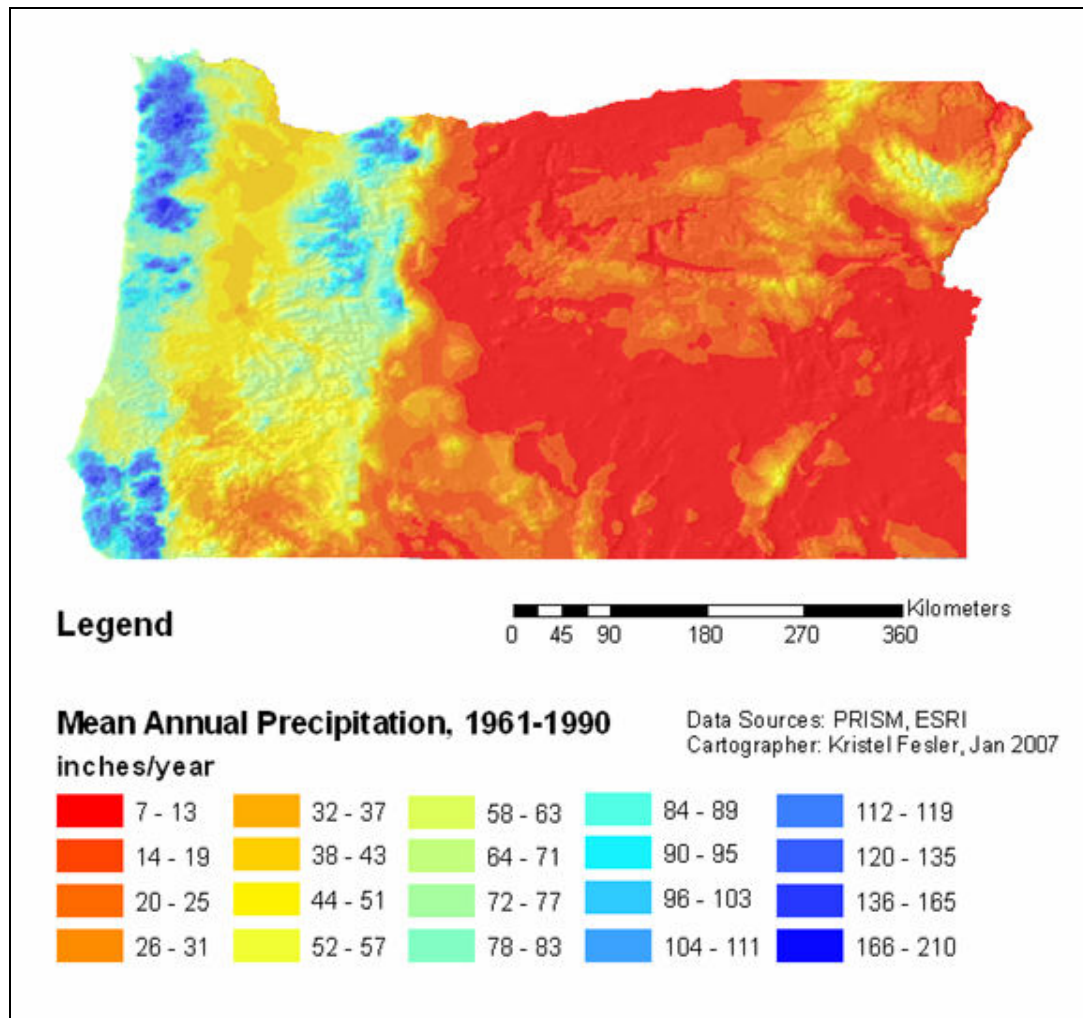
Oregon's distinct climatic zones are created by the Pacific Ocean and Cascade Mountains relative locations and have considerable temperature and precipitation variability (Taylor and Hannan 1999). Air moving east off the Pacific Ocean releases nearly all moisture while passing over the Coast and Cascade Mountains, leaving eastern Oregon in a rain shadow. Daily and yearly temperature variations are controlled by the proximity to the Pacific Ocean, with coastal areas having mild, uniform temperatures (Taylor and Hannan 1999; Allan et al. 2001).

In winter, a strong jet stream positions warm, wet ocean air over western Oregon and dry Arctic air over eastern Oregon; the Cascade Mountains prevents the mixing of these air masses. The Coast and Cascade Mountains receive the highest precipitation levels in Oregon (Figure 2), up to 5,080 mm/yr (200 in/yr) and 3,556 mm/yr (140 in/yr) respectively due to orographic lifting (Bastasch 1998; Taylor and Hannan 1999; Allan et al. 2001). The western Willamette and southern valleys receive high rainfall (762-15,524 mm/yr, 30-60 in/yr) mostly between November and March (Taylor and Hannan 1999). Summers are relatively dry due to a weak summer jet stream. Small amounts of summer precipitation are confined to the high elevation Cascade and Blue Mountains (Allan et al. 2001).

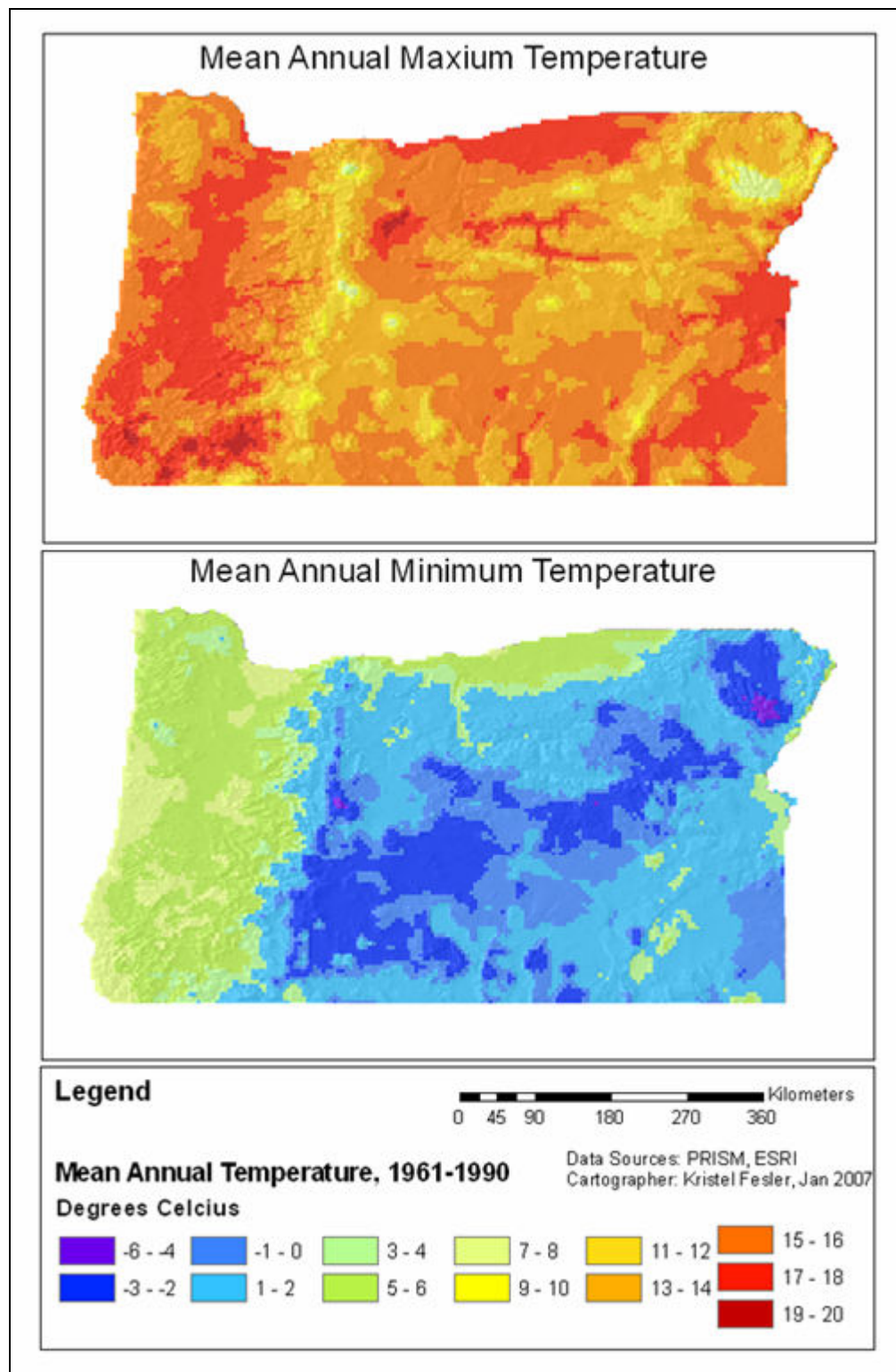
East of the Cascade Mountains annual precipitation is more uniform than in western Oregon (Taylor and Hannan 1999). In winter, after the wet air passes over the Cascade Mountains it is very dry, resulting in little precipitation even at high elevations (Allan et al. 2001). This semi-arid portion of the state contains vast areas that receive less than 305 mm/yr (12 in/yr) of precipitation; the driest of which is the Alvord Desert, receiving an average of 127 mm/yr (5 in/yr) (Allan et al. 2001).

Although the eastern yearly precipitation levels are more uniform than western levels, temperature ranges are more extreme (Figure 3). Temperature patterns of Oregon are created by continentality; landmasses gain and lose heat from solar radiation much more quickly than water bodies. Thus large landmasses, like eastern Oregon, have greater seasonal and daily temperature ranges than areas close to large water bodies, like western Oregon. The Cascade Mountains amplify this process in

Oregon, especially in winter, by preventing the mixing of warm oceanic air in the west and cold arctic air in the east. Average monthly high temperatures range from -1 to 32° C (30-90° F) in the east, while on the Pacific coast high temperatures remain between 7 and 21° C (45-70° F) (Allan et al. 2001).



**Figure 2: Mean annual precipitation between 1961 and 1990. Areas of highest precipitation align with the Cascade, Coast and Wallowa Mountain Ranges. Lowest precipitation levels occur in the eastern high desert. Data provided by PRISM.**



**Figure 3: Mean annual maximum and minimum temperatures between 1961 and 1990. The coldest areas of the state are in the eastern high desert. The warmest is the Rogue Valley. Data provided by PRISM.**

The Oregon Water Resources Department (OWRD) is the state agency that manages water resources. Figure 4 shows the 18 administrative basins created for management purposes that serve as the spatial resolution of this study<sup>1</sup>.

Oregon is bounded by three major water bodies: the Columbia River on the north, the Snake River (a tributary of the Columbia) on the east, and the Pacific Ocean on the west. The majority of Oregon's rivers flow into the Pacific Ocean directly or via the Columbia River. A few rivers have no outlet; south-central Oregon forms the northern tip of the Western Great Basin (Allan et al. 2001). Figure 5 shows the major river in each administrative basin and other significant tributaries.

River location and streamflow values are in direct response to precipitation. Eastern rivers are smaller, farther apart and have lower streamflow values than western ones (Table 1) (Allan et al. 2001). Peak streamflows in Western Oregon occur in winter as a response to high rainfall; in the east, peak flows are a reaction to spring snowmelt runoff (Allan et al. 2001). Low streamflow values occur in summer and fall across the whole state. An anomaly, the Deschutes River has an underlying geology of porous basalt that stores large amounts of water in winter that is released in the summer, supplementing the standard low flows (Bastash 1998).

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<sup>1</sup> OWRD's administrative basin boundaries are different from the Oregon Watershed Enhancement Board (OWEB) basins, the United State Geological Survey's (USGS) hydrologic accounting units and OWRD's own water master districts.



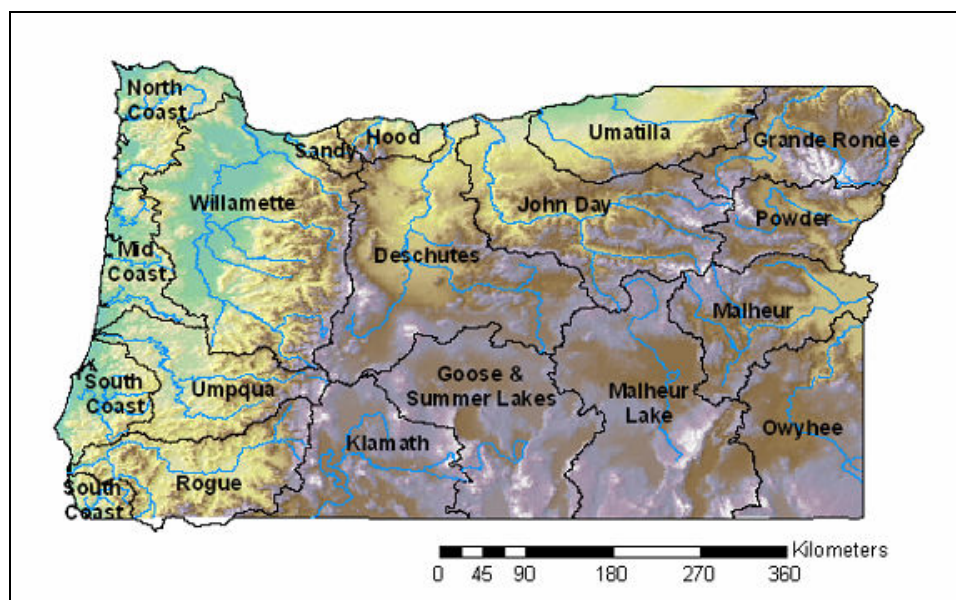


Figure 4: Map of Oregon's 18 administrative basins used by the Oregon Water Resources Department (OWRD). The South Coast basin is physically divided by the Rogue basin. All following discussion of the Rogue basin only refers to areas within Oregon's state boundary.

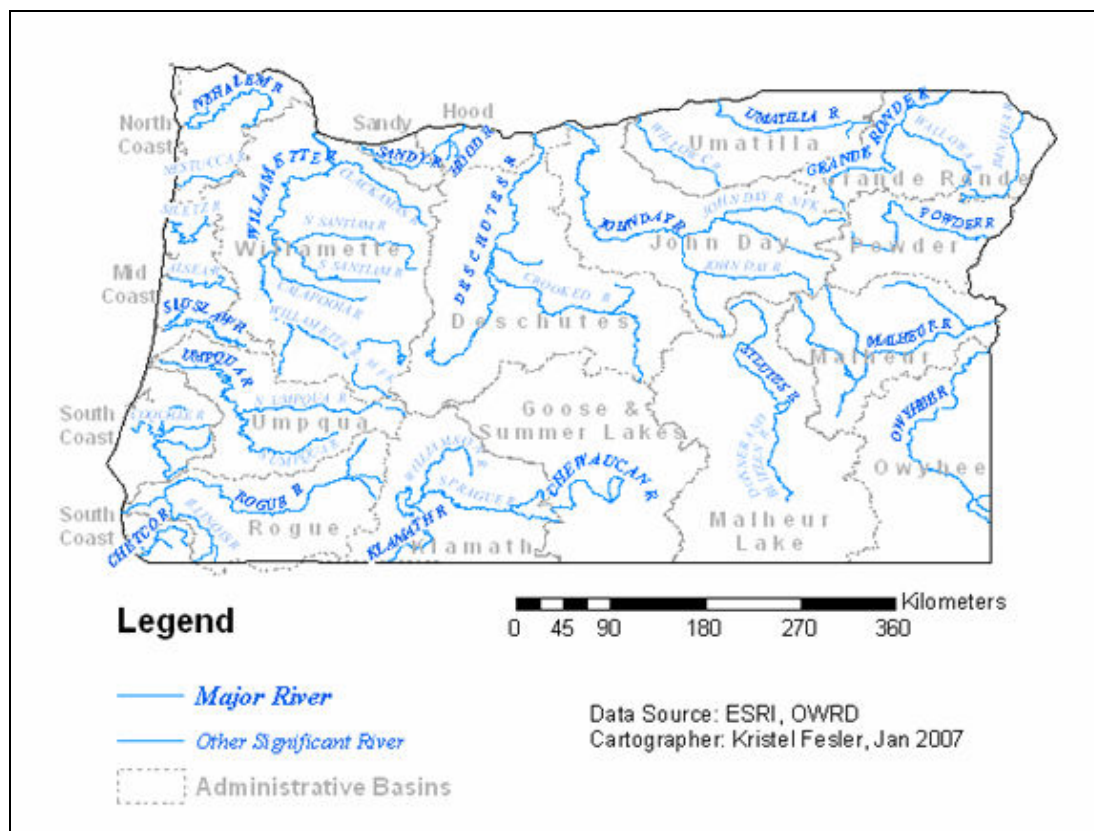


Figure 5: Rivers with highest streamflow and other significant rivers in each administrative basin. See Table 1 for annual discharge values of each major river and administrative basin.

Table 1: Streamflow characteristics of Oregon's 18 administrative basins. Refer to Figure 5 for basin and major river locations. \*Willamette and Sandy basins' area size and average annual discharge values are combined. Original discharge data provided in ac-ft, rounded to nearest thousand. Source: (Bastash 1998 and Macomber et al. 2005)

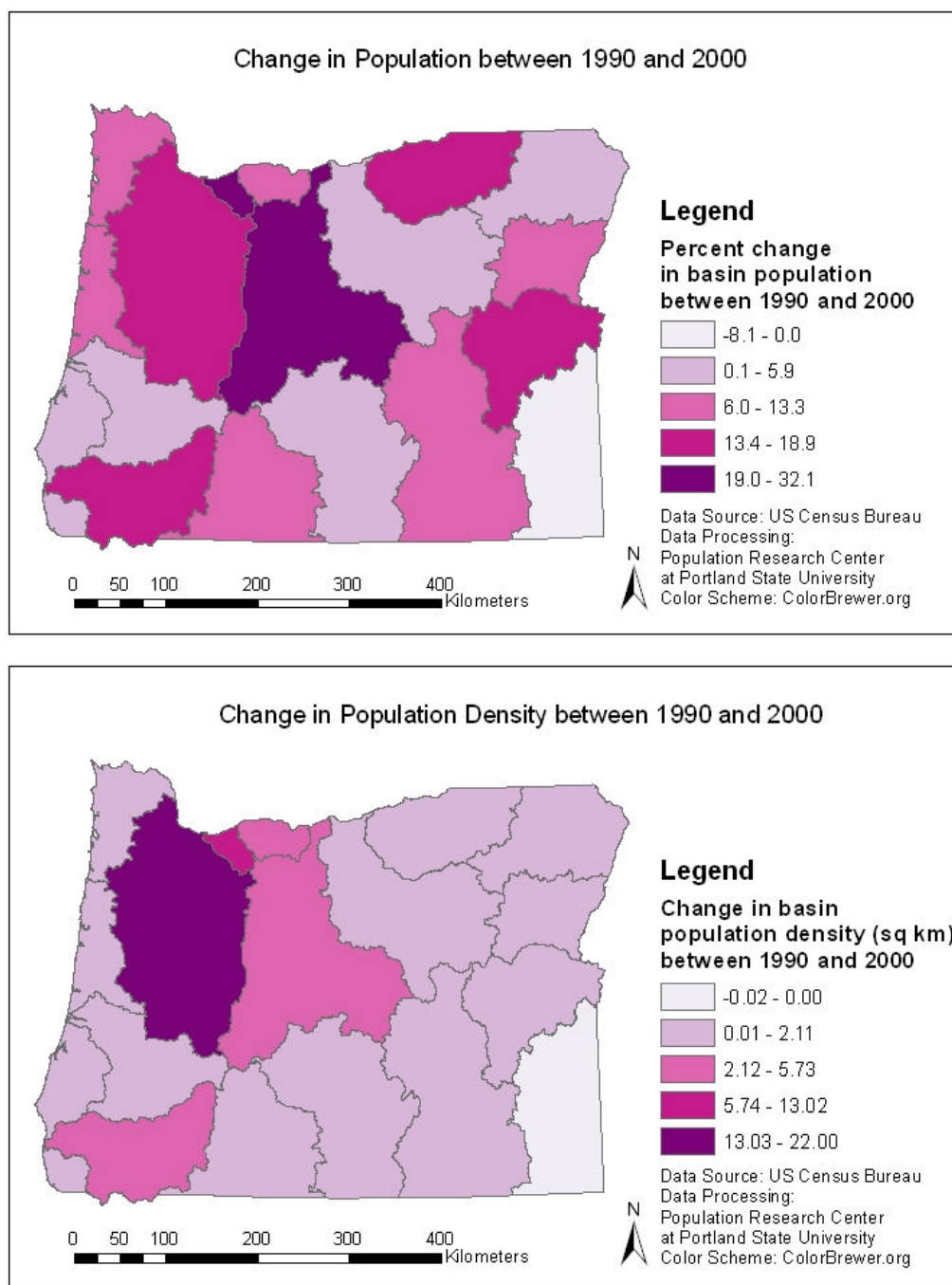
Administrative Basin	Basin Average		Basin Annual		River Average		River Annual
	Annual Discharge (cubic m)	Basin Area (sq km)	Discharge/ Area (cubic m/ sq km)	Major River	Annual Discharge (cubic m)	Discharge/ Basin Area (cubic m/ sq km)	
Deschutes	5,194,629,000	27,185	191,000	Deschutes	5,242,716,000		193,000
Goose & Summer Lakes	616,500,000	20,663	30,000	Chewaucan	132,177,600		6,000
Grande Ronde	3,470,895,000	12,743	272,000	Grande Ronde	2,779,182,000		218,000
Hood	1,701,540,000	2,657	640,000	Hood	948,670,200		357,000
John Day	1,738,530,000	20,909	83,000	John Day	1,879,092,000		90,000
Klamath	1,485,765,000	14,745	101,000	Klamath	1,722,501,000		117,000
Malheur	863,100,000	13,092	66,000	Malheur	482,905,683		37,000
Malheur Lake	9,987,300,000	26,022	384,000	Silvies	161,646,300		6,000
Mid Coast	172,620,000	6,066	28,000	Siuslaw	1,912,383,000		315,000
North Coast	12,609,891,000	6,620	1,905,000	Nehalem	2,411,748,000		364,000
Owyhee	493,200,000	16,110	31,000	Owyhee	936,216,900		58,000
Powder	863,100,000	8,430	102,000	Powder	476,677,800		57,000
Rogue	6,980,013,000	13,395	521,000	Rogue	5,562,063,000		415,000
Sandy*	33,794,064,000	31,176	1,084,000	Sandy	2,078,838,000		67,000
South Coast	11,097,000,000	7,651	1,450,000	Chetco	2,112,129,000		276,000
Umatilla	699,111,000	11,660	60,000	Umatilla	413,548,200		35,000
Umpqua	8,261,100,000	12,090	683,000	Umpqua	6,709,986,000		555,000
Willamette*	33,794,064,000	31,176	1,084,000	Willamette	29,752,290,000		954,000

## ***Human and Resource Geography***

### **Population**

According to the 2000 US census, 3.4 million people live within Oregon's 36 counties, a 20% increase from 1990 (Jackson and Kimerling 2003). In 2000 the average population density was 35 people/sq mi (Allan et al. 2001). The six most populated counties contain 65% of the people, mostly within the Willamette Valley (Allan et al. 2001). Small areas along the Pacific coast and in central Oregon also have high population densities (Allan et al. 2001). Only 8% of the people reside in the least populated eighteen counties (Allan et al. 2001) and the most sparsely populated south-east section of Oregon contains only 1 person/sq mi (Macomber et al. 2005). Figure 6 and Table 2 show that the Owyhee Administrative basin, in Oregon's south-east corner is the only basin in which population decreased between 1990 and 2004. The Sandy and Deschutes basins had the highest percentage increases in population the Willamette had the highest percent increases in population density.





**Figure 6: Population and population density change in Oregon's administrative basins between 1990 and 2000. Deschutes and Sandy administrative basins had the highest population increase while the Willamette basin had the highest increase in population density. See Figure 6 below for exact values. Source: Macomber et al. 2005**

Table 2: Population and population density of Oregon's administrative basins in 1990 and 2000. Percent change in population and population density in Oregon's administrative basins between 1990 and 2000. Source: US Census Bureau and Macomber et al. 2005

Administrative Basin	1990		2000		Change between 1990 and 2004		
	Population	Population Density (persons/sq km)	Population	Population Density (persons/sq km)	Population	Population Density (persons/sq km)	Percent
Deschutes	108,691	6.43	159,981	9.47	51,290	3.04	47.19
Goose & Summer Lakes	7,117	0.55	7,409	0.58	292	0.02	4.11
Grande Ronde	29,759	3.76	30,963	3.91	1,204	0.15	4.05
Hood	35,804	21.68	41,302	25.01	5,498	3.33	15.36
John Day	11,906	0.92	12,309	0.95	403	0.03	3.39
Klamath	56,102	6.12	61,726	6.74	5,624	0.61	10.02
Malheur	23,830	2.93	29,390	3.61	5,560	0.68	23.33
Malheur Lake	7,008	0.43	7,694	0.48	686	0.04	9.78
Mid Coast	53,470	14.19	61,444	16.30	7,974	2.12	14.91
North Coast	73,365	17.84	80,408	19.55	7,043	1.71	9.6
Owyhee	2,617	0.26	2,420	0.24	-197	-0.02	-7.52
Powder	16,068	3.07	17,536	3.35	1,467	0.28	9.13
Rogue	210,842	25.33	258,502	31.06	47,660	5.73	22.6
Sandy	34,185	37.40	46,091	50.42	11,906	13.03	34.83
South Coast	78,345	16.48	82,745	17.41	4,400	0.93	5.62
Umatilla	66,575	9.19	81,236	11.21	14,661	2.02	22.02
Umpqua	93,454	12.44	99,292	13.22	5,838	0.78	6.25
Willamette	1,931,068	104.62	2,337,137	126.62	406,069	22.00	21.03
<b>Oregon</b>	<b>2,840,206</b>	<b>18.20</b>	<b>3,417,585</b>	<b>21.89</b>	<b>577,379</b>	<b>3.70</b>	<b>20.33</b>

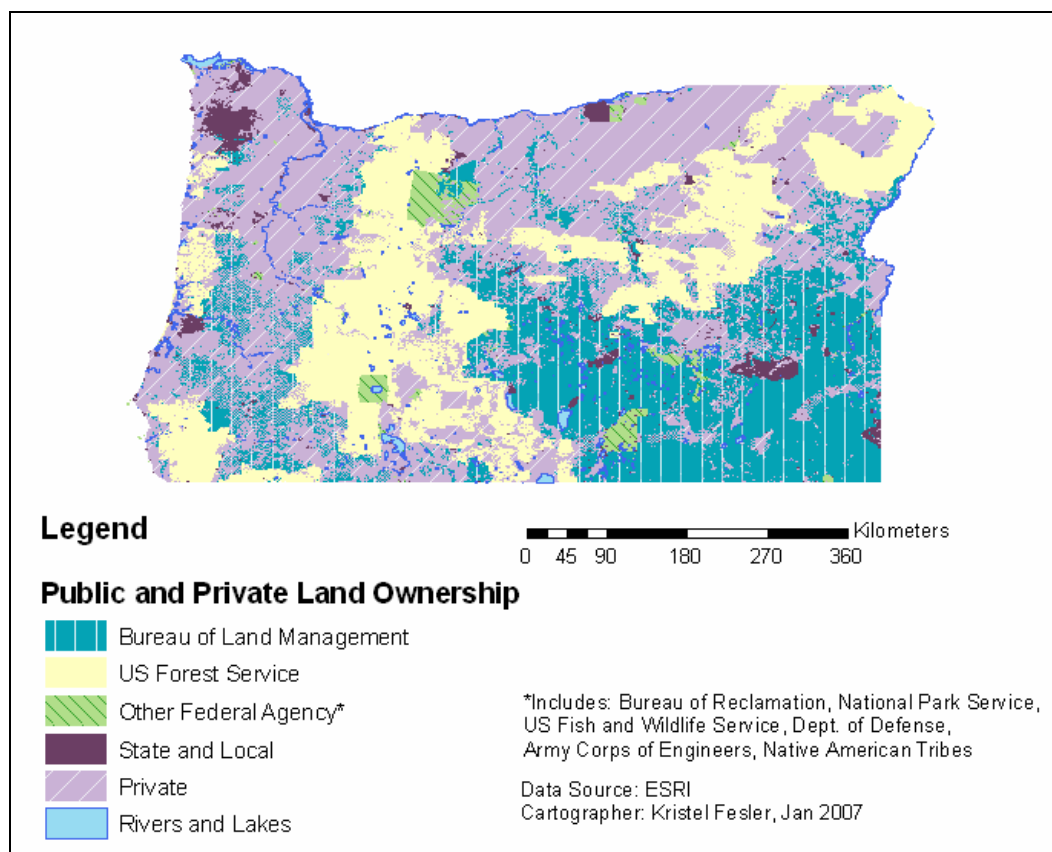
## Land Use

Approximately half of Oregon's 251,419 sq. km are owned by the federal government concentrated in the southeastern and mountainous regions (Table 3). Approximately thirteen million acres of public lands in southeastern Oregon are owned by the Bureau of Land Management and used for grazing; another thirteen million acres in central Oregon are owned by the US Forest Service and are available for timber harvest (Figure 7). State and local government ownership constitute a miniscule amount of Oregon's public lands.

Large portions of privately owned land are also used for timber production, concentrated in central Oregon, west of the Cascade Mountains and in the Coast Mountains (Allan et al. 2001). Agricultural use accounts for 16 of the 25 million rural acres of land (Allan et al. 2001). The fertile Willamette Valley is predominately used for agriculture, specializing in grass seed and high value produce. Of Oregon's 1.6 million acres of irrigated land, 80% are west of the Cascade Mountains (Bastasch 1998). Urbanized areas are concentrated within the Willamette Valley where population density is high.

**Table 3: Land ownership in Oregon. The majority of private and federal lands are used for commercial timber harvest or grazing. Approximately half of the state's land is owned by the Federal Government. Source: Jackson and Kimerling (2003). Original data provided in acres, conversions are rounded to the nearest whole number. See Figure 7 for breakdown of federal land ownership by agency.**

Owner	Land Use	Area (sq km)	Percent Area
Non Federal			
	forest	51,444	20.5
	rangeland	37,786	15.1
	crop	15,302	6.1
	irrigated	8,472	3.4
	developed	4,974	2.0
	pasture	1,964	0.8
	Total	119,942	47.9
Federal			
	commercial forest	56,197	22.4
	rangeland	53,450	21.3
	other forest	19,803	7.9
	National Park	689	0.3
	Total	130,137	52.0
	Oregon	250,479	99.9



**Figure 7: Public and private land ownership of Oregon.** The Federal government owns and manages approximately half of Oregon's 251,000 sq km, predominately by the Bureau of Land Management (BLM) in the south-east and US Forest Service in the Cascade Mountains. Data source: ESRI. See Table 3 for breakdown of land uses by federal and non-federal owner.

## Water Use

Water use mirrors land-use, with 80% of total water used in Oregon for agricultural purposes. Average withdrawals for agriculture account for 97% of total water use east of the Cascade Mountains, 62% along the coast, and only 28% in the Willamette River Basin even though the area is high in agricultural acres (Jackson and Kimerling 1993; Bastasch 1998). Municipal water withdrawals are highest in the Willamette Valley, accounting for 70% of total withdrawals in the Portland area (42% of withdrawals in the Willamette River Basin's and 70% in the Sandy Basin) (Bastasch 1998). The Willamette Valley and coastal areas also have significant water withdrawals for the pulp and paper industry (Jackson and Kimerling 1993).

## **A Review of Water Conflict Research**

Conflict occurs when two or more parties perceive an incompatibility in their interests or goals or where an one's action prevents or obstruct another's (Keltner 1997). Conflicts can be about facts, values, interests, personal relationships, culture, regulations or jurisdictions (Keltner 1997). Conversely, cooperation occurs when groups have decided to work together on commonly defined goals. The International Institute for Asian Studies (2006) more academically defines cooperation as stakeholders' ability to peacefully manage social incompatibilities. A conflict is driven by water resources when an incompatibility arises concerning water as a consumable resource to be managed, including water quality or allocation (Yoffe 2001). Water conflict can occur when water is a political or military goal, or if there are inequities in distribution and development (Gleick 1998).

### ***Research Scales of Water Resource Conflict***

#### **International Scale**

Although river water is the renewable resource most likely to spur conflict between two or more nations (Homer-Dixon 1994), such conflicts are often resolved by negotiations (Gleick 1993). Water conflict between countries has most often resulted from unilateral actions involving infrastructure, such as dam building, on an international waterway (Wolf 1998), but lower levels of conflict have been seen between countries where treaties existed (Yoffe et al. 2003). Yoffe et al. (2003) found that most interactions between nations were verbal, rather than economic, or militaristic additionally, no wars have been directly caused by conflict over water since 2,500 BCE (Wolf 1998). However, water disputes between countries can lead to regional tensions that can contribute to future conflict (Postel and Wolf 2001).

Droughts exacerbate transboundary water conflicts (Reuss 2002) but not to a substantial degree (Furlong and Gleditsch 2003). Scarcity (measured using several different variables, including climate, precipitation and water stress) has not been directly associated with international conflict (Yoffe 2001); international relations were more conflictive in times of drought when no institutions were in place to

adequately deal with the scarcity (Wolf et al. 2003b). Additionally, Yoffe et al. (2003) found that no single social, economic or physical variable correlated to international water conflict over a fifty-year time period.

### **Intranational Scale**

Using historical and contemporary evidence, Homer-Dixon (1994) suggests that conflict related to water is more often intranational than international. However, water conflict has been more thoroughly researched at the international scale than at the intranational scale. Intranational, or domestic, water related actions respond to both international water and non-water actions, but the strength of this relationship varies tremendously between countries and regions (Wolf et al. 2001; Giordano et al. 2002). An inverse relationship exists between the spatial scale and the intensity of water resources conflict (Wolf 1998): localized issues lead to a more heated conflict than issues. Even though conflicts may remain local, they can impact national and regional stability (Carius et al. 2004).

Scarcity is the factor to most likely increase tensions at the intranational scale (Postel and Wolf 2001). Water scarcity leading to conflict already causes intranational political and social instability (USBOR 2003), most likely in downstream regions of over-allocated rivers (Postel and Wolf 2001).

Human demographics are one of the most important factors affecting water resources (Naiman and Turner 2000). Recent population growth has been attributed to increased water scarcity and water resource conflict in the western United States (Cody and Hughes 2003; USBOR 2003). This pressure on water resources is felt first at the local scale: pitting farmer against farmer, city against city and farmer against city (Postel and Wolf 2001). However, the presence of institutional mechanisms for managing scarcity, such as water markets, may reduce conflict at the intranational scale (Jaeger 2004).

## ***Event Data and Database Comparison***

### **Event Data**

Event data collection is a commonly used research method for systematic collection and organization of quantitative information regarding political interactions, both conflictive and cooperative (Gerner et al. 1994). This method allows researchers to connect general behavioral theory to empirical observations of that behavior (Schrodt 1994) by breaking out single interactions and analyzing for statistical regularities. Event data provides the “most detailed record of interactions between and among actors” (Shellman 2004), while also offering a “formal method of measuring phenomena” (Schrodt 1993). In this case, event data are compiled for all interactions concerning the water resources of Oregon.

Goldstein (1992) defines event data as “day-by-day coded accounts of who did what to whom as reported in the open press.” An event is any interaction between parties that is recorded and made available to the public. It is an observable behavior; motivations, intentions, perceptions alone are not events (Davies 1998).

### **Event Databases and Comparisons**

An event database can focus on international, intranational or local political events or can focus on a specific type of interaction, like protests or wars. The majority of event databases focus on general international political, economic and militaristic actions; very few event databases focus on resource driven actions.

The major event databases focus on all types of political interactions that occur on the international playing field. The first event databases were the Conflict and Peace Data Bank (COPDAB) and the World Event Interaction Survey (WEIS), created in the 1960’s (Azar 1980; Gerner et al. 1994). The temporal coverage of event databases vary greatly, but the most extensive, Polity, has information on political regimes dating between 1800 and 2003 (Rodik et al. 2003).

The Violent Intranational Conflict Data Project (VICDP) was the first substantial database focused solely on intranational events (Moore and Lindstrom 1996). It was created in 1992 and was subsequently followed by the Intranational

Political Interactions (IPI) project and others (Moore and Lindstrom 1996). No event database focuses solely on cooperative actions, but several focus on protests or war, like the Behavioral Correlates of War Project (BCOW) and the International Conflict Behavior (ICB) and the VICDP (Moore and Lindstrom 1996; Maney and Oliver 2001; Rodik et al. 2003).

Until recently natural resource scientists and managers have not utilized event databases when discussing conflict over natural resources. One limitation is that these databases are focused on diplomatic and militaristic behaviors and not well suited for environmental issues (Schrodt 1994). The Freshwater Transboundary Dispute Database (TFDD) modified the COPDAB event database, to focus on international water resource events (Yoffe 2001). No event database exists with a geographic/political boundary of the United States covering a range of interactions. Consequently, to complete the goals of this study, events had to be searched, collected and coded for the state of Oregon.



## **METHODS**

Two types of data were used in this research: newspaper reports of conflictive and cooperative water resource events, and geospatial data gathered from a variety of governmental and non-governmental agencies. Newspaper articles classified according to specific guidelines show the frequency and intensity of conflict and cooperation across Oregon between 1990 and 2004. Demographic, hydrologic and political data were collected to test correlations between event and geospatial data.

### ***Creation of an Event Database***

Several steps are required to create an event database. First, an information source and collection method is chosen. Next, the term ‘event’ is specifically defined and a coding system to sort the data into meaningful categories is developed (Schrodt 1993). Various coding techniques have been extensively researched and summaries can be found in Rodik et al. (2003) and Schrodt (1994).

### **Data Sources for Event Data Collection**

Several arenas of historical record are available to gather event documentation. Davis et al. (1998) contends that even though the news media is not completely accurate, they are the best source for event data collection. The best way to gather news reports regarding a specific geographical area is to search local newspapers or papers with a regional section (Sahai and Chan). In addition newspaper articles are also easily accessed and widely spread mainly due to their availability on no-cost internet-based databases.

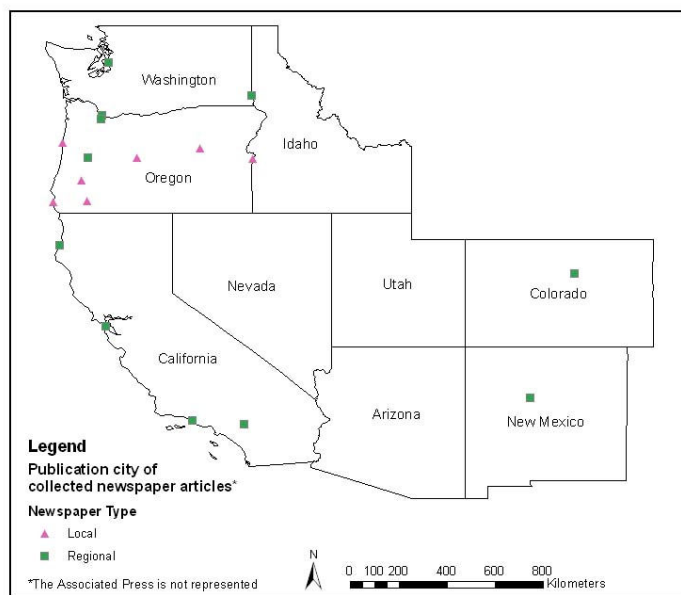
Newspaper articles were collected from 22 different newspapers, located across the western United States (Figure 8 and Appendix Table 1). Circulation numbers of these newspapers ranged from under 20,000 (The Rogue River Press) to over 1.25 million (The San Francisco Chronicle). The large circulating papers were available in Lexis-Nexis and EBSCOhost’s Newsbank databases. Eight small Oregon city newspapers were randomly selected from twenty-nine that had free online archives and searched for the year 2004. This was done to reduce the time requirements of data collection and sorting. Only two newspapers produced a large

number of articles, The News Times in Newport, Oregon and The Argus Observer in Ontario, Oregon.

### Data Search and Collection

Two different search methodologies are available for data collection: keyword and event-specific (Maney and Oliver 2001). Keyword searches are used when no prior knowledge of events is known. The event-specific method is used to gather information on a specific instance or stakeholder known to the researcher. In this study, keyword searches were relied on most heavily to gather information.

Newspaper articles were found using keyword searches based from Yoffe (2001). These search terms revolved around three basic categories; geographic location, aspects of water resources, and possible stakeholder interactions. The search terms used could not be exactly the same for all search engines due to differing search interfaces, but remained as similar as possible (Appendix Table 2).



**Figure 8: Location of newspapers used to gather articles to create the water resources event database. Ten of the 22 newspapers were located in Oregon. The Associated Press is not represented on the map. Only events that occurred in 2004 were collected from local newspapers. Two newspapers from Portland, OR and San Francisco, CA were used. The most articles gathered were from the Oregon cities of Portland, Eugene, Newport and Ontario. See Appendix Table 1 on page 92, for a list of newspapers used, their locations, the earliest date the source was available and the number of collected events.**

### Event Data Definition

The definition of an ‘event’ presented in the international literature was modified to accommodate the natural resource focus and domestic scope of this study. For purposes of this research an **event is defined as: an interaction, conflictive or cooperative, between stakeholders over fresh water resources located within Oregon as reported in the open press.** To be relevant to this study, an event has to be driven by some aspect of fresh water resources, affect water bodies within the state of Oregon, and occur between 1990 and 2004. Aspects of water resources include water “as a scarce or consumable resource or as a quantity to be managed (Yoffe 2001).” Thus any actions that are driven by, or concern water quality and quantity, among others are considered relevant events. A series of interactions between stakeholders would be comprised of several events. For example, if one party sues another over a water right, they agree to negotiate and then reach a settlement, three events are classified: filing a lawsuit, negotiating and reaching a formal agreement.

### Event Classification

Following the Basins at Risk project (Yoffe 2001) and other international event databases and organization methods (Azar 1980; Keltner 1997), several categories were created to classify event information. Each event in the database is classified by the following coding variables:

- Conflict- cooperation spectrum (intensity) ranking
- Issue type
- Administrative basin
- Specific water body or location of event
- Article citation and source
- Article report date
- Event summary

### **Conflict-Cooperation Spectrum Classification**

An international conflict-cooperation scale presented by Yoffe et al. (2003) formed the basis of the intranational scale used in this research and both are most similar to Conflict and Peace Databank (COPDAB). Modifications made include, removing the extremes of political and military possibilities, like ‘declaration of war,’ to resemble the possible actions within Oregon. Inclusion of actions at the domestic scale was done with the aid of the Intranational Political Interactions (IPI) presented by Shellman (2004b). Additionally, cooperative actions were modified referencing Keltner (1994) to mirror the conflictive classifications. Taking the above into account, Oregon events were given an intensity ranking between 5 (most cooperative) and -5 (most conflictive), with neutral events given a zero rating (Table 4).

### **Issue Classification**

Events are also classified into issue types encompassing all possible aspects of water resource management and were based off of Yoffe (2001) (Table 5). Water supply concerns are broken down into the following issue types: water quality, conservation, groundwater, infrastructure, fish passage, flood, and invasive species. Allocation concerns are broken down into: water rights, instream, intergovernmental, navigation and recreation.

**Table 4: Conflictive intensity coding definitions presented from most conflictive to most cooperative. Each category groups similar observable actions into comparable conflictive or cooperative intensities. Category definitions are based upon Yoffe et al. (2003) and Shellman (2004b).**

<b>Intensity</b>	<b>Title</b>	<b>Theme</b>
-5	Hostility	Small scale acts of violence, threats, protests, and police force presence
-4	Litigation	Judicial intervention, legal proceedings or management group dissolution, bill or ballot nonpassage, appeal of administrative actions
-3	Dispute	Cooperative group meltdown, regulatory action on violations, halting negotiations, threat of litigation, proposal and permit denials
-2	Disagreement	Roadblocks or temporary failure of settlement or project progress, withdrawal of third party support, petitions
-1	Difference	Voicing opinions of opposition, negotiation or vote delays, report reviews, preliminary rejection of proposals or settlements
0	Neutral	Events have no major effect on party interactions. Does not decrease nor increase conflictive intensity of interaction. Announcements, no comment statements, court rulings, testimony
1	Similarity	Voicing opinions of approval, preliminary proposal approval, compliance with voluntary guidelines, court forced negotiations, votes and deadline extensions
2	Agreement	Progress in stakeholder agreements and minor project support, calls for negotiations, third party support, meetings
3	Assent	Preliminary agreement to settlement and regulatory compliance agreements to participate in negotiations, permit approvals, fixing violations
4	Alliance	Legally binding cooperation actions like regulation approval and lawsuit settlements, management transfer, regulation approvals
5	Solidarity	State bill passage, compacts and management or authority group formation, official agreements signed or ratified between states, municipalities or nations

**Table 5: Issue categories and definitions were created to classify events according to different aspects of water resources. Events can only be classified into one issue type. Definitions were modified from Yoffe et al. (2003).**

<b>Issue</b>	<b>Definition</b>
Water Quality	Surface or groundwater quality does not meet local, state or federal standards for municipal use or endangered species regulations or stakeholder has water quality related concern. Includes illegal discharge, sewage overflows, remediation processes, fluoride additions, and insurance liability claims regarding water quality issues.
Invasive Species	Any non-agricultural species, invasive, exotic or native, that are detrimental to water quality.
Conservation	Includes agriculture, municipal and industrial conservation measures and water bans.
Flood	Flood control and management actions including delineation of flood plains, flood insurance, floods resulting in destruction of property and reservoir releases.
Groundwater	Creation of new groundwater supply source, declaration of critical groundwater areas and other regulations on groundwater pumping. Water table lowering, groundwater use depleting surface water flows, or leading to land subsidence.
Infrastructure	Water conveyance, storage or treatment systems nonexistent, in disrepair, inadequate or not predicted to meet future needs due to agricultural or municipal/population growth. Conversely, these systems being expanded, repaired or created including new surface water source development and public works project funding.
Instream	River flows or lake levels too low to support endangered species or other regulatory requirements (including the Wild and Scenic Rivers Act) due to high consumptive uses or diversions. Instream flow requirements, and obtaining and transferring water rights to instream uses, contractual and water right agreements that may not be met due to instream requirements.
Water Rights	Contention over water right, basin adjudication, Native American Tribal claims, lease and sale of water for consumptive use, and other property rights issues.
Intergovernmental	Actions concerning whom has control over the rules, standards and allocation of water resources and other related procedural events including formation of municipal water users associations
Navigation	River system and structure creation or maintenance; including canals and locks, dredging and flow requirements for navigational purposes.
Fish Passage	Dam, hydropower or irrigation facilities block fish passage or inhibit fish survival due to lowered flows or altered habitat. Related actions could involve fish ladders, dam removal, bypasses or irrigation pump alterations.
Recreation	Recreational access to water ways including access permits.

### **Event Location**

Oregon's administrative basins compose the spatial scale of this research. These basins are the managerial organization, based on watersheds, used by the Oregon Water Resources Department (OWRD)<sup>2</sup>. Because the Columbia and Snake Rivers are not within the state boundary, these rivers are not considered within the scope of this study.

Each event was classified into one of the 18 administrative basins. If an action concerned more than one basin, all the affected basins were listed, but they are not separate events. If an event affected or concerned every basin in the state, it was designated as 'state wide'. If an event was impossible to locate, it was not mapped.

### **Temporal Extent**

The time period of study is 1990 to 2004, if an event is reported outside of this time period, it was not recorded. The event date is the day that the event occurred, not the day it was reported.

Fifteen years of data sufficiently encapsulates changes in the independent variables. Between 1990 and 2004 two major census data gatherings (1990 and 2000) occurred. Additionally, there was a wide range of climatic variability, from droughts to wet periods. Significant institutional changes managing water resources also occurred, including endangered species listings, creation of the Oregon Plan, Oregon Water Enhancement Board (OWEB), and significant lawsuits affecting judicial precedence. Additionally, the availability of event data decreases dramatically for years before 1990, becoming very difficult to obtain without extensive effort and the possible use of different collections methods.

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<sup>2</sup> These boundaries are different from the ones used by the Oregon Watershed Enhancement Board (OWEB), Oregon Water Resources Department's (OWRD) watermaster districts and United State Geological Survey's (USGS) hydrologic accounting units.

**Table 6: Examples of event database entries. All events are classified according to the date it occurred, the basin/s it concerned, the surrounding issue type, and the conflictive-cooperative intensity. If an event concerns more than one basin all are listed, but they are not separate events. An event summary is also provided for each event.**

<b>Report Date</b>	<b>Basin</b>	<b>Issue</b>	<b>Intensity</b>	<b>Event Summary</b>
2/13/1990	Willamette	Water Quality	Similarity (1)	The Unified Sewerage Agency supports a proposed state mandated ban on phosphorus detergents.
8/27/1998	Mid Coast	Infrastructure	Litigation (-4)	The Oregon Shores Conservation Coalition has sued the city of Florence requesting a halt on all new sewer hookups in the city until a new sewer treatment plant can be put online.
8/27/2004	Willamette	Water Quality	Neutral (0)	Presents how lawn fertilizers and pesticides damage water quality, compares area users and announces public awareness events.
7/9/2001	Klamath	Instream	Hostility (-5)	In protest of a federal decision to not release water for irrigation, dam head gates have been removed by area farmers.
4/21/2001	Umatilla	Water Rights	Alliance (4)	The city of Pendleton and the Umatilla Tribes reached a water rights agreement involving the city's point of diversion in the Umatilla's North Fork.



### ***Independent Variables for Analysis***

Five datasets related to the relative water supply and demand of each administrative basin were collected for analysis of water resource conflict and cooperation. These data sets are:

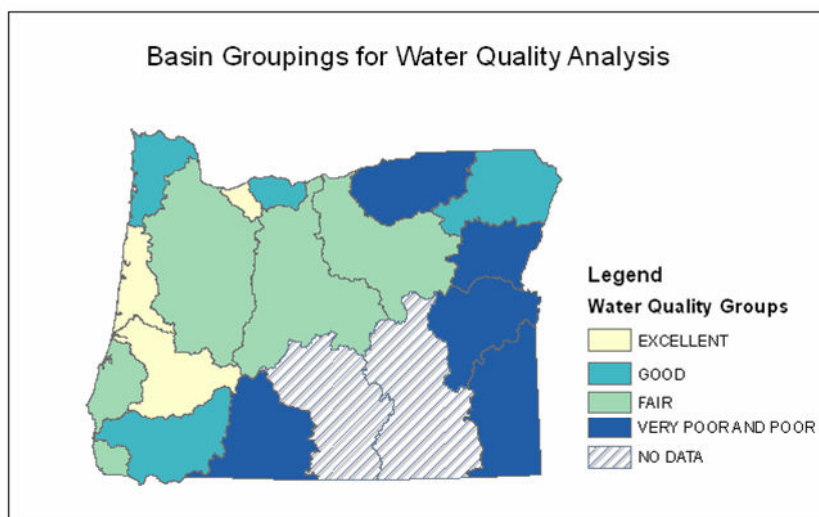
- Population
- Consumptive use
- Water quality
- Surface water supply
- Institutions

The first four independent variables were provided by Macomber et al. (2005), and were specifically created to provide geospatial data at the spatial resolution of the administrative basins. They are described briefly below, explained in full at the following website: <http://www.geo.oregonstate.edu/research/orbasins/>.

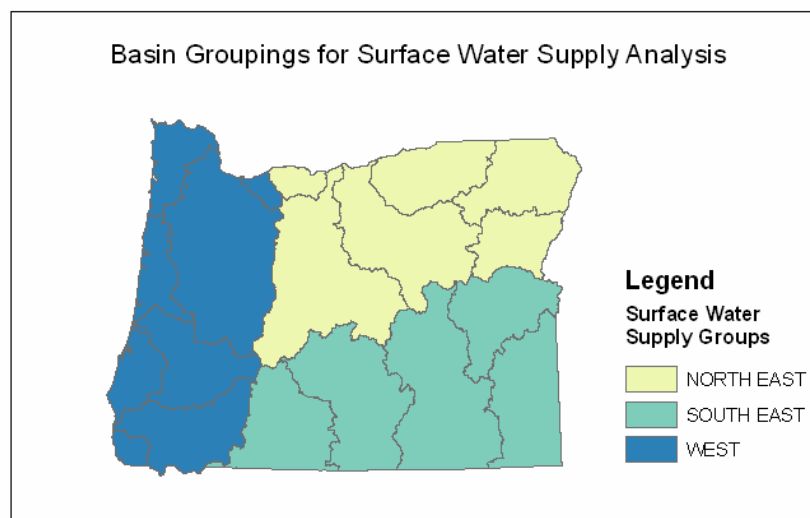
To create a population dataset at the resolution of administrative basins, Macomber et al. (2005) reclassified US census blocks assuming that the population in each block was evenly distributed. The selected variable for analysis is percent of change in population density between 1990 and 2000 to account for basin size and rate of growth.

The Oregon Water Resources Department's (OWRD) regulation requires that appropriations cannot be greater than the natural streamflow reached 80% of the time (Cooper 2002). Macomber et al. (2005) created index values equal to the percent of the 80% exceedance level that is out-of-stream allocated to consumptive use. If the index value is 100 then the amount allocated is equal to the 80% exceedance level.

The Oregon Department of Environmental Quality compiles the Oregon water quality index (OWQI) using eight water quality variables: pH, dissolved oxygen, biochemical oxygen demand, total solids, temperature, nitrogen, phosphorus, and fecal coli form. Macomber et al. (2005) created basin scale water quality index values by aggregating the most downstream monitoring points in each basin, weighting by streamflow. Basins are divided into four groups based on average water quality for use in temporal analysis (Figure 9).



**Figure 9: Administrative basin groups for temporal analysis of the Oregon Water Quality Index (OWQI) values. Index values are a combination of eight water quality variables: pH, dissolved oxygen, biochemical oxygen demand, total solids, temperature, nitrogen, phosphorus, and fecal coli form. Data collected by the Oregon Water Resources Department (OWRD), and was reclassified into administrative basins by Macomber et al. (2005).**



**Figure 10: Administrative basin groups used in temporal analysis of surface water supply index. Groupings are based on geographic location and similarities in precipitation patterns. The Surface Water Supply Index (SWSI) is composed of four measurements: precipitation, snow pack, streamflow and reservoir storage. The SWSI is created by the NRCS and OWRD and reclassified into administrative basins by Macomber et al. (2005).**

The surface water supply index (SWSI) is compiled by the Natural Resource Conservation Service (NRCS) and the OWRD and values were assigned to administrative basins by Macomber et al. (2005). The SWSI combines four variables: snow pack, precipitation, reservoir storage and streamflow. Index values represent the amount of water available in the basin compared to that basin's long-term average; they range between -4.1, indicating extreme drought, and 4.1, indicating an extreme wet period. In temporal analysis basins are divided among three geographic regions; western, north-eastern, and south-eastern as shown in Figure 10.

Institutional changes were collected from the created event database and used in temporal analysis. An institution can be a tradition or an organization providing society with guidelines or rules for acceptable behavior (Michaels 2001). Institutional organizations are often dedicated to public service and provide a managerial and legal framework for society (Riverside Webster's II Dictionary 1996). These organizations often have the ability to alter the rules and guidelines by which society functions. Broadly defined, an institutional change is an alteration or uncertainty regarding: regulations and standards or requirements, agencies and authorities, and procedures. Specific examples of these institutional alterations include the release of biological opinions regarding endangered species management, agency or program creations and alterations, state and local bill passages, regulation changes, high-impact legal challenges, or any change that creates uncertainty in the management or allocation of water resources.

### **Data Analysis**

Event summary statistics were calculated for each coding variable. Events were binned for each conflict-cooperation intensity and issue type for each administrative basin and year. These summary statistics include all the events recorded, from both the regional and local sources. Conflictive events were assigned negative values to easily differentiate from cooperative values.

One set of dependent variables is the number of ‘high’ intensity events for each basin and year. A high intensity event is defined as having an intensity of negative four, negative five, four or five (-4,-5, 4 or 5). This was chosen as a dependent variable to represent the occurrence of major, large-impact events.

The second set of dependent variables is the conflictive and cooperative weighted average intensities for each basin and year. Weights, which were equal to the square of the intensity, were used because the interval between higher intensity actions is actual greater than events with low intensity (Shellman 2004b). In other words, the level of impact between intensities 1 and 2 is much smaller than the between intensities 4 and 5. This was chosen as a dependent variable to represent the overall level of conflict or cooperation in a basin or year.

To minimize source bias in analysis, the two sets of dependent variables do not include the events collected from local sources which were only collected in 2004. Additionally, spatial analysis does not include events that affected the entire state.

Linear regression techniques were utilized to test spatial correlations between independent variables; population density change, consumptive use, and water quality and dependent variables; weighted average intensities and frequency of high intensity events. At the local scale, qualitative time series analysis was performed for each basin group, water quality and surface water supply, against both sets of dependent variables. In a similar fashion, institutions, water quality and surface water supply were analyzed at the state scale. To analyze the temporal relationships between conflict and cooperation time-lagged scatter plots were created. Series of related events were investigated in pairs of years to better understand conflict resolution.

## Results

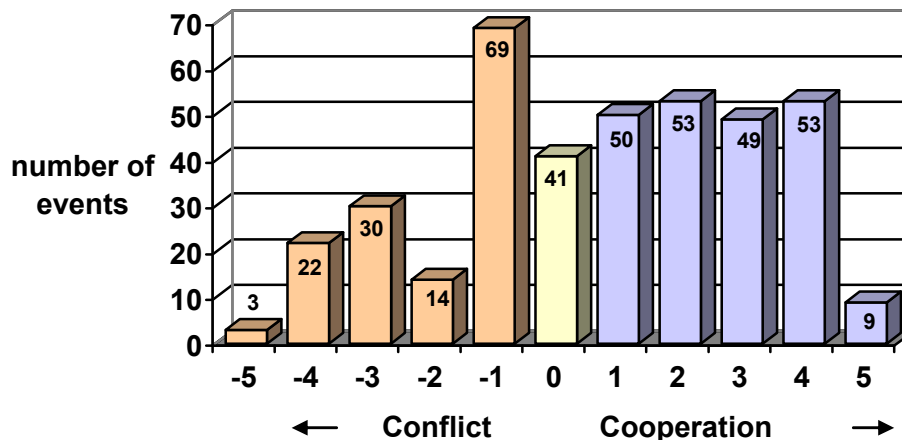
While detailed result descriptions are presented below, major findings include that population density, consumptive use, and water quality, are not correlated to the spatial distribution of cooperative or conflictive behavior. Water conflict and cooperation was not related to water quality at either the state or local scale over the time period, 1990 to 2004. At the local scale, conflict levels were higher in western basins when surface water supply was above average and in eastern basins when it was below average. In years of below average surface water supply all basin groups had higher cooperation levels. Institutional changes were associated with peaks in cooperation, (1991, 1999 and 2004) and conflict (1991, 2001 and 2004). Conflict is auto-correlated in low time lags and increases in intensity as the time lags increase. In every time lag instances indicating that major conflict led to major cooperation were present.

Summary statistics were calculated on the 393 news events for conflict-cooperation intensity distribution, administrative basin, issue type, and year. A majority of events were cooperative; the most common issue type was water quality. Between 1990 and 2004 an increase in the number of events, high intensity conflictive and cooperative events and conflictive intensity occurred, but there was no change in cooperative intensity was seen.

### *Spatial Summary Statistics*

#### **Conflict-Cooperation Intensity Distribution**

As shown in Figure 11, more events were cooperative (214, 54%) than conflictive (138, 35%) even though mildly conflictive (intensity -1) events outnumbered mildly cooperative (intensity 1) events 69 to 50. However, for more extreme intensities, there are twice as many cooperative events (164, 42%) as conflictive (69, 20%). The extremely cooperative events (intensity 5) outnumber the most intense conflictive events by a margin of 3 to 1. The 41 neutral events make up 10% of the reported news events.



**Figure 11: Distribution of all events reported in articles between 1990 and 2004, along a conflict-cooperation intensity spectrum. Overall more interactions between stakeholders were cooperative, rather than conflictive. N= 393**

### Spatial Distribution of Events

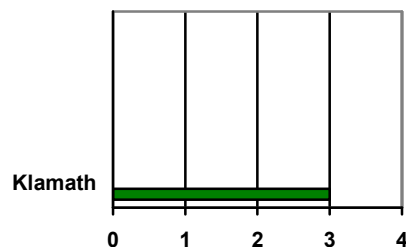
The spatial distribution of events across the 18 administrative basins was extremely varied (Table 7 and Figure 13). The Willamette and Mid Coast basins had the most events overall (83 and 80 respectively). Four basins: Willamette, Mid Coast, Klamath, and Malheur, accounted for 270 of the 393 events or 68.7%. Fourteen of the basins had less than 20 events and no events were collected for the Hood, Malheur Lake or Powder basins. Thirty-four (8.7%) events affected every basin in the state and are labeled as ‘state wide.’

The Klamath basin had the highest number of conflictive events (30, 21.7%) and was the only basin in which conflictive events substantially outnumbered cooperative ones. Additionally, the Klamath was the only basin where extreme (intensity -5) conflictive events occurred. Approximately equal numbers of conflictive events occurred in the Mid Coast (25, 18.1%), Willamette (23, 16.7%), and Malheur (21, 15.2%) basins. Approximately the same number of cooperative events occurred in the Willamette (52, 24.3%) and Mid Coast (49, 22.9%) basins, nearly twice the number of conflictive events occurring in those basins. Nine extremely cooperative events (intensity 5) occurred in six basins; Klamath, Mid Coast, Rogue, Sandy, Willamette and Umpqua and two at the state level.

**Table 7: Cooperative, conflictive, and total events broken down by basin. High conflict refers to intensities -4 and -5; high cooperation refers to intensities 4 and 5. All extremely conflictive events occurred in Klamath basin; comparatively extremely cooperative events were spread between six basins and state wide (affecting every basin in Oregon). Hood, Malheur Lake and Powder basins had no reported events. Percentage values are rounded to the nearest tenth.**

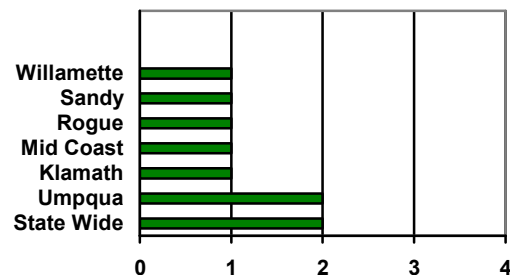
Basin	Total		Conflict		Cooperation		Neutral		High Conflict		High Cooperation	
	#	%	#	%	#	%	#	%	#	%	#	%
Deschutes	20	5.1	3	2.2	15	7	2	4.9	0	0	5	8.1
Goose & Summer Lakes	5	1.3	3	2.2	2	0.9	0	0	1	4.0	0	0
Grande Ronde	2	0.5	2	1.4	0	0	0	0	1	4.0	0	0
Hood	0	0	0	0	0	0	0	0	0	0	0	0
John Day	5	1.3	1	0.7	3	1.4	1	2.4	0	0	1	1.6
Klamath	62	15.8	30	21.7	23	10.7	9	22	9	36.0	3	4.8
Malheur	45	11.5	21	15.2	21	9.8	3	7.3	0	0	4	6.5
Malheur Lake	0	0	0	0	0	0	0	0	0	0	0	0
Mid Coast	80	20.4	25	18.1	49	22.9	6	14.6	2	8.0	9	14.5
North Coast	1	0.3	0	0	1	0.5	0	0	0	0	0	0
Owyhee	2	0.5	0	0	1	0.5	1	2.4	0	0	0	0
Powder	0	0	0	0	0	0	0	0	0	0	0	0
Rogue	19	4.8	6	4.3	10	4.7	3	7.3	1	4.0	3	4.8
Sandy	14	3.6	5	3.6	9	4.2	0	0	1	4.0	3	4.8
South Coast	6	1.5	3	2.2	3	1.4	0	0	1	4.0	1	1.6
Umatilla	5	1.3	1	0.7	2	0.9	2	4.9	0	0	2	3.2
Umpqua	10	2.5	3	2.2	7	3.3	0	0	0	0	6	9.7
Willamette	83	21.1	23	16.7	52	24.3	8	19.5	7	28.0	18	29.0
State Wide	34	8.7	12	8.7	16	7.5	6	14.6	2	8.0	7	11.3
<b>Total</b>	<b>393</b>	<b>100</b>	<b>138</b>	<b>99.9</b>	<b>214</b>	<b>100</b>	<b>41</b>	<b>99.9</b>	<b>25</b>	<b>100</b>	<b>62</b>	<b>100</b>

**Basins with Extremely Conflictive Intensity Events**



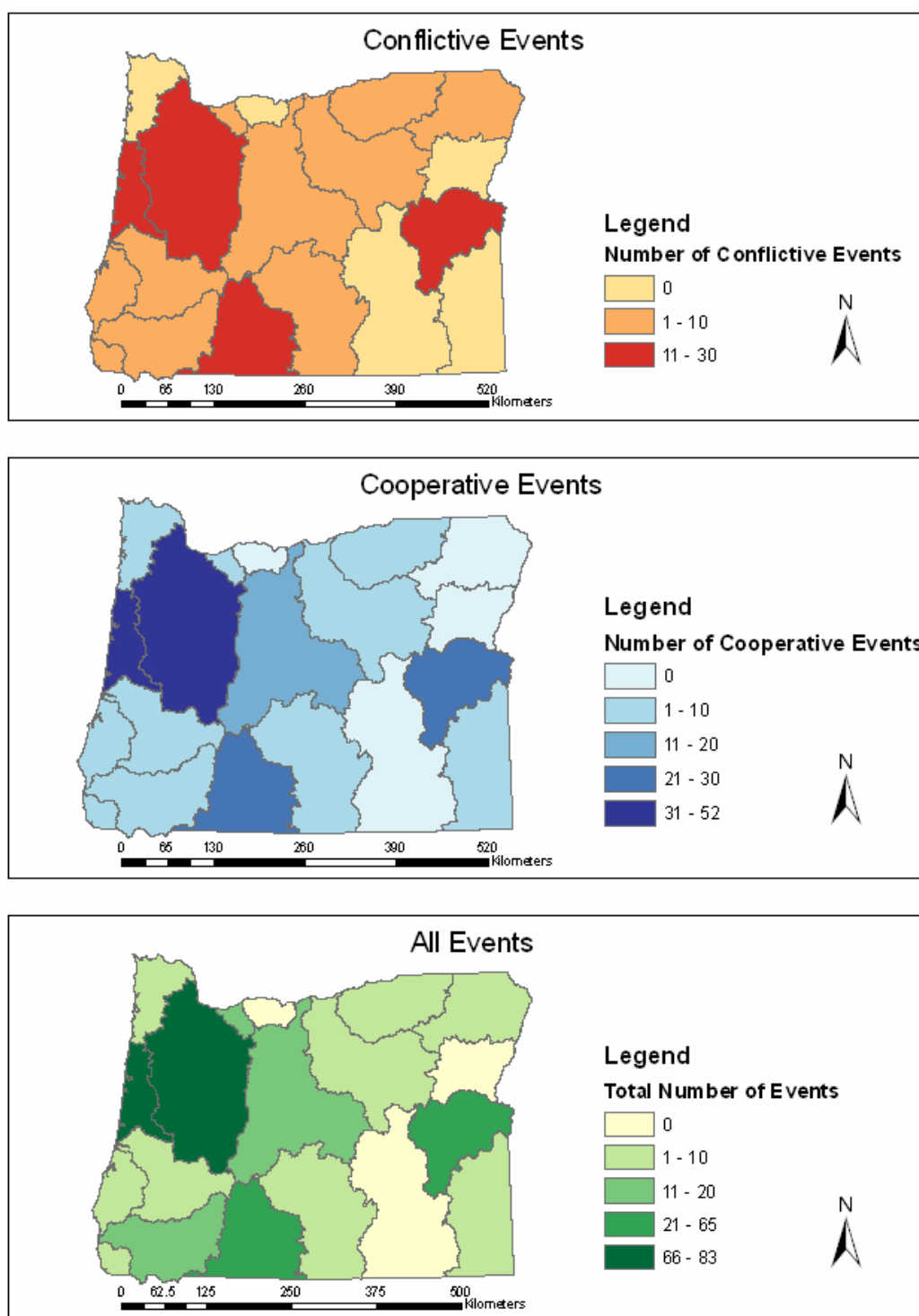
a)

**Basins with Extremely Cooperative Intensity Events**



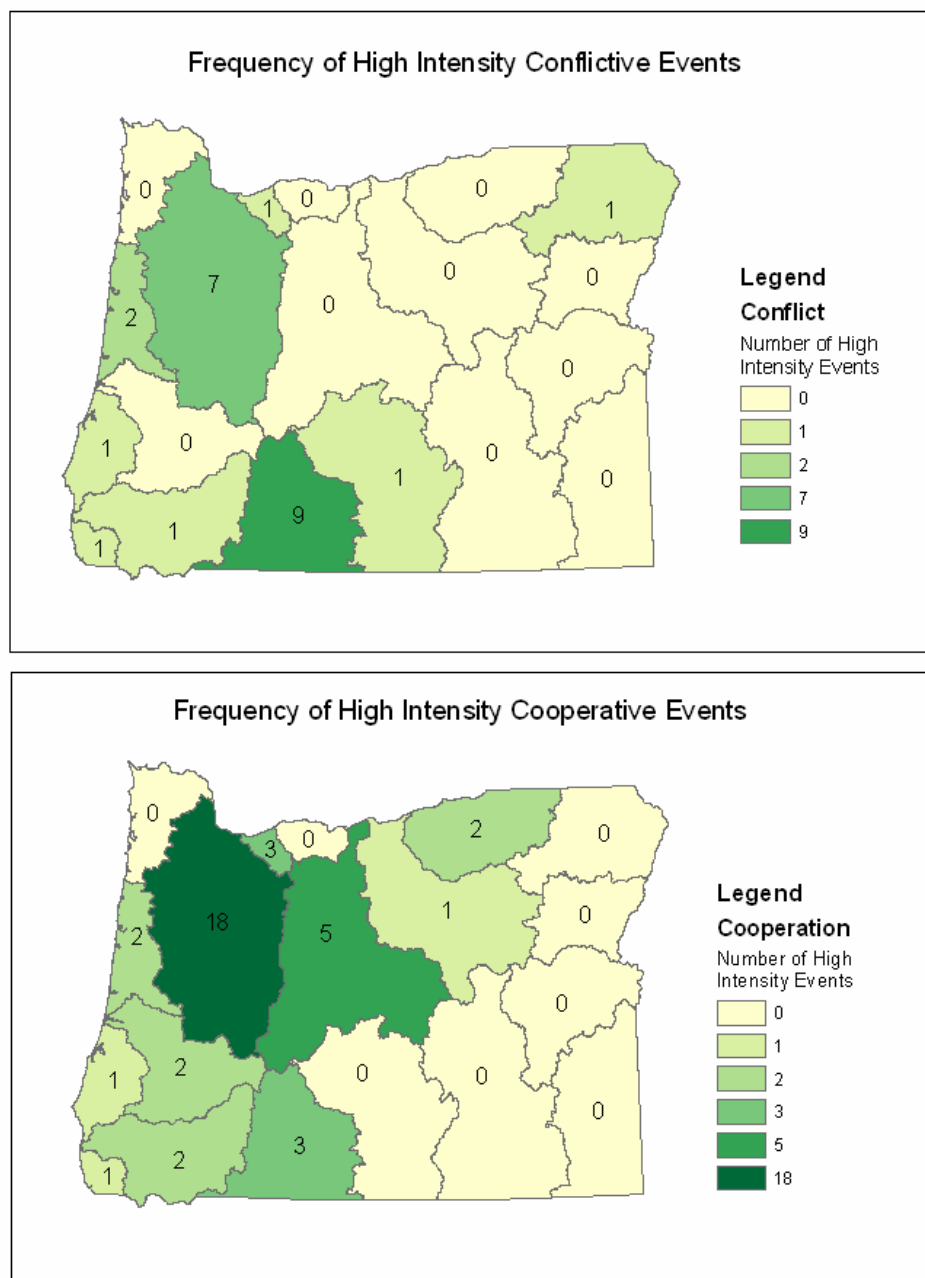
b)

**Figure 12: Frequency of extremely a) conflictive (intensity -5) and b) cooperative (intensity 5) events shown by basin. All three extremely conflictive events took place in the Klamath basin. The seven extremely cooperative events occurred in six basins and two affected the entire state.**



**Figure 13: Number of conflictive, cooperative and total number of events displayed by basin. Three basins; Hood, Powder, and Goose & Summer Lakes, had no recorded events. Willamette and Mid Coast basins had the most cooperative and Klamath had the most conflictive. Color palette provided by (Brewer and Harrower 2002).**

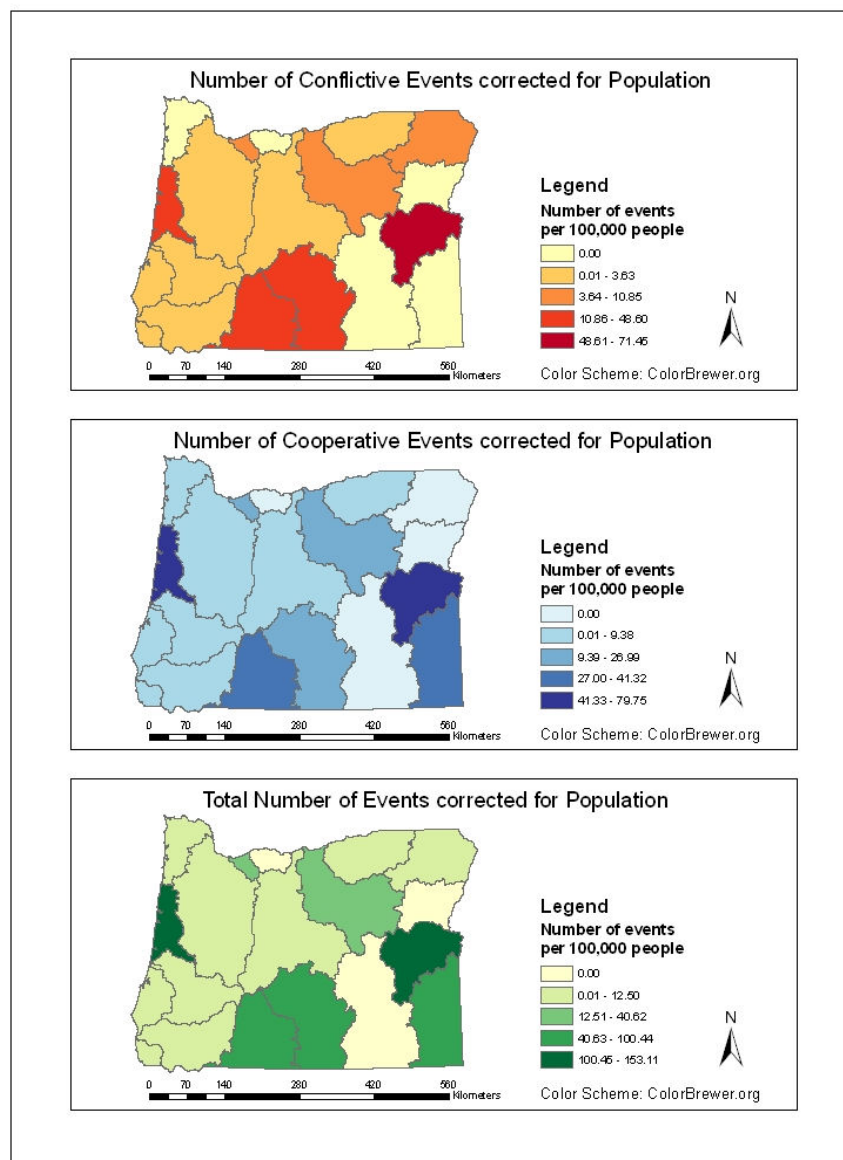




**Figure 14: Spatial distribution of high intensity events from all recorded events. This serves as one of two dependent variables for spatial analysis. High intensity events are defined as having cooperative intensities 4 and 5 and conflictive events with intensities -4 and -5.**

## Population and Area Corrections of Events

When the number of news events in each basin is corrected to account for the vast population variation throughout the state a slightly different trend emerges. The Willamette basin has one of the smallest frequencies of events per 100,000 people. The Malheur and Mid Coast basins have the most news events per capita (Figure 15).



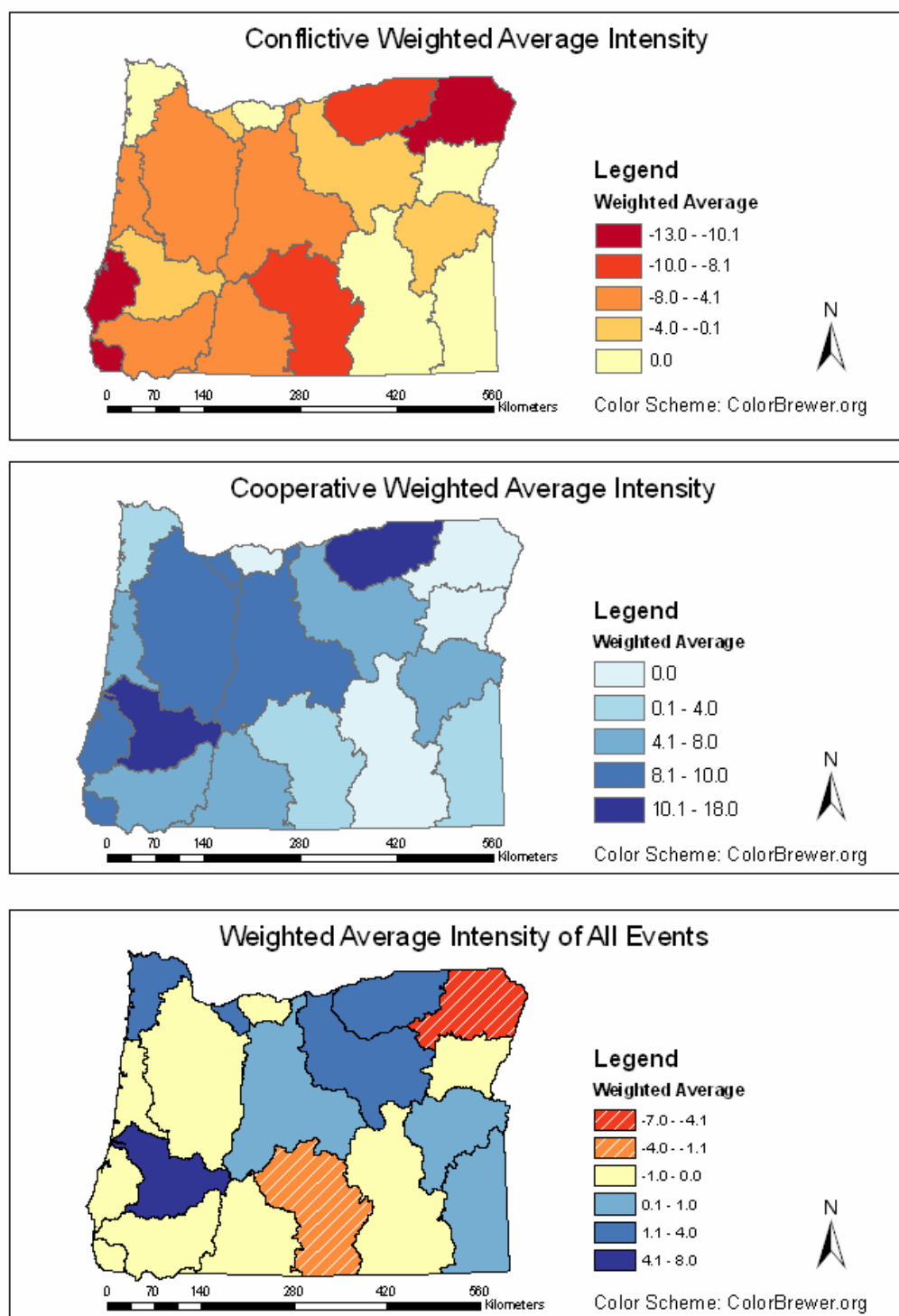
**Figure 15: Conflictive, cooperative and total events per 100,000 people. Malheur and Mid Coast basins had the highest number of events per capita.**

### Spatial Distribution of Weighted Average Intensities

Most of the basins on the western side of the Cascades Mountains have relatively high cooperative intensity averages (Figure 16 and Table 8). Basins to the east have a greater range of cooperative intensities ranging from the very high (Umatilla, 16) to three basins with zero cooperative events (Grande Ronde, Malheur and Malheur Lake). The Umpqua was the most cooperative basin with an intensity of 18, followed by the Umatilla with an intensity of 16. The Willamette, South Coast and Rogue basins had approximately equal intensities of conflict and cooperation. No geographic pattern is seen in the distribution of conflictive intensities among the basins in Oregon. The Grande Ronde and South Coast basins were the most conflictive. Average intensities of all the events show that the Grande Ronde and Goose & Summer Lakes basins were the most conflictive and the Umpqua was the most cooperative.

**Table 8: Conflictive, cooperative and total weighted average intensities for Oregon's administrative basins. Weights are equal to the square of the intensity. Neutral events are included only in the total average. 'State Wide' refers to events that affect every basin in the state. The highest cooperative average occurred in the Umpqua basin. The most conflictive average occurred in the Grande Ronde. These values serve as one of two dependent variables for analysis. Refer to Figure 16 for a detailed map.**

Weighted Averages of Event Intensities			
Basin	Cooperative	Conflictive	Total
Deschutes	9	-5	1
Goose &			
Summer Lakes	3	-10	-4
Grande Ronde	0	-13	-7
Hood	0	0	0
John Day	7	-1	2
Klamath	6	-8	0
Mahleur	7	-2	1
Mahleur Lake	0	0	0
Mid Coast	7	-5	0
North Coast	4	0	2
Owyhee	4	0	1
Powder	0	0	0
Rogue	8	-8	0
Sandy	9	-4	3
South Coast	10	-11	-1
Umatilla	16	-9	2
Umpqua	18	-2	8
Willamette	9	-8	0
State Wide	10	-5	1
Total	8	-6	0



**Figure 16: Conflictive, cooperative, and total weighted average intensities of the administrative basins of Oregon. Weighted averages were calculated by summing the squares of the event's conflict-cooperation intensity. The most conflictive basins were the Grande Ronde and Goose & Summer Lakes. The most cooperative was the Umpqua.**

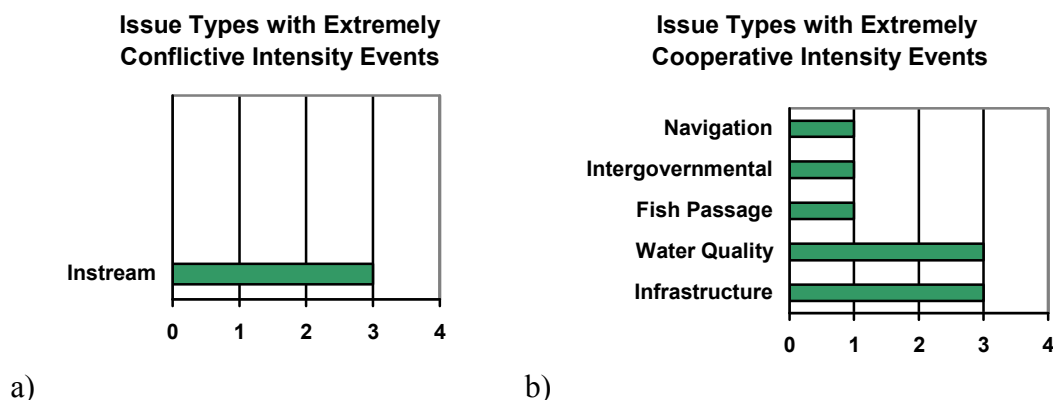
## Issue Types

Table 9 shows the distribution of the 393 events into twelve issue type categories. The most common issue type was water quality (147 events, 37%). Seventy-eight (20%) of the events were related to infrastructure. Intergovernmental and instream events occurred in approximately the same frequency, 42 (11%) and 40 (10%) events, respectively.

Instream events were the only issue type that had more conflictive events than cooperative. Eight of the issue types were composed of between 20% and 37% conflictive events. Recreation, conservation, and groundwater had no conflictive events, while flood and navigation issues only had one each. Recreation events were 89% cooperative but there were only eight events total. Cooperative events accounted for more than 50% of the events for nine issue types. All three of the extremely conflictive events (intensity -5) were classified as instream events (Figure 17). Extremely cooperative events (intensity 5) comprised five issue types; water quality, infrastructure, navigation, intergovernmental and fish passage (Figure 17).

**Table 9: Issue types of news events divided into conflictive, cooperative and neutral categories. The most common issue type of the 12 was water quality. Instream events are the only issue type with more conflictive events than cooperative events.**

Issue	Total	Conflictive		Cooperative		Neutral	
	#	#	%	#	%	#	%
Conservation	6	0	0.0	3	50.0	3	50.0
Fish Passage	19	7	36.8	11	57.9	1	5.3
Flood	5	1	20.0	2	40.0	2	40.0
Groundwater	2	0	0.0	1	50.0	1	50.0
Infrastructure	78	29	37.2	44	56.4	5	6.4
Instream	40	21	52.5	18	45.0	1	2.5
Intergovernmental	42	14	33.3	17	40.5	11	26.2
Invasive Species	11	4	36.4	7	63.6	0	0.0
Navigation	5	1	20.0	3	60.0	1	20.0
Recreation	8	0	0.0	7	87.5	1	12.5
Water Quality	147	53	36.1	84	57.1	10	6.8
Water Rights	30	8	26.7	17	56.7	5	16.7
Total	393	138	35.1	214	54.5	41	10.4



**Figure 17: Frequency of extreme intensity events by issue type. The three extremely conflictive events (intensity -5) all concerned instream issues. Extremely cooperative events not only outnumbered conflictive ones, but encompass more issue types.**

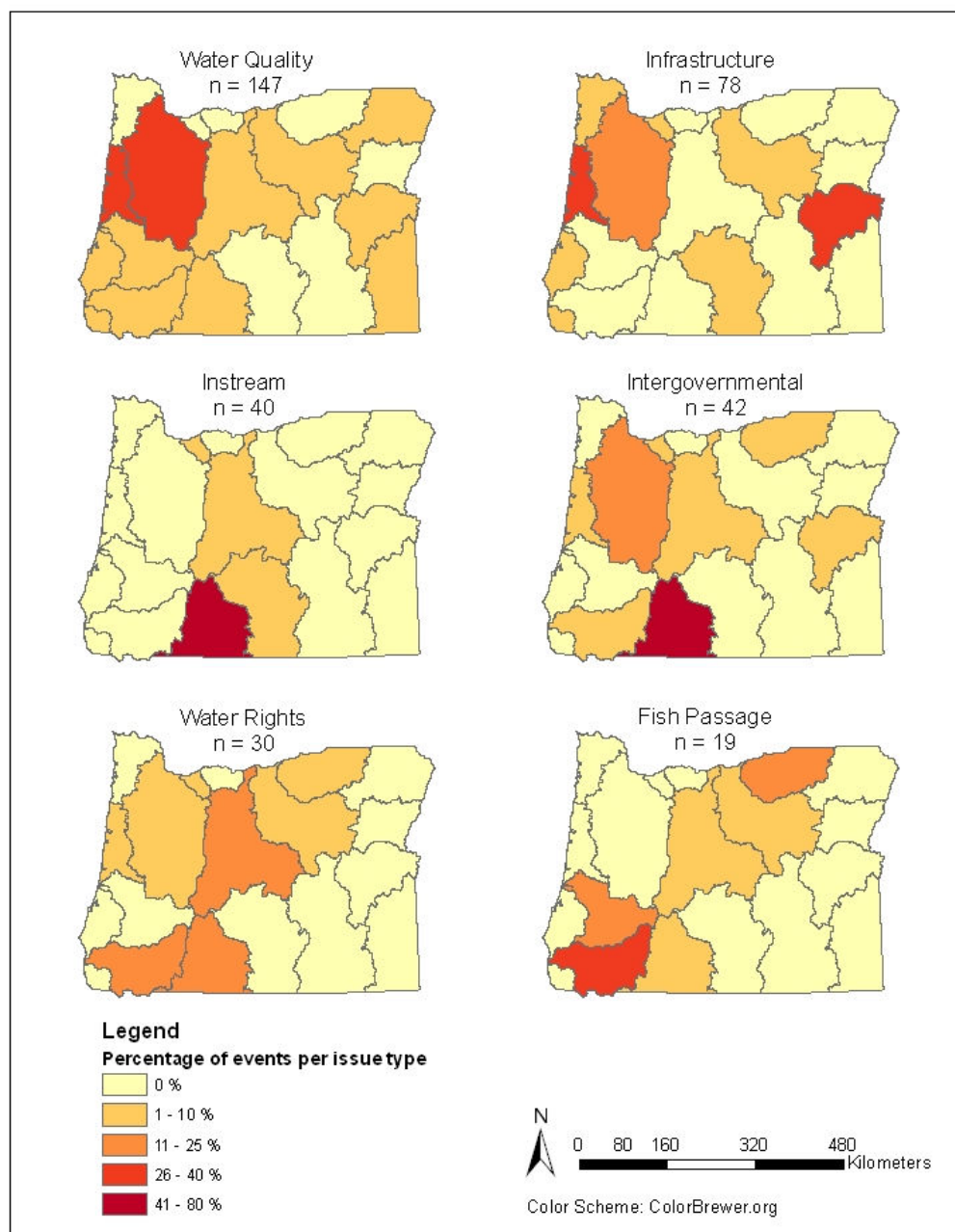
### Spatial Distribution of Issue Types

The spatial distribution of the most prominent issue types: water quality, infrastructure, instream, water rights, and fish passage are shown below (Figure 18 and Table 10).

Water quality events were the most evenly distributed issue type; eleven basins had events and none had more than 40%. The Willamette basin had 39% of the 147 water quality events and the Mid Coast had 26%. Infrastructure events were concentrated in the Mid Coast and Malheur basins. No issue type was more concentrated than instream events, where 78% occurred in the Klamath basin. Water rights events were more widely distributed; no basin had more than 25% of the water rights events. The seventeen events related to fish passage predominately occurred in the Rogue and Umpqua basins. Intergovernmental events were concentrated in western Oregon, but infrastructure events were distributed across the entire state.

**Table 10: Spatial distribution of the most reported issue types. Instream and intergovernmental events were highly concentrated in the Klamath basin. Infrastructure events were concentrated in the Mid Coast and Malheur basins. Water quality events were concentrated in the Willamette and Mid Coast basins. Fish Passage events were concentrated in the Rogue and Umpqua basins. The ‘Total’ column includes all twelve issue types, not just the six most reported.**

Basin	Fish Passage		Infrastruc- ture		Instream		Intergovern- mental		Water Quality		Water Rights		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Deschutes	1	5	0	0	3	8	1	2	4	3	6	20	20	5
Goose & Summer Lakes	0	0	3	4	2	5	0	0	0	0	0	0	5	1
Grande Ronde	0	0	0	0	0	0	0	0	2	1	0	0	2	1
Hood	0	0	0	0	0	0	0	0	0	0	0	0	0	0
John Day	1	5	1	1	0	0	0	0	2	1	1	3	5	1
Klamath	1	5	0	0	31	78	22	52	2	1	5	17	62	16
Malheur	0	0	30	38	0	0	1	2	12	8	0	0	45	11
Lake	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mid Coast	0	0	25	32	0	0	2	5	38	26	3	10	80	20
North Coast	0	0	1	1	0	0	0	0	0	0	0	0	1	0
Owyhee	0	0	0	0	0	0	0	0	1	1	0	0	2	1
Powder	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rogue	7	37	0	0	0	0	1	2	4	3	5	17	19	5
Sandy	0	0	3	4	4	10	3	7	0	0	2	7	14	4
Coast	0	0	1	1	0	0	0	0	5	3	0	0	6	2
Umatilla	2	11	0	0	0	0	1	2	0	0	2	7	5	1
Umpqua	4	21	0	0	0	0	0	0	2	1	0	0	10	3
Willamette	0	0	13	17	0	0	7	17	57	39	1	3	83	21
State Wide	3	16	1	1	0	0	4	10	18	12	5	17	34	9
Total	19	100	78	99	40	101	42	99	147	99	30	101	393	101



**Figure 18: Maps of the six most recorded issue types, shown as a percentage of issue type events per basin. Instream and intergovernmental issues were concentrated in the Klamath basin. Water rights and to a lesser extent water quality events were more evenly distributed across Oregon. State wide events are not represented.**



## Spatial Analysis

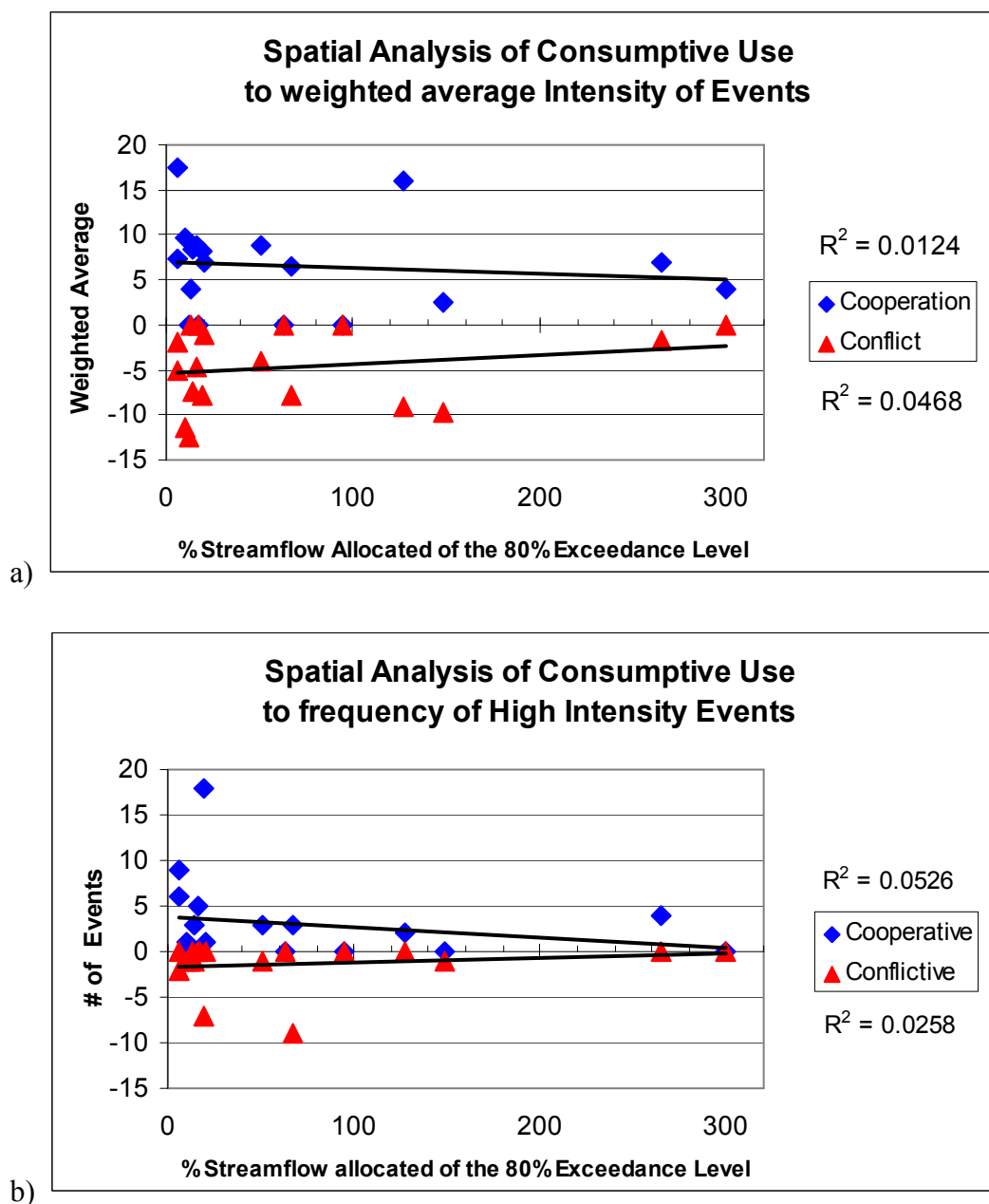
### Consumptive Use, Population Density Change, and Water Quality

Linear regression analysis was performed to test if variations in conflict or cooperation could be explained by percent change in population density, percent of 80% exceedance level basin's surface water allocated to consumptive use, or average water quality. None of these variables explained spatial variation in weighted averages of intensity or frequency of high intensity events at the state scale.

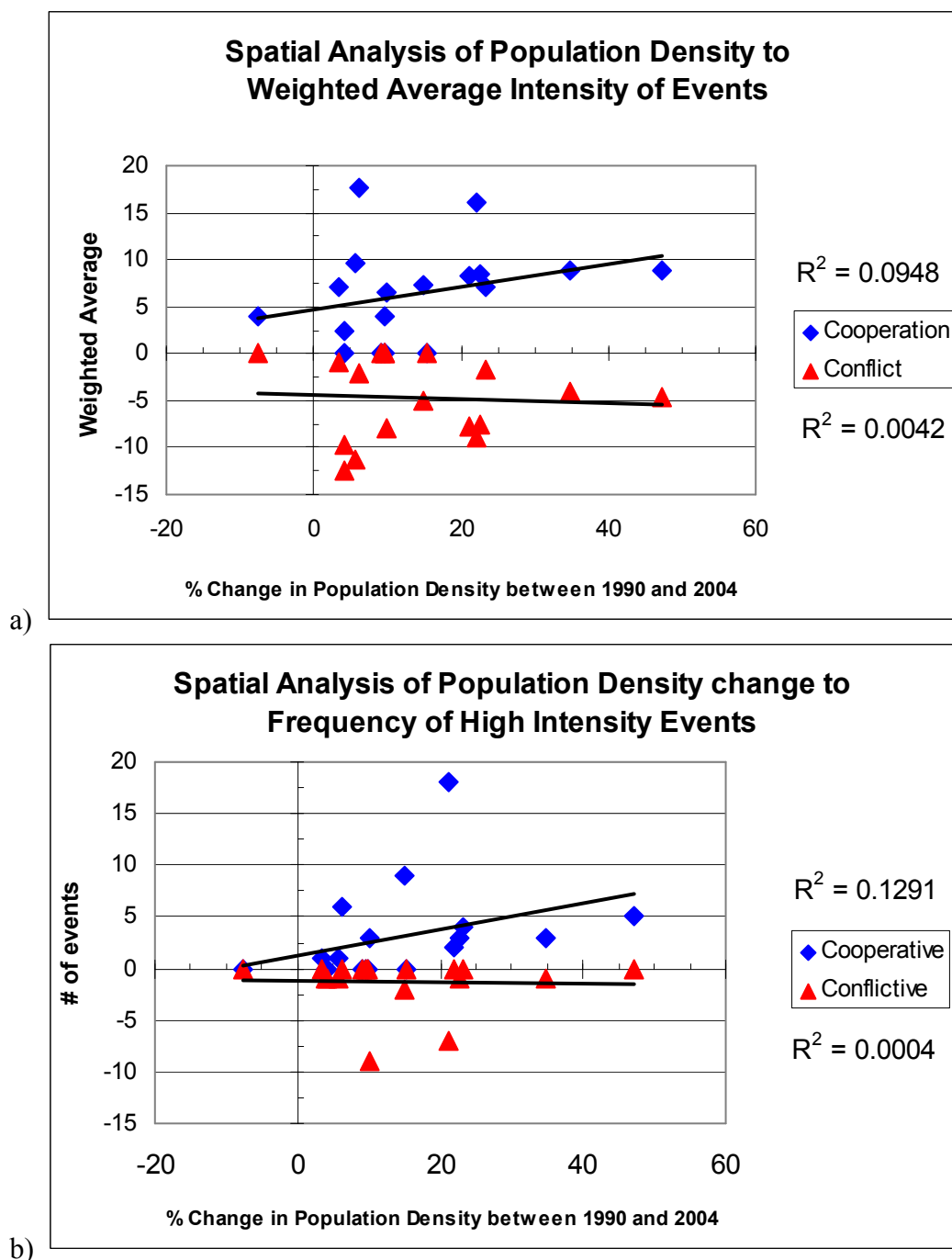
Although some general trends are present, none were statistically significant (Table 11). As consumptive use increased, decreases in conflict and cooperation were seen (Figure 19). Consumptive use explained at most five percent of the variance in conflict levels. As population density increased, cooperation increased, but no change in conflict was seen (Figure 20). Up to thirteen percent of the variation in cooperation was explained population, but less than one percent explained variation in conflict. No trends in conflict or cooperation emerged as water quality increased, explaining at most four percent of the variance (Figure 21).

**Table 11: Results from correlation analysis testing spatial variation of conflict and cooperation (as measured by the weighted average and frequency of high intensity events) to three variables. Spatial variation in conflict and cooperation across Oregon's administrative basins could *not* be explained by consumptive use, population density or water quality. See Figure 19, Figure 20, and Figure 21 for graphical display of results.**

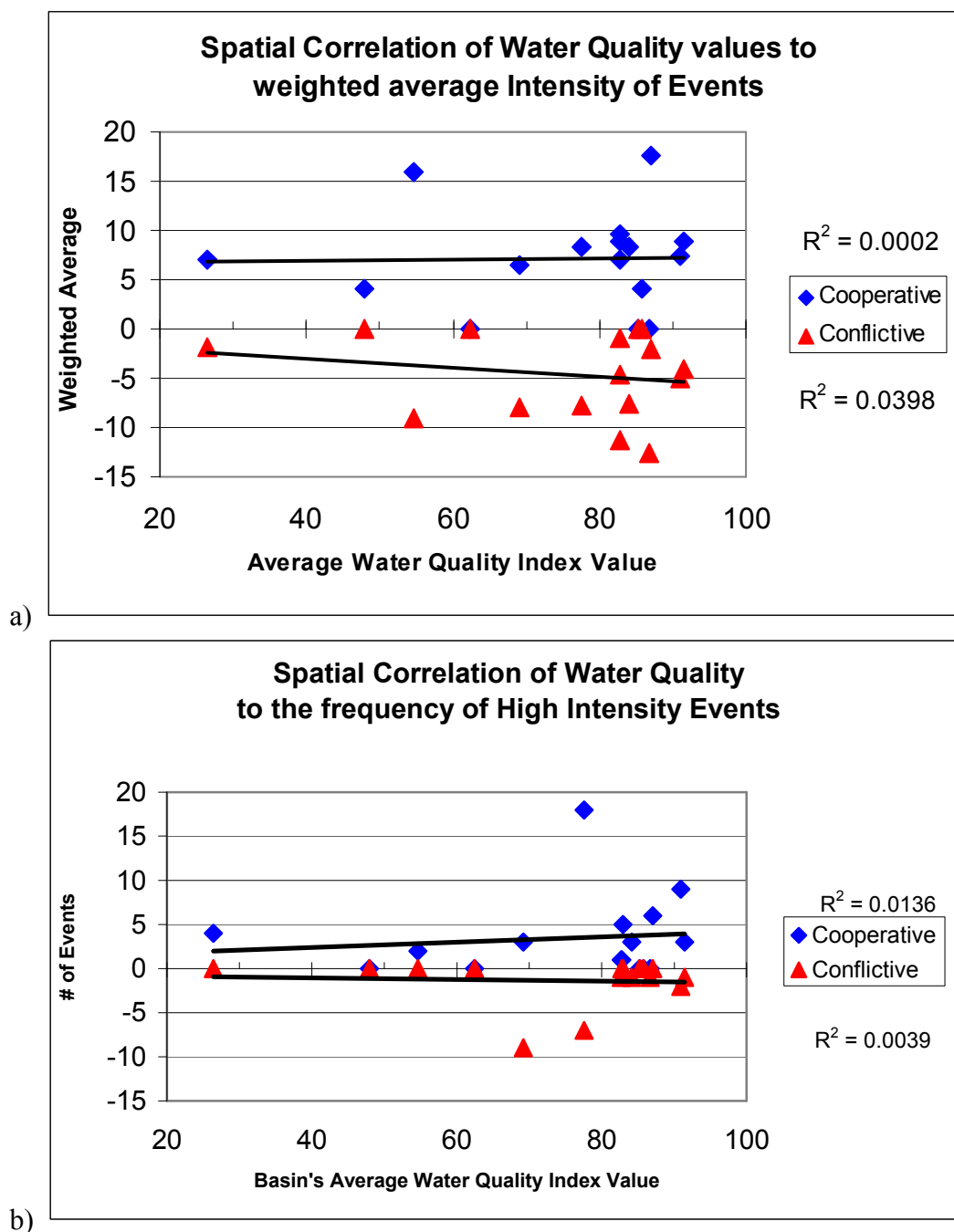
		Consumptive Use		Population Density		Water Quality	
		p-value	r2	p-value	r2	p-value	r2
<b>Weighted Average</b>	Cooperative	0.6	1.2	0.2	9.5	0.9	<0.1
	Conflictive	0.3	4.7	0.7	0.4	0.4	4.0
<b>Frequency of High Intensity Events</b>	Cooperative	0.3	5.3	0.1	12.9	0.6	1.4
	Conflictive	0.5	2.6	0.9	<0.1	0.8	0.4



**Figure 19: Overall trend implies decreases in conflict and cooperation as consumptive use increases, but not to a significant degree. Consumptive use values are the amount of water appropriated to out of stream uses expressed as a percent of the streamflow exceeded 80% of the time. Consumptive use data is collected by the Oregon Water Resources Department and was spatially reclassified into administrative basins by Macomber et al. (2005). Weighted averages were calculated by summing the squares of the event's conflict-cooperation intensity. High intensity events are events conflict-cooperation intensity equal to -4, -5, 4, or 5.**



**Figure 20: Changes in population density do not significantly explain differences in conflict or cooperation. Increases in population density are more correlated to cooperation than conflict, but not a significant degree. Population data was collected by the US Census Bureau and was spatially reclassified into administrative basins by Macomber et al. (2005). Weighted averages were calculated by summing the squares of the event's conflict-cooperation intensity. High intensity events are events conflict-cooperation intensity equal to -4, -5, 4, or 5.**

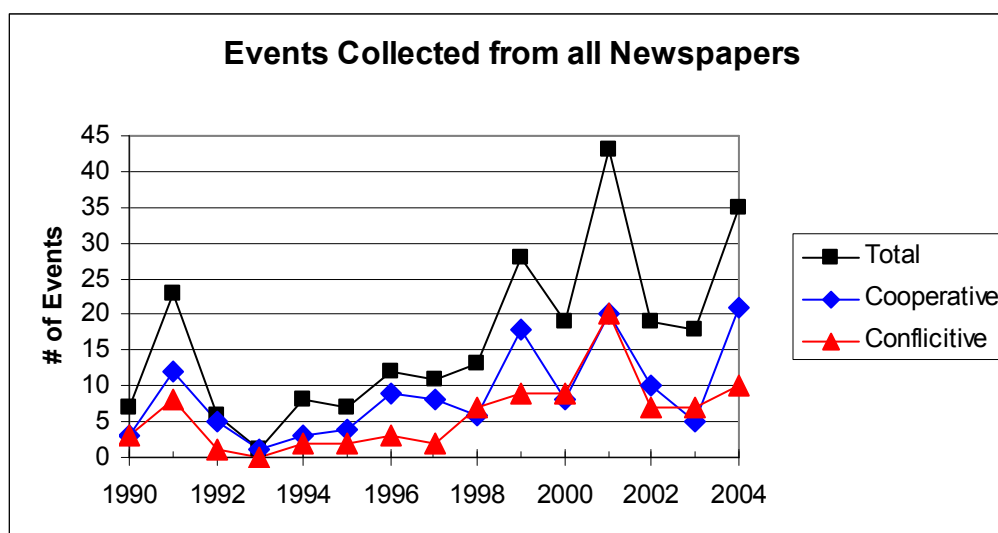


**Figure 21: Neither cooperation nor conflict is correlated to water quality values. A slight increase in conflictive intensity tends to occur in basins with better water quality. Water quality does not significantly explain differences in conflict and cooperation between basins. The Oregon water quality index is calculated from eight water quality variables. It is managed by the National Resource Conservation Service and Oregon Department of Environmental Quality and was spatially reclassified into administrative basins by Macomber et al. (2005). Weighted averages were calculated by summing the squares of the event's conflict-cooperation intensity. High intensity events are events conflict-cooperation intensity equal to -4, -5, 4, or 5.**

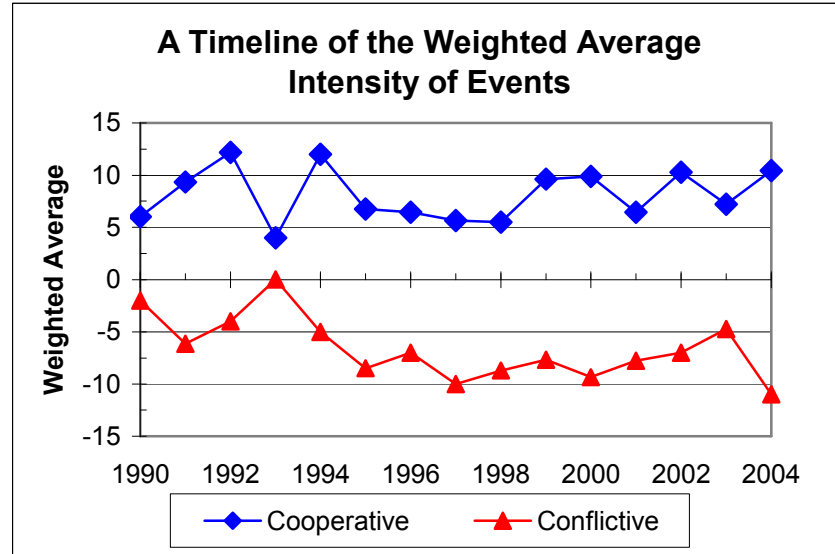
### **Temporal distribution of events**

Overall, the total number of reported events increased between 1990 and 2004 (Figure 22). In general the frequency of cooperative and conflictive events increased over time; only one event was recorded in 1993, and the highest numbers of events were recorded in 2001. Thirty-one of the 43 events (72%) recorded in 2001 were in the Klamath basin, the most events during one year in any basin. In almost every year more cooperative events were recorded than conflictive. In 1999 and 2004 about twice as many cooperative occurred and an equal frequency of conflictive and cooperative events occurred in 2001. Events collected from local sources were not included in temporal analysis because they were only gathered for 2004 leaving a total of 250 reported events.

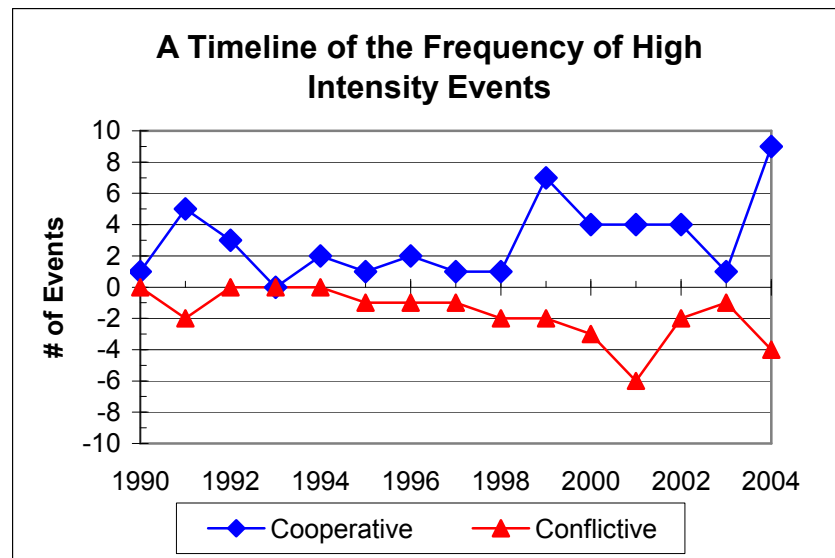
Figure 23 illustrates that between 1990 and 2004 there was no overall change in cooperative intensity, but there was an increase in conflictive intensity. The frequency of high intensity events (intensities -4, -5, 4, and 5) increased over time, similar to the trend for total number of events (Figure 24).



**Figure 22: Timeline of the total, cooperative and conflictive news events reported between 1990 and 2004 in regional newspaper sources. A general increase in both cooperative and conflictive events was seen. Cooperative events outnumbered conflictive events in almost all years. N= 250**



**Figure 23: Weighted average intensities of conflictive and cooperative events. Weighted averages were calculated by summing the squares of the event's intensity. There was no change in cooperative intensity over time, but the intensity of conflict increased between 1990 and 2004.**



**Figure 24: Number of high intensity events in recorded in each year. High intensity events have cooperative intensities of 4 and 5 and conflictive intensities of -4 and -5. The frequency of both cooperative and conflictive high intensity events increased between 1990 and 2004. The total number of cooperative events reported was 45; total number of conflictive events was 25.**

### **Temporal Analysis**

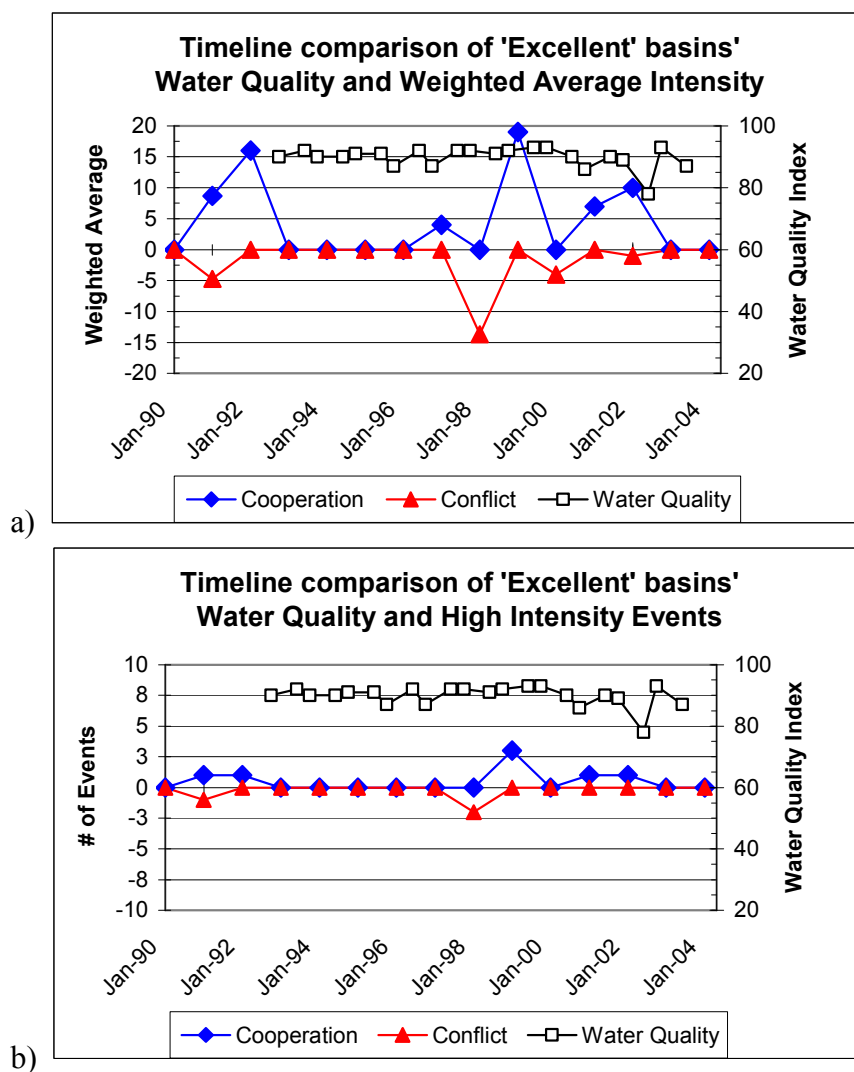
Briefly, presented are the results from temporal analysis. Three independent variables: water quality, surface water supply, and institutional change were analyzed to explain temporal variations in conflict or cooperation. Qualitative analysis of water quality in four basin groups did not adequately explain fluctuations in conflict or cooperation between 1990 and 2004. However, trends could be established between surface water supply, geographic region and overall levels of conflict and cooperation. Higher conflict was seen in western basins in wet years; higher conflict was seen in eastern basins in dry years. Additionally, higher levels of cooperation were seen in all basins in dry years, but the trend is strongest in eastern basins. At the state scale, institutional changes were associated with peaks in cooperation in 1991, 1999, and 2004 and peaks in conflict in 1991, 2001 and 2004. Analysis of time-lagged relationships of conflict and cooperation indicate that conflict intensity increases over time. Major conflict leads to major cooperation, but minor conflict may lead to either minor or major cooperation. These results are explained in detail in the following sections.

### **Water Quality**

In all four water quality basin groups, no major fluctuations in water quality were seen during the time period data was available, October 1992 to June 2003. However, water quality did vary seasonally in all basin groups, with decreased scores in drier months. These fluctuations were more pronounced in basins with lower water quality scores. Two water quality values were gathered for each year, June and October and are displayed in Figure 25, Figure 26, Figure 27, and Figure 28 for each basin group. Explanations of water quality basin groupings can be found on page 31, Figure 9. Qualitative time series analysis does not indicate a relationship between fluctuations in water quality and conflict or cooperation in any basin group.

Basins with a water quality rating of ‘excellent’ had spikes in weighted-average conflict in 1998 and weighted-average cooperative in 1999. Additional moderate increases in the cooperative weighted average occurred in 2001 and 2002 (Figure 25a). This increase in cooperation is associated in time with a general decrease

in water quality. Very few conflictive and cooperative high intensity events were reported (Figure 25b).

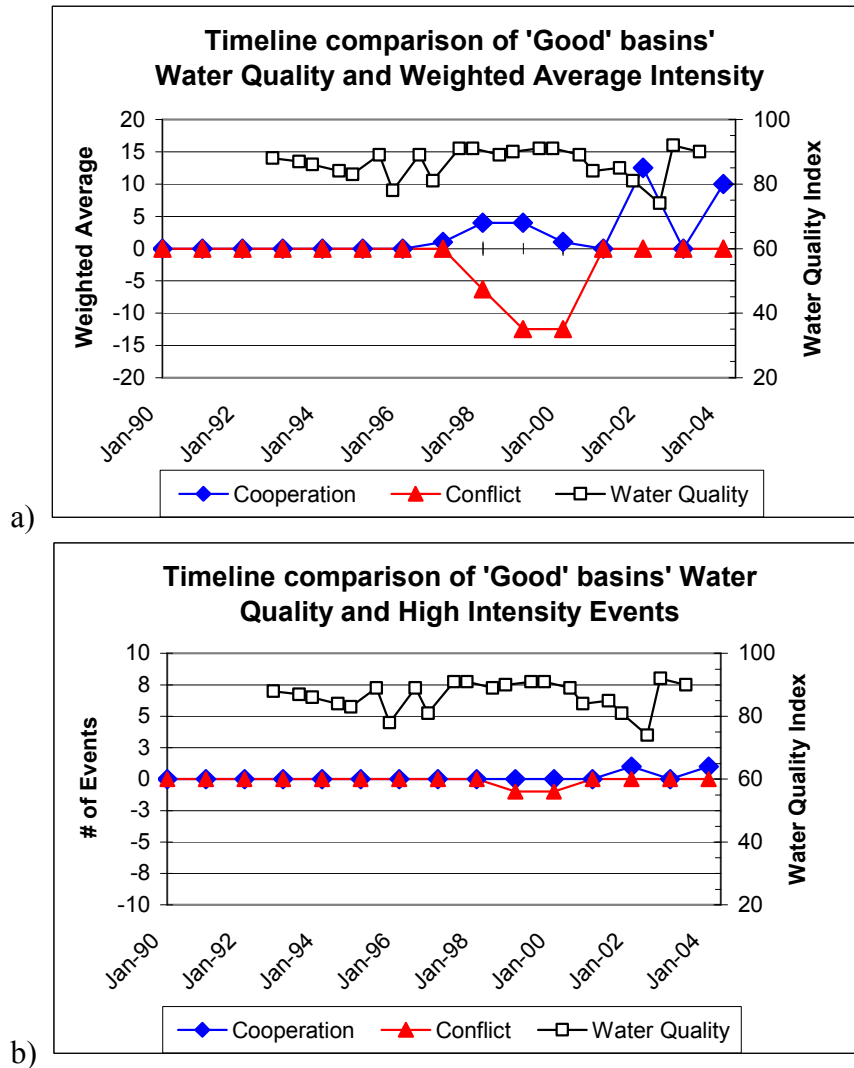


**Figure 25: Timeline comparison of ‘Excellent’ basin group’s water quality to conflictive and cooperative a) weighted average intensities and b) frequency of high intensity events. Water quality values were consistent through the time period while some years were punctuated by increases in conflict and cooperation. Water quality data provided by Oregon Water Resources Department and reclassified by Macomber et al. (2005). Weights were equal to the square of the event’s conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

Basins with a water quality rating of ‘good’ had an increase in both cooperative and conflictive weighted averages, but no change in the frequency of high intensity events (Figure 26). Conflictive weighted average increased between 1998 and 2000, the same years of relatively stable water quality. A small increase in

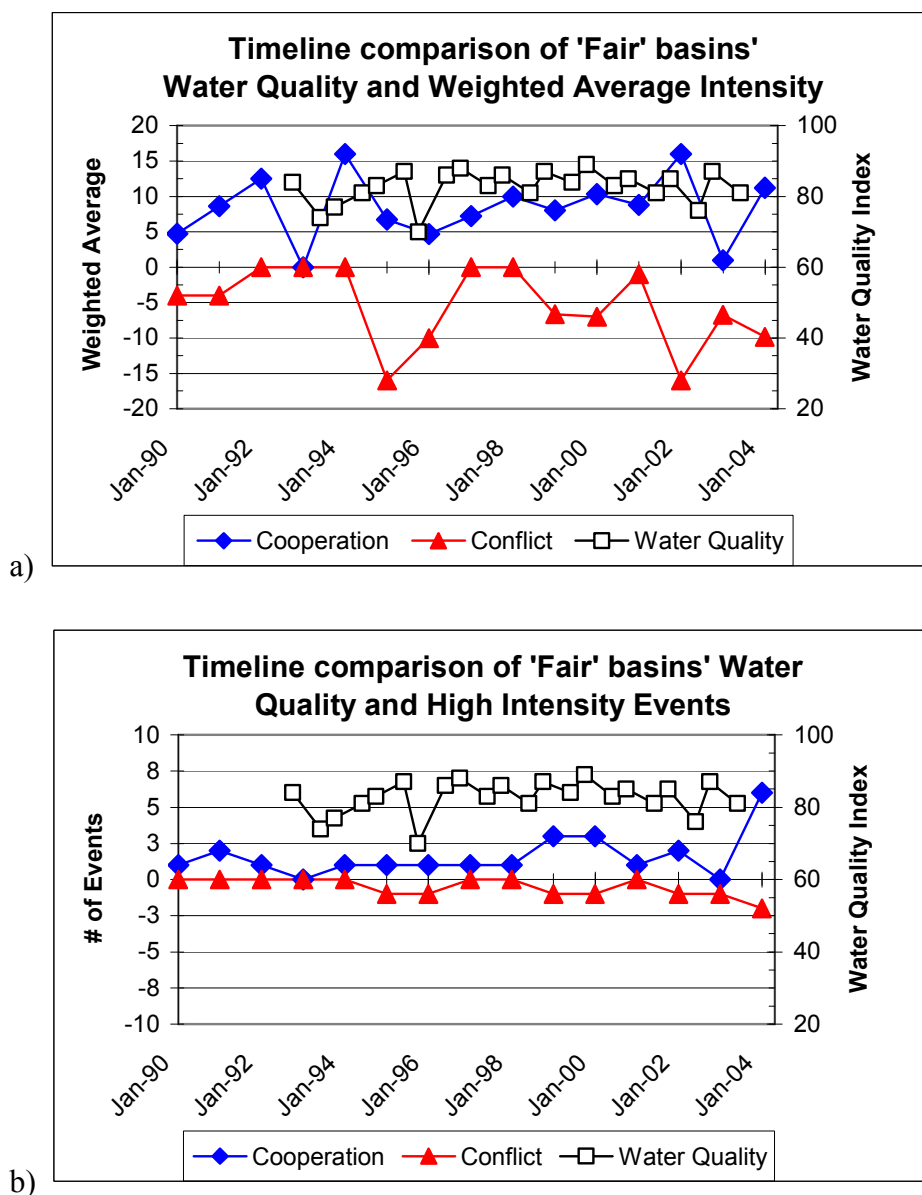


cooperative weighted average occurred between 1997 and 2000, again years of stable water quality values. Cooperation increased substantially in 2002, the same year of the lowest water quality.



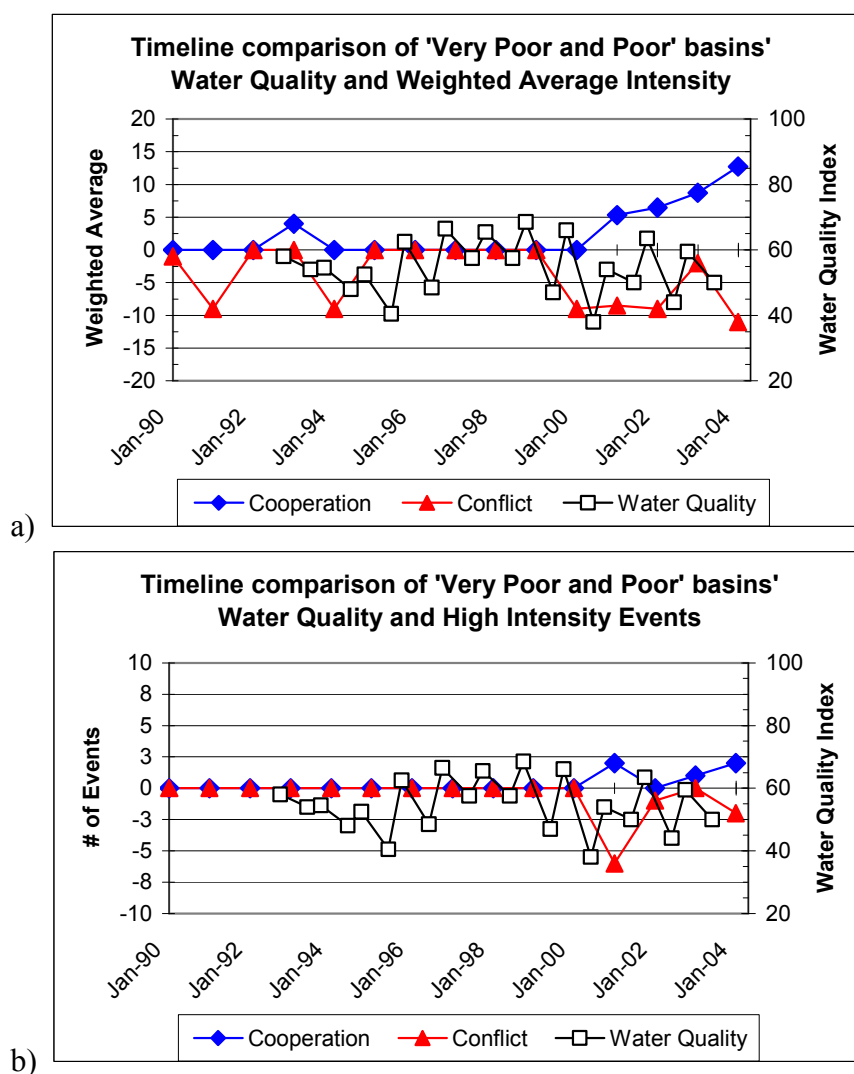
**Figure 26: Timeline comparison of 'Good' basin group's water quality to conflictive and cooperative a) weighted average intensities and b) frequency of high intensity events. Years of stable water quality values also had fluctuations in cooperation and conflict. Water quality data provided by Oregon Water Resources Department and reclassified by Macomber et al. (2005). Weights were equal to the square of the event's conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

Basins with a water quality rating of ‘fair’ had an overall increase in conflictive, but not cooperative weighted average between 1990 and 2004, (Figure 27a) and both types of high intensity events increased (Figure 27b). These increases in conflict and cooperation are not mirrored in the overall consistent water quality values.



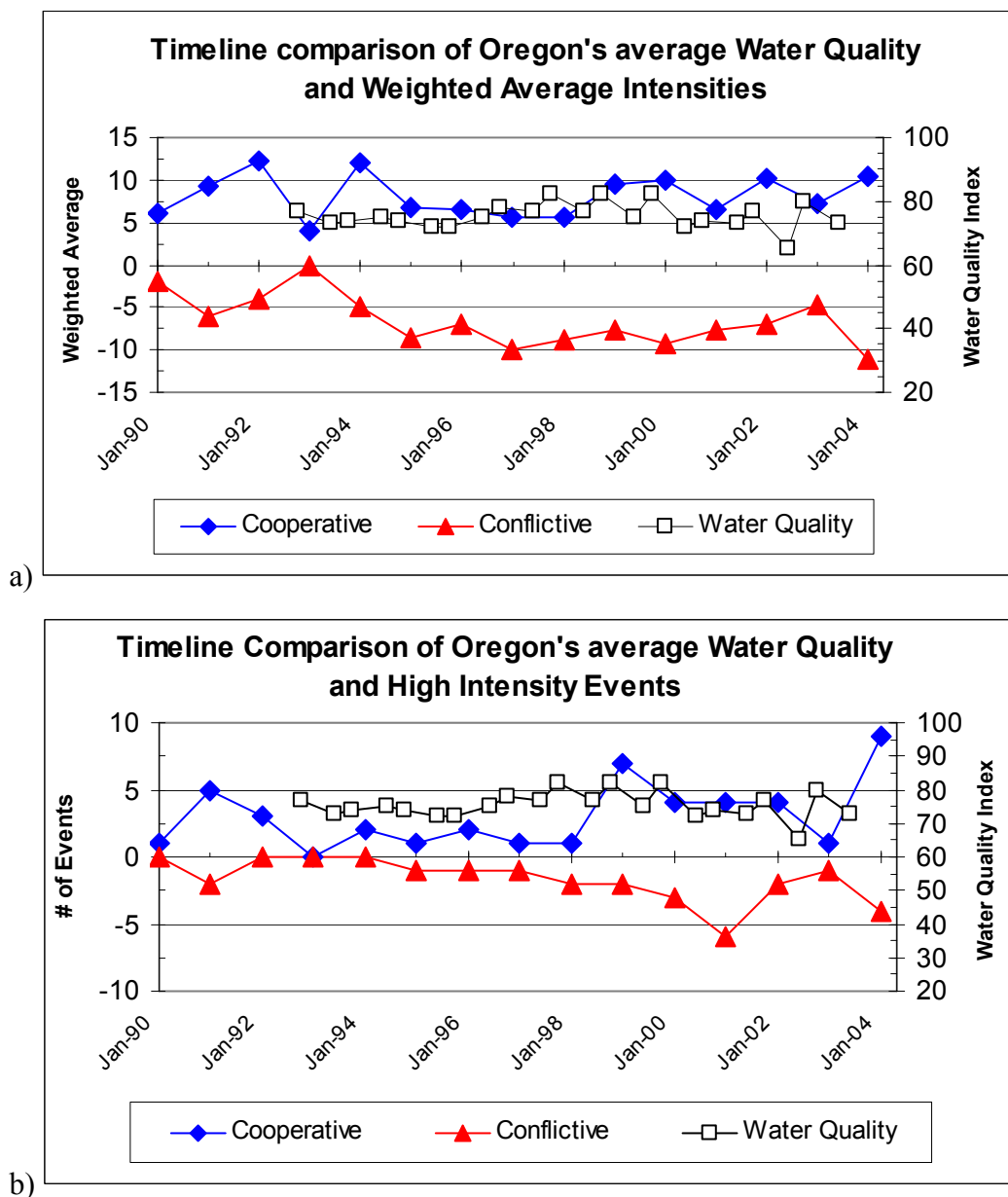
**Figure 27: Timeline comparison of ‘Fair’ basin group’s water quality to conflictive and cooperative a) weighted average intensities and b) frequency of high intensity events. Fluctuations in water quality are not temporally associated with fluctuations in conflict or cooperation. Water quality data provided by Oregon Water Resources Department and reclassified by Macomber et al. (2005). Weights were equal to the square of the event’s conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

Both cooperation and conflict weighted averages increased in association with decreased water quality scores in basin group 'very poor and poor' (Figure 28a). This trend was seen early in the time period, between 1993 and 1994, and later on, after 2000. The number of cooperative and conflictive high intensity events increased in years with decreased water quality after 2000, but the trend was not found in earlier years (Figure 28b).



**Figure 28: Timeline comparison of 'Very Poor and Poor' basin group's water quality to conflictive and cooperative a) weighted average intensities and b) frequency of high intensity events. Increases in conflict and cooperation occurred in years of decreased water quality after year 2000 for both parameter sets. The trend was also seen in years 1993 and 1994 in weighted average intensities. Water quality data provided by Oregon Water Resources Department and reclassified by Macomber et al. (2005). Weights were equal to the square of the event's conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

No association between fluctuations in water quality and conflict and cooperation at the state scale were found (Figure 29).



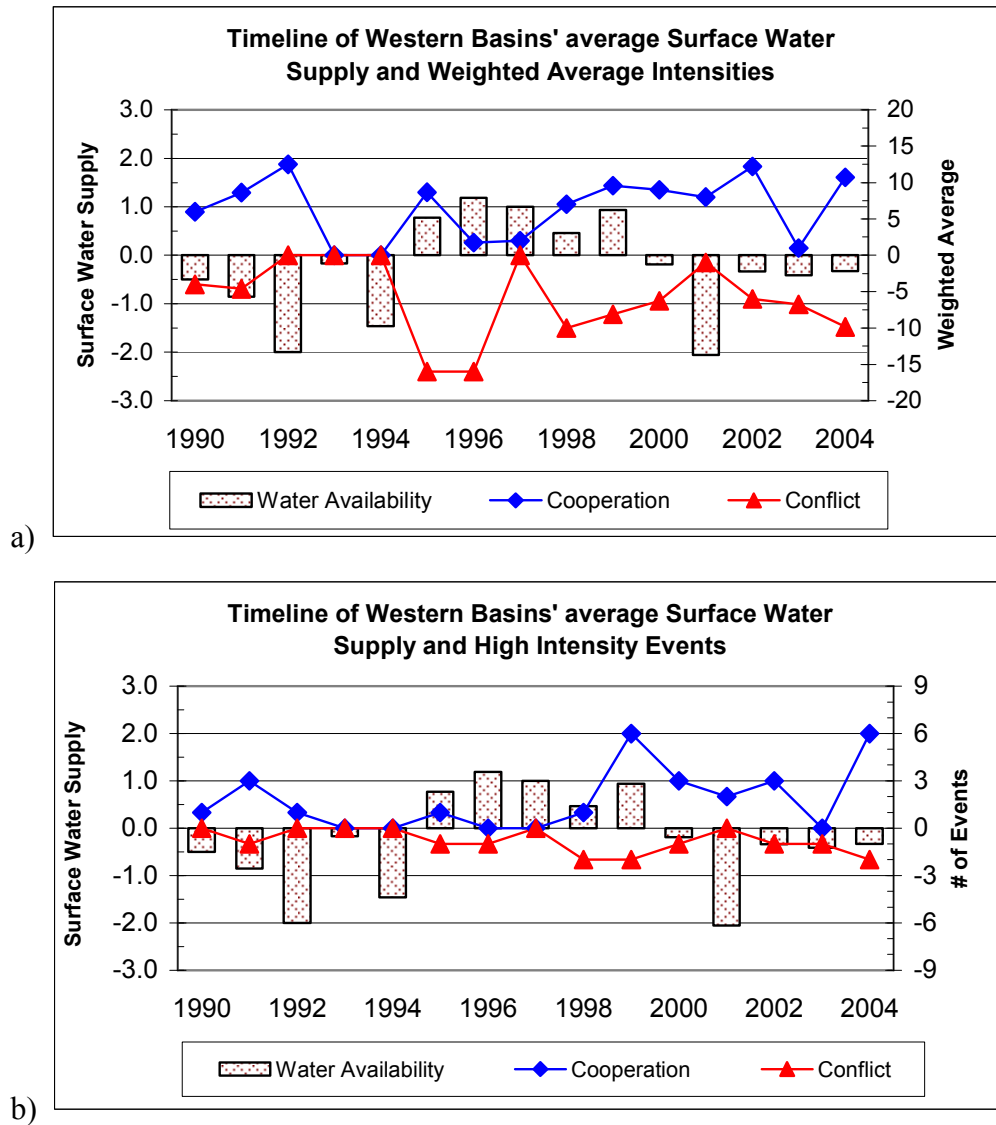
**Figure 29: Timeline comparison of state-side averages of water quality to conflictive and cooperative a) weighted average intensities and b) frequency of high intensity events. No associations between water quality and conflict and cooperation levels can be made. Water quality data provided by Oregon Water Resources Department and reclassified by Macomber et al. (2005). Weights were equal to the square of the event's conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

## **Surface Water Supply**

Water availability, as measured by the surface water supply index (SWSI) was qualitatively correlated to overall variations in conflict and cooperation in three basin groups. Higher cooperative intensity averages occurred in all basin groups in years of below average water availability. Eastern basins exhibited higher conflictive intensity averages during dry years. Western basins had higher conflict levels in years of above average water supply. Fluctuations in SWSI explained some of the variation in conflict and cooperation, but not consistently in any basin group. Explanations of surface water supply index basin groupings, Figure 10 can be found on page 31.

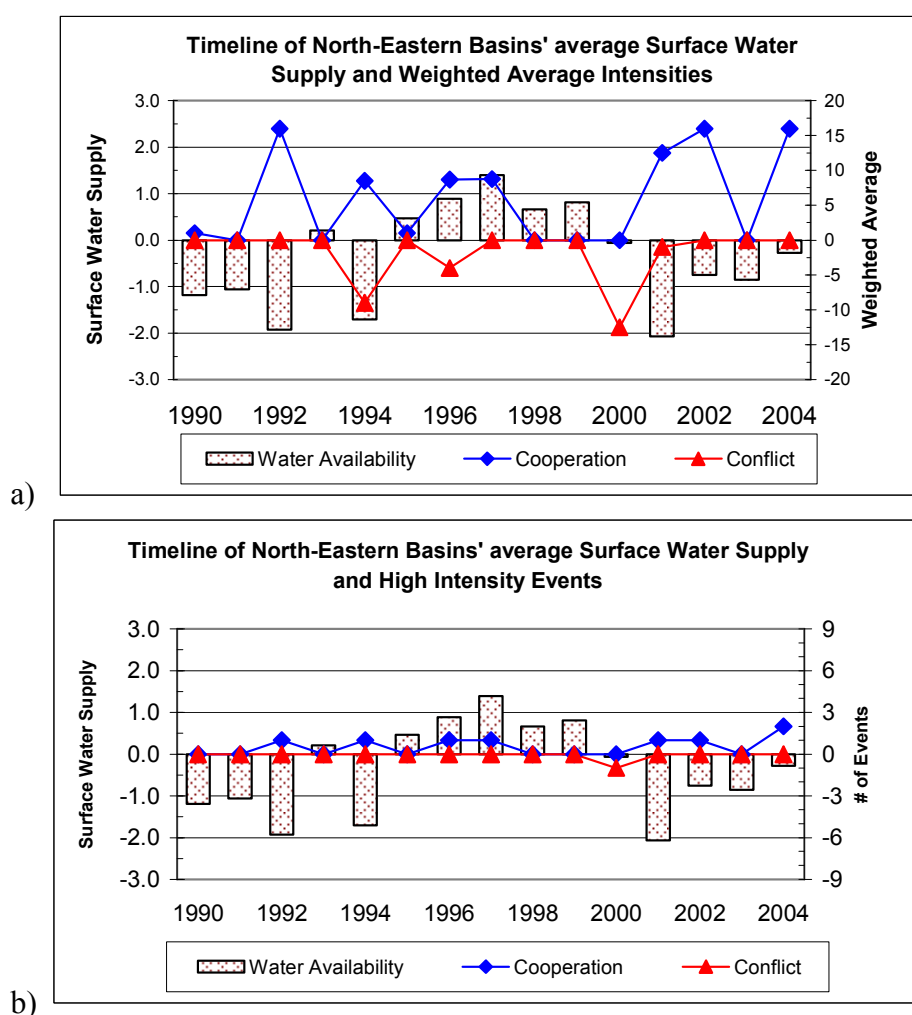
Timelines of surface water supply index (SWSI), weighted average intensities, and frequencies of high intensity events are shown for western basins (Figure 30) north-eastern basins (Figure 31) and south-eastern basins (Figure 32). Surface water supply was below average between 1990 and 1994 in the three groups, though the western basins were just above normal in 1993. All basin groups had above normal surface water supply between 1995 and 1999. Another series of dry years hit all basins between 2000 and 2004 (Figure 30, Figure 31 and Figure 32). The lowest surface water supply levels were reached in 1992, 1994 and 2001 with index values between -1.5 and -2.5 for all basin groups. The wettest years, 1996 and 1997 had SWSI scores around 1.0.

Western basins' most extreme dry years were associated with three of five (1992, 1994, and 2001) conflict intensity averages near zero (Figure 30a). This same pattern was seen with conflictive high intensity events (Figure 30b). Qualitative timeline analysis cannot explain other instances of high cooperation or any high level of conflict by variations in SWSI.



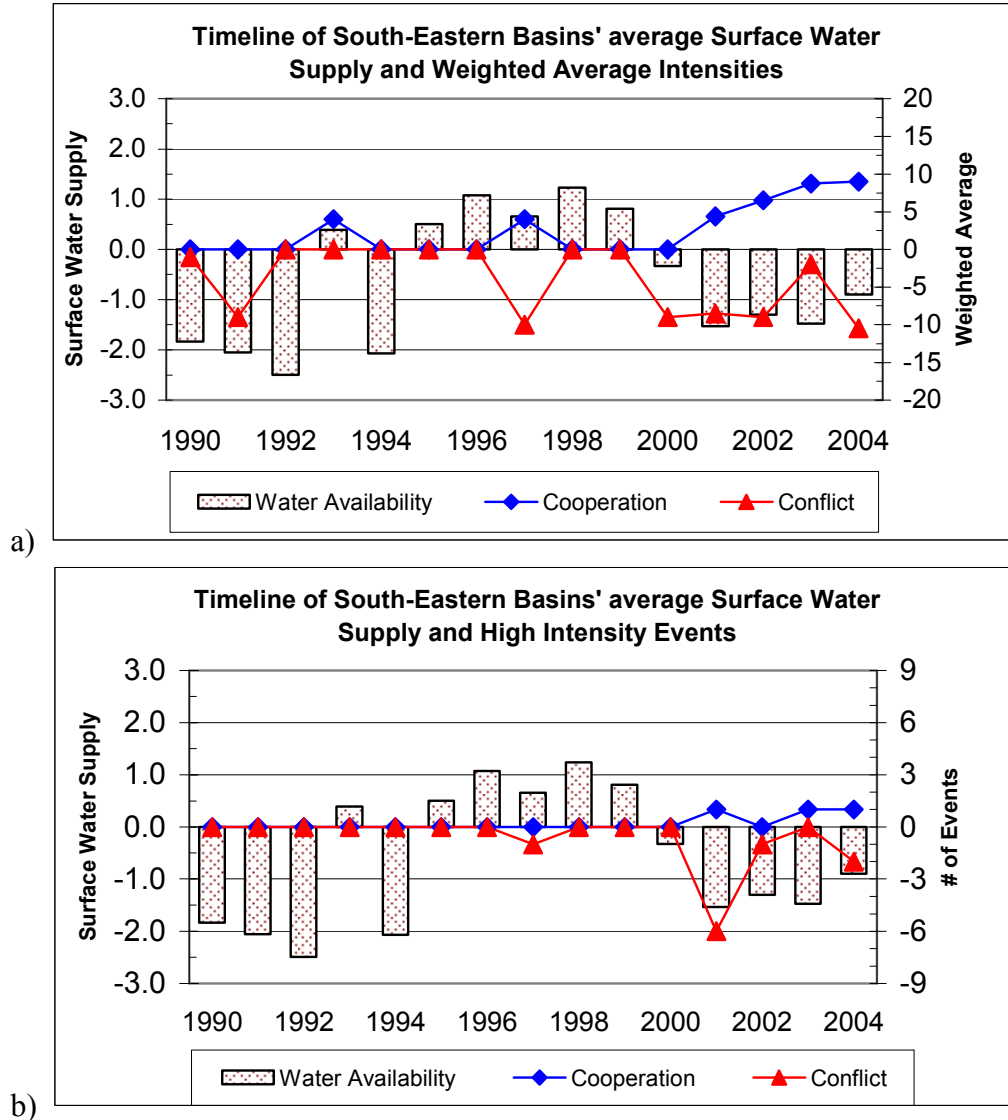
**Figure 30: Timeline comparison of western basin group's surface water supply index and cooperative and conflictive a) weighted average intensities and b) frequency of high intensity events. Years of the most intense drought tended to have near zero conflict levels and higher conflict was seen in years of above average surface water supply. Surface water supply index data provided by the Oregon Department of Environmental Quality and reclassified by Macomber et al. (2005). Weights were equal to the square of the event's conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

At most four events per year occurred in the north-eastern basin group, totaling only 24 events. The lowest surface water supply occurred in 1992, 1994, and 2001; increases in cooperative averages also occurred in 1992 and 1994 (Figure 31a). Years of increasing water supply, 1995 to 1997 also had increasing cooperation averages, but the trend did not continue for the duration of above average water supply. Levels of conflictive intensity and several years of high intensity cooperation are unexplained by fluctuations in SWSI. No relationship between water supply and frequency of high intensity events was seen in north-eastern basins (Figure 31b).



**Figure 31: Timeline comparison of north-eastern basin group's surface water supply index and cooperative and conflictive a) weighted average intensities and b) frequency of high intensity events. High cooperative weighted averages were seen in years of above and below surface water supply. Surface water supply index data provided by the Oregon Department of Environmental Quality and reclassified by Macomber et al. (2005). Weights were equal to the square of the event's conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

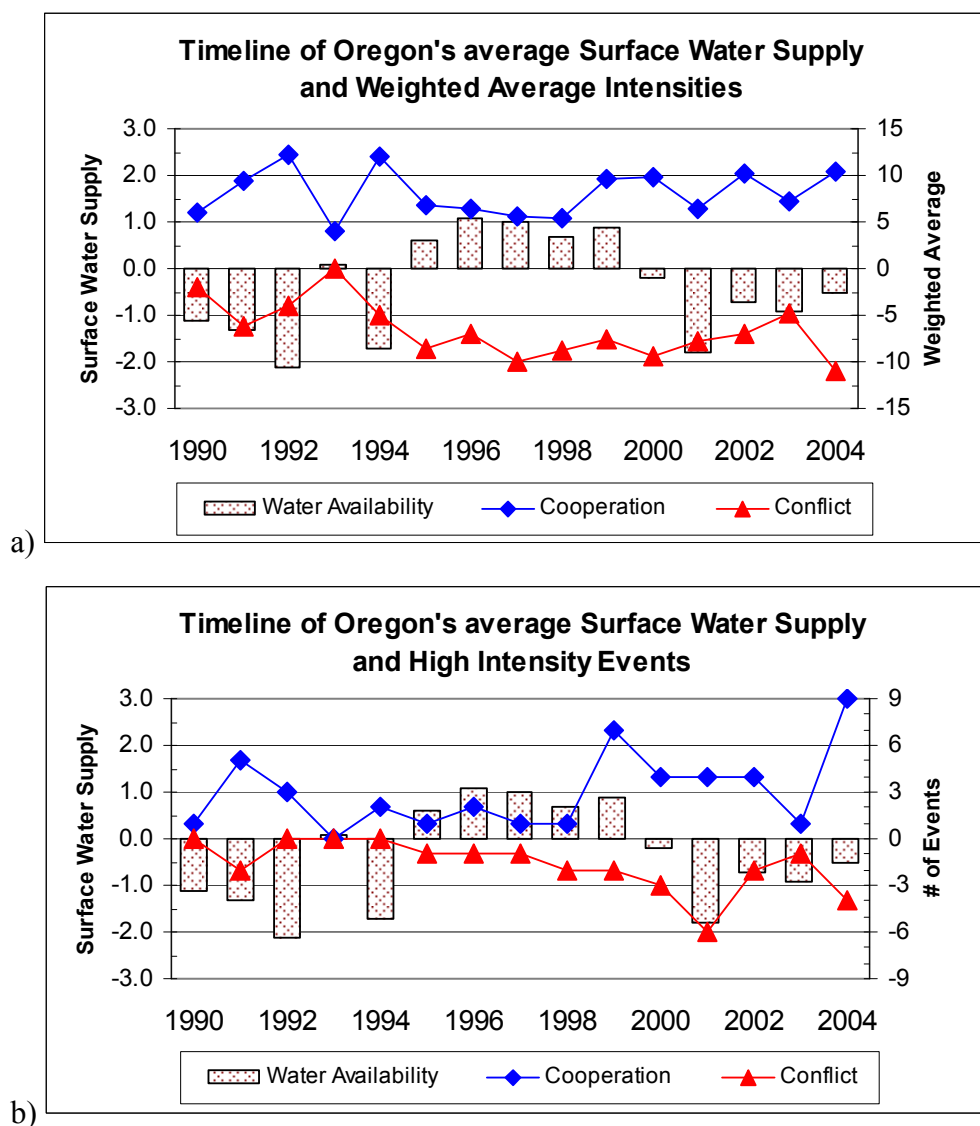
Half of the 67 events occurring in the south-eastern basin group occurred in 2001. Decreasing SWSI values between 2000 and 2004 are associated with increases in cooperative average intensity, but earlier years of below average SWSI are not (Figure 32a). Variations in the frequency of high intensity events cannot be explained by SWSI values (Figure 32b).



**Figure 32: Timeline comparison of south-eastern basin group's surface water supply index and cooperative and conflictive a) weighted average intensities and b) frequency of high intensity events. Increasing cooperation is associated with below average surface water supply between 2000 and 2004 for both metrics. Surface water supply index data provided by the Oregon Department of Environmental Quality and reclassified by Macomber et al. (2005). Weights were equal to the square of the event's conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**



At the state scale, two of three extreme drought years (1992 and 1994), were associated with the two largest peaks in cooperative weighted average (Figure 33a). One of three drought years (2001) was associated with an increase in the number of high intensity conflictive events (Figure 33b).



**Figure 33: Timeline comparison of a state-wide average surface water supply index and cooperative and conflictive a) weighted average intensities and b) frequency of high intensity events. Years of below average surface water supply may have either an increased conflict or cooperation level. Surface water supply index data provided by the Oregon Department of Environmental Quality and reclassified by Macomber et al. (2005). Weights were equal to the square of the event's conflict-cooperation intensity. High intensity events have intensities -4, -5, 4, or 5.**

Table 12 illustrates overall trends by dividing cooperative and conflictive weighted averages and frequency of high intensity events into two groups: average surface water supplies above and below the mean. Higher cooperation weighted averages were present in dry years for all groups, most predominantly north-eastern basins. Higher conflictive weighted average was apparent in western basins in wet years, and at the state scale. Both eastern basin groups had higher conflictive weighted averages in dry years. Frequency of high intensity events did not vary between basin groups in either wet or dry years.

**Table 12: Dependent variable averages for wet and dry years for each surface water supply basin group. Western basins had a higher conflict weighted average in wet years. North-eastern basins had a higher cooperative weighted average in dry years. South-eastern basins had a higher conflictive average in dry years. The state wide basin group includes all events from regional sources.**

Basin Group	# of Events	SWSI Average	Weighted Average Intensity		Frequency of High Intensity Events	
			Cooperation	Conflict	Cooperation	Conflict
Western	129	DRY	6.8	-3.8	1.9	-0.6
		WET	5.8	-10.0	1.6	-1.2
North-Eastern	24	DRY	7.8	-2.5	0.7	-0.1
		WET	3.1	-0.7	0.3	0.0
South-Eastern	67	DRY	3.2	-5.4	0.3	-1.0
		WET	1.3	-1.7	0.0	-0.2
State Wide	250	DRY	9.3	-6.3	3.7	-2.0
		WET	6.3	-7.0	2.0	-1.2

In summary, higher cooperation levels occur in years of below average water supply seen in each basin group, but the evidence is stronger for eastern basins. In years of above average water supply higher conflict was seen in western basins. Conversely, higher levels of conflict occurred in north- and south-eastern basins in years of below average surface water supply. This evidence explains variation in overall intensity levels of conflict and cooperation in dry and wet years, but cannot be used to predict the intensity in any one year.

## **Institutional Change**

Figure 34 and Figure 35 (pages 67 and 68) illustrate that the timing of institutional change explains the variation in both conflictive and cooperative high intensity events at the state scale better than the other tested independent variables between 1990 and 2004. Institutional changes were associated with an elevated number of high intensity cooperative events in 1991, 1999, and 2004 and conflictive events in 1991, 2001 and 2004. However, no association was found between weighted-average intensities and institutional changes. In each year with a relative increase in the frequency of high intensity events an institutional alteration also occurred. One institutional change was not associated with fluctuations in cooperation or conflict, 1997. However the reported events were spread between 1996 and 1997 and represent the last year of a long-lasting debate. Institutional changes were gathered from the event database, are explained in the following paragraphs and represented on the figures below with labeled vertical lines.

The Metro Council of Portland passed a resolution banning phosphorus in detergents specifically aimed at the Tualatin River in 1991 (indicated by vertical line ‘A’ in Figure 34 and Figure 35). Following this the Oregon Department of Environmental Quality issued a report on phosphorus effects on the state’s water bodies. Then the Oregon state legislature began debate on a statewide ban which did not pass. These interactions are an example of how local discussion and small-scale institutional change may influence events pushing for state-wide change.

As the state-side phosphorus ban was in debate, Clackamas County officials asked the state government to modify the Sandy River basin plan to allow increased flows for municipal use in 1991 (Figure 34 and Figure 35, institutional change ‘A’). This created an opportunity to reestablish minimum flow requirements and put forward a request for the Middle Sandy River to be designated a federal Wild and Scenic River. This led to committee formation and an ultimate settlement, that included a federal proposal to designate it Wild and Scenic. In this instance a local action lead to an institutional change and opened a door way for establishing Title Navigability on portions of the Sandy River in the future.

The tribes of Warm Springs disputed with Oregon officials regarding alterations to their treaty and water rights agreement for a decade before a final proposal was accepted in August 1996 (Figure 34 and Figure 35, institutional change ‘B’). However, before the proposal was enacted, it was used as leverage against changes to state laws regarding state/tribal interactions. This continual heated debate raged from August 1996 to November 1997. Ultimately, the agreement was enacted, establishing the Warm Springs Tribe as the oldest water rights holder in the basin and minimum flows along the Deschutes River. These events indicate how difficult major water resource agreements can be to reach and how seemingly unrelated events affect agreement progress and process.

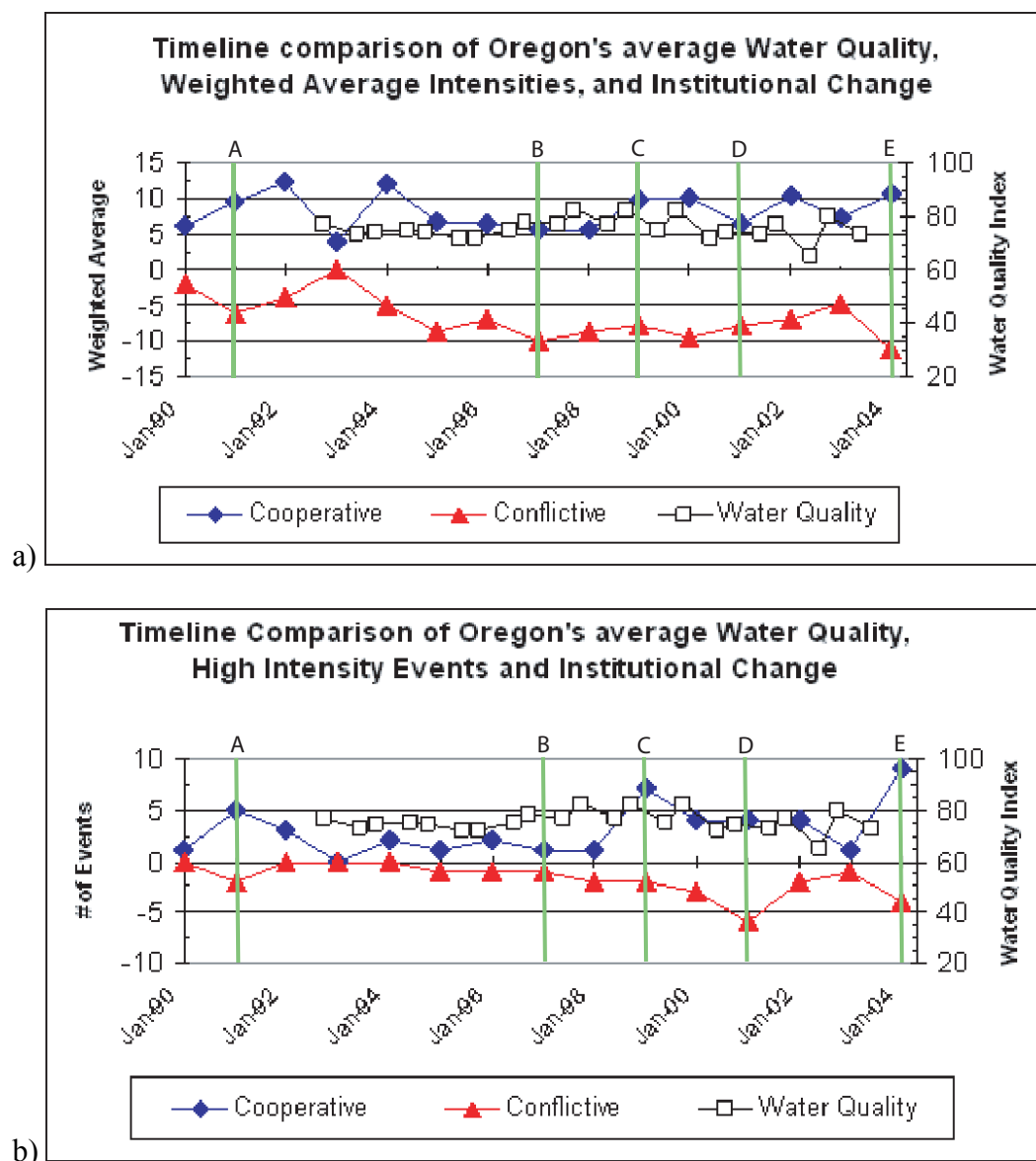
The Oregon Plan for Salmon and Watersheds was enacted in 1999, created to increase awareness of water resource concerns and enhance water resource and salmon restoration programs (Figure 34 and Figure 35, institutional change ‘C’). Additionally, the Oregon Watershed Enhancement Board (OWEB) has had a major hand in distributing grants to local entities working towards water resources improvements. This initiative was not Oregon’s alone. In 1997 representatives from Oregon, California, Washington, and Idaho met to discuss salmon problems and agreed to create and strengthen local watershed councils in all states, leading to the Oregon Plan. These interactions are a prime example of how specific events may precede a major institutional change and also create a new mechanism for future events. In this case the Oregon Plan created a mechanism for local watershed groups to be eligible for monetary grants to promote and protect local watersheds.

Also during 1999, a question of authority between the Department of Environmental Quality, a state agency, and the Environmental Protection Agency, a federal agency, occurred over a contaminated site in the Willamette River. This dispute began when the Portland Harbor was proposed to be listed as a federal superfund site. The state, resisting the designation, attempted to formulate a clean-up plan. Those efforts failed leading to sovereignty debate. Ultimately, the Portland Harbor was designated as a superfund site, with heavy state involvement in the cleanup process (Figure 34 and Figure 35, institutional change ‘C’). This series of

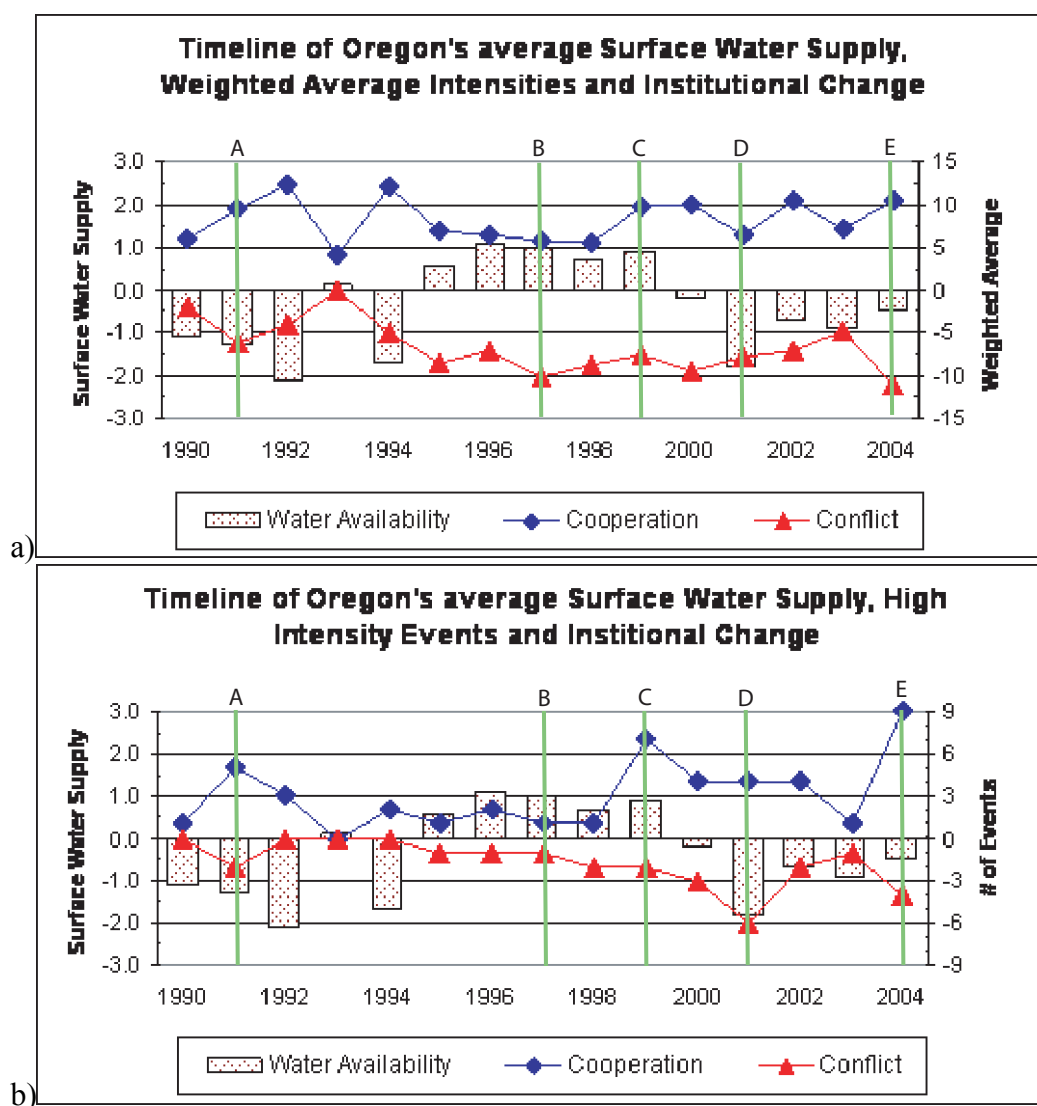
events shows how the threat of institutional change can lead to events and a series of proposals to reach a more amenable agreement.

In 2001 the water allocation needs of endangered fish and agriculture clashed in the Klamath basin (Figure 34 and Figure 35, institutional change ‘D’). The US Fish and Wildlife Service (US FWS) and National Oceanic and Atmospheric Administration (NOAA), the two agencies responsible for managing endangered fish species, released new minimum instream flows for two different fish species in early 2001. This, in combination with an intense drought, led to an irrigation shut-off by federal officials in the Klamath basin. Of the 43 events that occurred in 2001, 33 of them occurred in the Klamath or were a direct result from the release of these new minimum flow requirements. This case is an example of how serious high intensity events can be consequences of an institutional change.

The dispute in the Klamath basin came to a close in 2004 (Figure 34 and Figure 35, institutional change ‘E’). The Klamath River Watershed Coordination Agreement was signed by state and federal officials detailing water allocation procedures for the future. Other actions in 2004 were also in response to 2001 events in the Klamath basin. Local authorities focused on increasing water flows to a National Wildlife Refuge (Goose & Summer Lakes), increasing fish passages (Deschutes), and land easements to increase instream flows (Umatilla). These local institutional changes illustrate how previous local scale events may affect water management across the state.



**Figure 34: A timeline of institutional changes and water quality index with a) weighted average intensities and b) frequency of high intensity events at the state scale. Institutional changes correlated to elevated numbers of high intensity events. Water quality data provided by Oregon Water Resources Department and reclassified by Macomber et al. (2005). Weighted averages were calculated by summing the squares of the event's conflict-cooperation intensity. High intensity events are events conflict-cooperation intensity equal to -4, -5, 4, or 5.**



**Figure 35: A timeline of institutional changes and surface water supply index with a) weighted average intensities and b) frequency of high intensity events at the state scale. Institutional changes correlated to elevated numbers of high intensity events. Surface water supply index data provided by the Oregon Department of Environmental Quality and reclassified by Macomber et al. (2005). Weighted averages were calculated by summing the squares of the event's conflict-cooperation intensity. High intensity events are events conflict-cooperation intensity equal to -4, -5, 4, or 5.**

### **Time-lagged Relationships of Conflict and Cooperation**

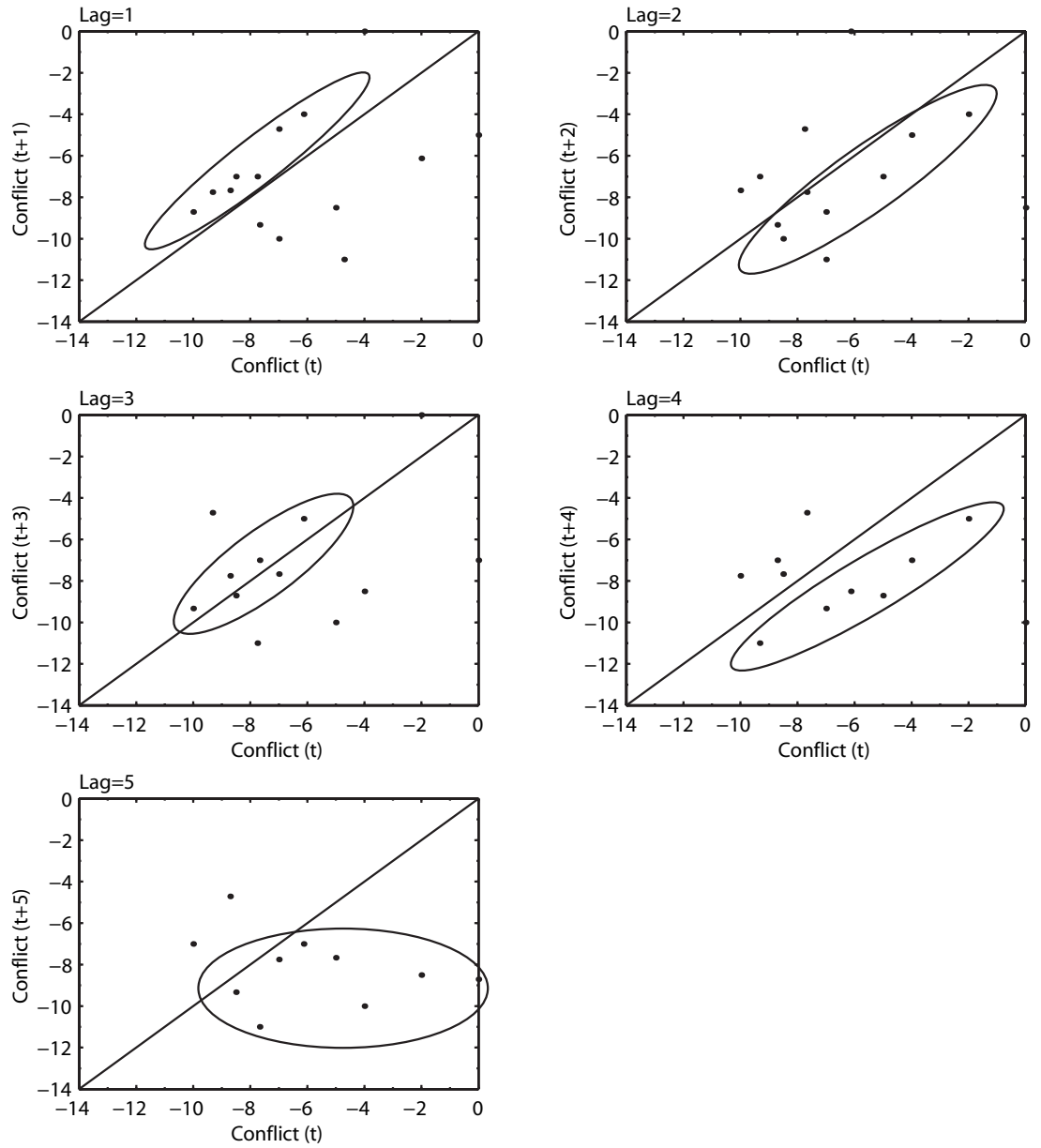
Results of time-lagged analysis of weighted average intensities indicate an auto-correlation in conflict, but not in cooperation. Evidence for note-worthy relationships between conflict and subsequent cooperation are also present. The most prevalent is that instances of major conflict leading to major cooperation are present in each time lag.

Generally, particular levels of conflict lead to years with the same or an increased conflict intensity in all time lags. In smaller time lags (one to three years) an auto-correlated relationship of conflict is seen, indicated by the close approximation of the point cluster to the one-to-one line shown in Figure 36. In other words, subsequent years have approximately the same level of conflict as earlier years. As the time lags increase from three to five years the point cluster travels farther right and downward of the one-to-one line indicating increasing conflict levels. This analysis shows indicates that the duration of deteriorating water resource conflict is between three and five years and as time passes the likely hood that conflict worsens increases.

Conversely, these relationships were not found in time-lagged analysis of cooperation. Cooperation intensity levels were independent of time in all time lags (Figure 37). A certain level of cooperation in any one year does not correlate to successive cooperation levels.

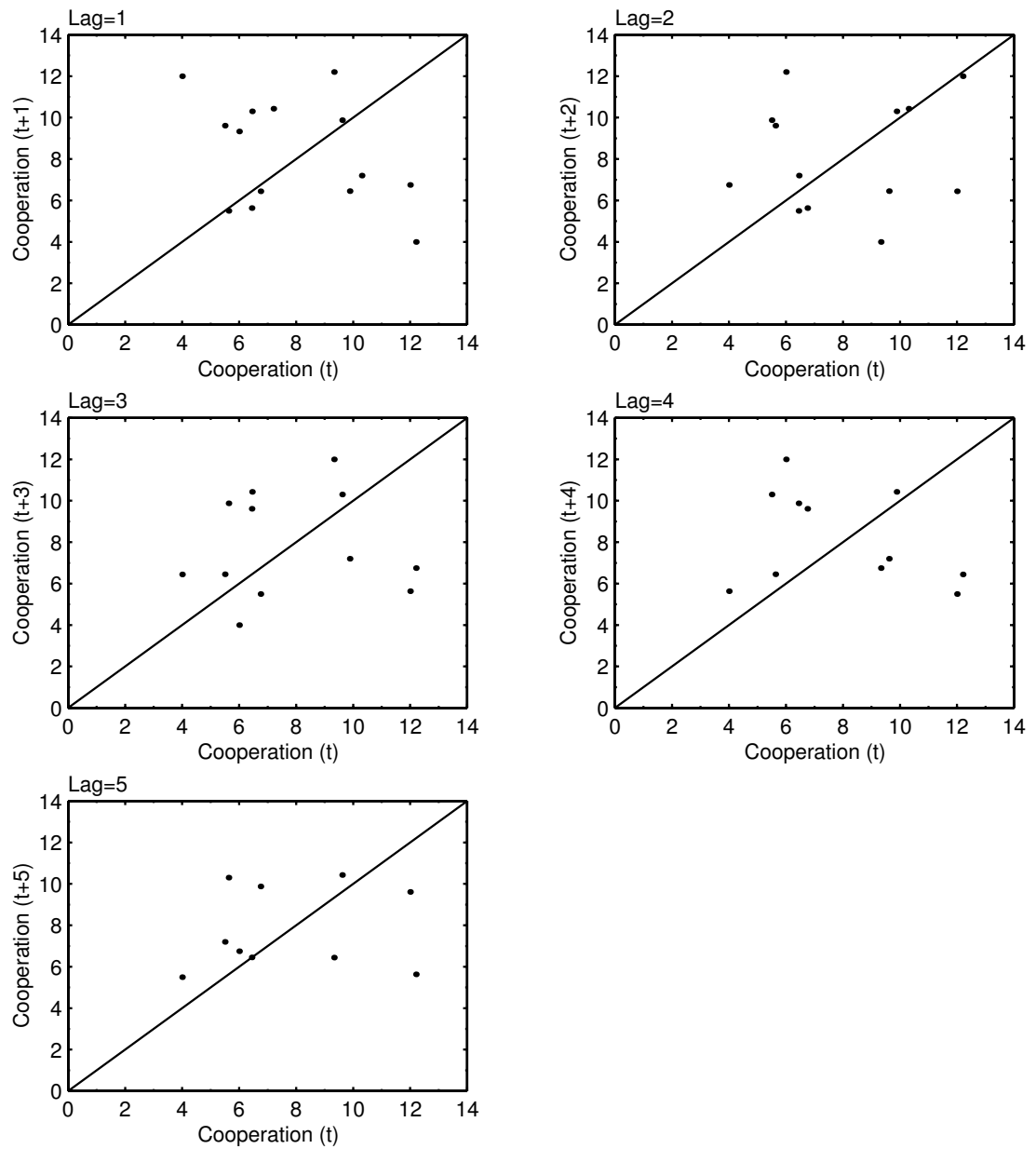


Time-lagged analysis of weighted-average intensities:  
conflict to conflict



**Figure 36: Analysis of weighted average intensities of temporal auto-correlation of conflict. Results indicate that conflict levels are maintained between one and three years and worsen four to five years later.**

Time-lagged analysis of weighted-average intensities:  
cooperation to cooperation



**Figure 37: Analysis of weighted average intensities of temporal auto-correlation of cooperation. Results indicate that cooperation levels in one year do not precede any particular cooperation level in later years.**

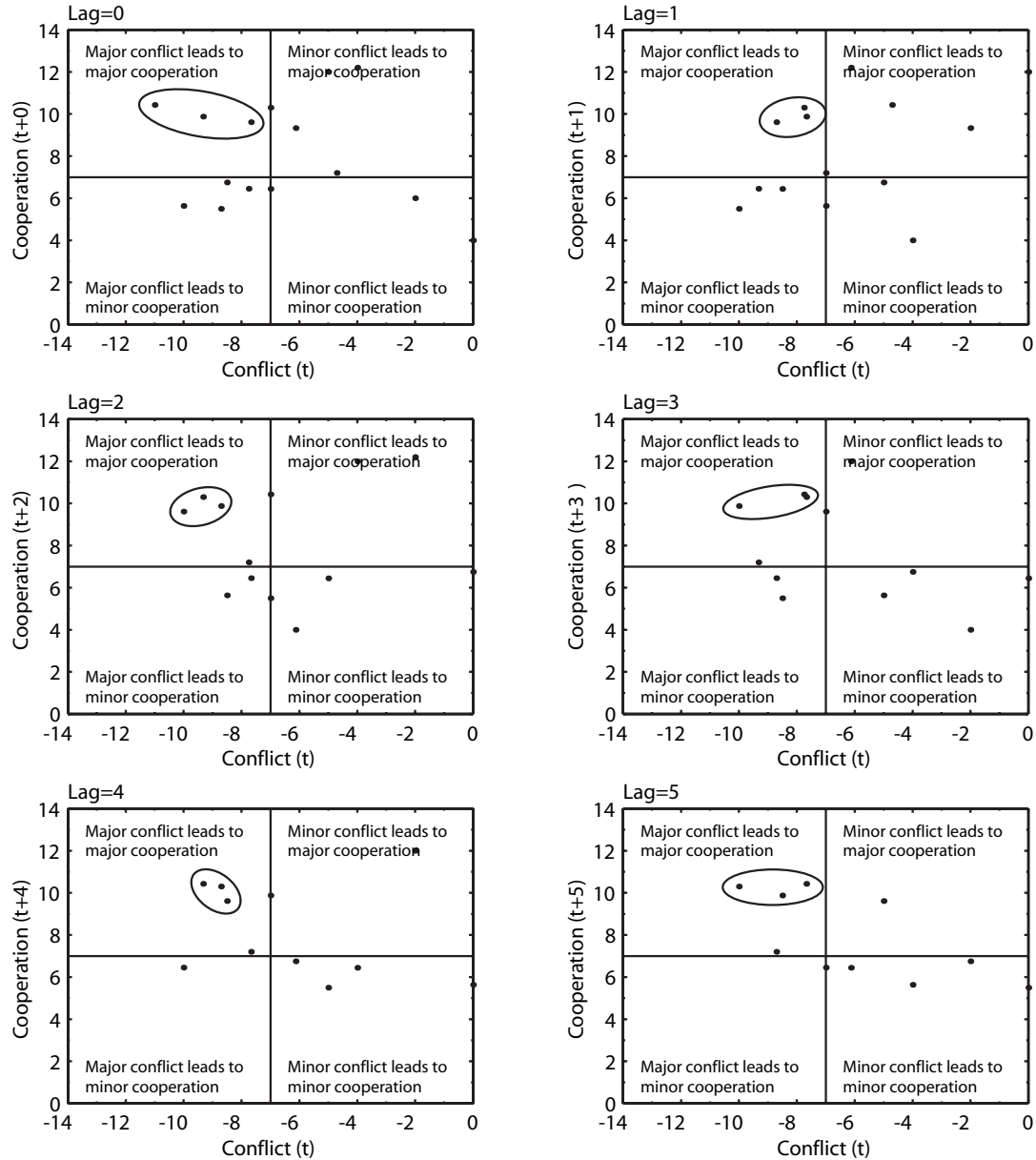
Although no preferential pattern was established between conflict and ensuing cooperation, there are pairs of years which indicate that major conflicts lead to major cooperation (Figure 38, Table 13). There are four possible combinations of conflict and cooperation; major or minor conflict leading to major or minor cooperation. First, major conflict leads to major cooperation occurs with the most regularity in all time lags and the results are highlighted on Figure 38. Years with a relatively high conflictive weighted average intensity at some point lead to a year with a high cooperative intensity supporting evidence. Second, minor conflict followed by major cooperation is seen more frequently in time lags of zero to two years. As the time lags increase the frequency of this behavioral pattern decreases. Following the same pattern, as time lags increase major conflict is less likely to be followed by minor cooperation and did not occur in the five-year time lag. The conflict and cooperation values in this pattern have lower weighted average intensities of the four groups. Finally, as the time lags increase the frequency of minor conflict leading to minor cooperation increases.

Overall there was no preferential pattern in behaviors. However, since each year with a high conflictive intensity lead to a high cooperative intensity, this behavior has the best supporting evidence. In contrast, lower intensity conflict is followed by either low or high intensity cooperation. However, as time lags increase low intensity conflict is more likely to be followed by low intensity cooperation.

**Table 13: Pairs of years illustrating that major conflict can lead to major cooperation, circled on Figure 38 (page 73).**

<b>Lag time (years)</b>	<b>Pairs of years</b>
0	(1999, 1999); (2000, 2000); (2004, 2004)
1	(1998, 1999); (1999, 2000); (2001, 2002)
2	(1997, 1999); (1998, 2000); (2000, 2002)
3	(1997, 2000); (1999, 2002); (2001, 2004)
4	(1995, 1999); (1998, 2002); (2000, 2004)
5	(1995, 2000); (1997, 2002); (1999, 2004)

Time-lagged analysis of weighted average intensities:  
conflict to cooperation



**Figure 38: Temporal analysis of weighted average intensities of conflict preceding cooperation. An average behavior is not seen, but in every time lag three points indicate that high conflict precedes high cooperation. Minor conflict is more likely to be followed by major cooperation in small time lags and more likely to be followed by minor cooperation in large time lags.**

## Discussion

### *Errors resulting from Research Methods*

#### **Statistical Assumptions**

The statistical analysis of event data is controversial and not well researched. It is best put by Schrodtt (1994 pg. 2):

“Despite their prevalence in contemporary quantitative studies, event data are odd statistical objects: they are nominal random variables occurring at irregular intervals over time subject to non-random selection bias. The conventional statistical repertoire has almost no techniques explicitly designed for such data and, [...] virtually no original statistical work has been undertaken to fill these gaps. As a consequence, event data are commonly aggregated and then analyzed using interval level statistical techniques.”

This is quite a disadvantage for event data and sets it apart from other arenas of social science, especially economics and survey data, where the statistical characteristics of data have been exhaustively specified and researched (Schrodtt 1994). The best method of understanding the error involved in event data use is to theoretically clarify all sources of error in data collection and classification, which is done in the following sections (Shellman 2004b).

Due to these shortcomings in the statistical methods, ordinary least squares regression and vector auto-regression are commonly utilized methods to analyze interval type event data. [See Goldstien (1992), Schrodtt (1993), Yoffe (2001), Shellman (2004) and Shellman (2004b) for examples.] Ordinary least square regression techniques requires independence and random sampling (Abdi 2003). Event data do not meet these requirements.

**Event data are not completely independent.** If events are independent, then occurrence of one event does not make the occurrence of another event any more or less likely. The most obvious violation of this rule in event data is the relationship between lawsuits and settlements. The filing of a lawsuit makes the occurrence of a settlement more likely, making them interdependent events. The most prominent example in this research is the 50 interdependent events as reactions to release of a

biological opinion on endangered fish species in the Klamath basin in 2001.

Unfortunately, no literature has been written on the affects of the interdependence of event data and the consequential affects on data analysis.

Event data are **not randomly sampled** from the entirety of occurring events (Shellman 2004b). The chance of selecting a certain event is not based on random chance placing interpretative limitations on the data. Generalizations cannot be made with any known degree of accuracy, thus the analysis performed and patterns found only represent the basins in Oregon and cannot be inferred to other areas. This research is not based on a random sample because not every event has an equal chance of being collected, due to reporting bias and source choice, explained below.

### **Reporting Bias**

There are two main types of bias in newspapers: description and selection bias. **Description bias**, or “spin”, affects how actual events are recounted and interpreted in the media and is dependent upon the reporter’s desire for events to appeal to a mass audience (Smith et al. 2001). It affects the way in which a reporter discusses an event, often making a social or political judgment, but it does not affect recounting of the actual actions that have taken place. Event databases only recount actual events and do not include interpretations; making no judgment as to if the action was a ‘good’ or ‘bad’ one. Thus, description bias does not affect the coding of event data.

The major downfall of event data is that not all events are public and not all public events are reported. Maney and Oliver state “it has long been recognized that newspapers neither cover all events nor sample randomly from the universe of events (2001, pg. 3).” This **selection bias**, the decision to report an event, is ultimately affected by the type of event, the issue, and the news agency (Snyder and Kelly 1977; Smith et al. 2001; Earl et al. 2004). For example, one study found that 83% of protest events were covered in a newspaper article, leaving 17% of protests unreported, victims of selection bias (Maney and Oliver 2001). Media fatigue, a specific form of selection bias, refers to when journalists and newsreaders become uninterested in an ongoing controversy. A greater number of news reports are published when actors reach several small agreements over a long time period due to sustained interest in the

topic (Schrodt 2000). Thus, selection bias affects the number and type of events contained in an event database, but is not controlled by event data researchers (Maney Oliver 2001).

### **Source Choice**

The effects of selection bias can be decreased by obtaining events from a high diversity of sources, since news outlets will have different criteria for publishing events (Oliver and Myers 1999; Maney and Oliver 2001). For example, the New York Times covered only 18% of protests covered in local media sources over a five month period across 43 cities (Snyder and Kelly 1977).

The inclusion of local, regional and national sources in this research illustrates the effects of selection bias on an event database. Utilizing local news sources for one year in the Malheur and Mid Coast basins substantially increased the number of events reported in those basins, by 45 and 74 events respectively. In total, local sources added 143 events, and 25% were mildly conflict (intensity -1). Comparatively, only 13% of events reported from regional newspapers were mildly conflict (intensity -1). The analysis of local source events provides evidence that large scale newspapers underreport mildly conflictive actions (intensity -1) in smaller cities. Additionally, events gathered from local sources were predominantly of two issue types: infrastructure (56, 39%) and water quality (57, 40%). Water quality events occurred in approximately the same percentages for both local and regional source types, but infrastructure events occurred at a much higher frequency in the local sources.

### **Search Method**

Selection bias determines if an event is available for collection, but the way in which the available events are collected also has an effect on the quality of the event database, since a single search never gathers every available event (Maney and Oliver 2001). A comparison of three different search methodologies: a full-text reading of newspapers on microfilm, a generic keyword search, and an event-based keyword search, demonstrated that each method found articles missed by the other two (Maney and Oliver 2001). Generic keyword searches retrieved the highest percentage of events, but missed articles that avoided conventional terminology; manually scanning

microfilm misses relevant events buried inside larger, non-relevant articles that a keyword search would find (Maney and Oliver 2001). Event-based keyword searches are recommended, but since that method requires prior information on events to aid in keyword selection, it could not be applied widely in this study. Since the generic keyword search methodology utilized included a wide variety of terms, it is assumed a high percentage of available events were collected.

### **Temporal Distribution**

The number of events collected over time is also influenced by the search method. An artificially low number of events were collected in years prior to the advent of the internet, due to using sources with free online archives. Thus, the actual number of events did not increase over time, but the number of available events did. A full listing of news sources' availability by year is presented in the appendix.

### **Classification Method**

The reliability of sorting events into an event database, or coding, consists of three components: accuracy, stability, and reproducibility (Gerner et al. 1994; Schrodtt 2001). Stability, the ability of a coder to consistently assign the same classification to a given text; accuracy, the ability of a coder to conform to a standard; and reproducibility, the ability for multiple people to classify events identically, have been under scrutiny for some time.

Well-trained coders can classify events identically 85% to 90% of the time (Schrodtt 1993) although experts classify events much more consistently than the trained lay person (Goldstein 1992; Davis et al. 1998). A 91% agreement between coders was found for the World Event Interaction Survey (WEIS) classification scheme (Gerner et al. 1994). Goldstein (1992) found all but one of 61 actions were consistently classified as either conflictive or cooperative and placed within 2 points of each other on a 20 point scale. Additionally, extreme and neutral rank events have a higher coding consistency than mid-intensity events (Goldstein 1992). When classifying mid-ranking events, conflictive events had a higher reproducibility than cooperative ones (Goldstein 1992). Inter-coder reproducibility exceeding 80% was found in the original Conflict and Peace Databank (COPDAB) conflict-cooperation



intensity coding, the system on which this research was based (Burgess and Lawton 1972). Assuming COPDAB's reproducibility statistic, 314 of Oregon's 393 events' conflict-cooperation intensity would be coded identically by other coders.

When coding procedures are complex the accuracy can be reduced to between 55% and 80% (Davis et al. 1998). Stability decreases when coders are bored or inattentive which is not uncommon since most coders are poorly paid and poorly motivated, and do not review their work (Gerner et al. 1994). To account for these, the classification scheme and methods for this study was simplified to increase accuracy, and reviews of data classification were performed to ensure a high stability.

### **Summary of Errors in Research Methods**

The discussion above illustrates that several inherent limitations in the utilized research methods affect the created event database in different ways. First, a low inclusion of local source data decreases the total number of events reported, most likely in more rural areas of Oregon and related to infrastructure and water quality. Additionally, the dataset probably under reports very mild conflictive ones (-1 intensity), because of small inclusion of local sources. A low number of events near the beginning of the time period is most likely due to a low availability of information via online search engines, rather than fewer events. Coding reproducibility can be assumed to be relatively high, around 80% with assurances that events were correctly classified within one or two intensities.

### ***Revealed Trends and Patterns in Oregon Water Resource Conflict***

#### **Issue Type Comparison: Spatial Scale and Time Frame**

Water resource issues that dominate Oregon events differ from issues at the international scale presented in Yoffe (2001) (Table 14). In Oregon, most events revolved around water quality issues (158, 40%) but water quality accounted for only 6% of the international events. Conversely, fewer events involved water quantity in Oregon (78, 20%) than at the international scale (824, 45%). Infrastructure, intergovernmental and flood related events all occurred at nearly the same proportion at the international and state scale.

**Table 14: Issue type aggregations of International and Oregon water conflict research. International issue type breakdowns originally presented in Yoffe (2001). The category ‘Other’ is so designated because exact international percentages could not be determined from literature.**

<b>International Issue Types</b>	<b>#</b>	<b>%</b>	<b>Oregon Issue Types</b>	<b>#</b>	<b>%</b>
Water Quality	110	6	Water Quality, Invasive Species	158	40
Water Quantity	824	45	Water Rights, Conservation, Instream, Groundwater	78	20
Flood Control/ Relief	37	2	Flood	5	1
Infrastructure, Hydro-power/ Hydro-electricity	531	29	Infrastructure, Fish Passage	97	25
Joint Management, Technical Cooperation/ Assistance	256	14	Intergovernmental, Recreation	50	13
<b>Other (includes the following)</b>	73	4	<b>Other (includes the following)</b>	5	1
Navigation			Navigation		
Border Issues					
Irrigation					
Economic Development					
<b>Total</b>	<b>1831</b>	<b>100</b>		<b>393</b>	<b>100</b>

Water quality events are much more frequent at the intra-state scale than the international scale. This trend was also seen in a comparison of local to regional sources used in this study; local sources reported a higher frequency of water quality events than regional sources. This trend can be attributed to the localized effects water quality problems. Often these events concern small-scale polluters affecting local water bodies, such as waste water treatment plant overflows and leaking underground storage tanks. Water quality issues severe enough to concern international parties are much fewer and farther between than these localized water quality concerns, leading to a higher frequency of water quality events as the spatial scale decreases.

Major differences in issue type between the international and Oregon studies can also be explained by the time frame. The international study covers fifty years (1950 to 2000) while the Oregon research only covers fifteen years (1990 to 2004). Thus, the Oregon study does not capture the full range of historical changes in social awareness of water resource related issues. Some differences in issue type proportion between the international and Oregon study can be explained by this temporal difference.

The future of water resource management in Oregon may involve a sharp increase in the number of infrastructure related events. Many dams and hydropower facilities around Oregon will begin the relicensing process in the next 25 years. The frequency of infrastructure issues increases when dams are being proposed, built, and relicensed. The majority of dam building in Oregon ended long before 1990 and the majority of dams have not been up for relicensing. A series of these events occurred in the Klamath basin surrounding the Salt Caves project, illustrating how contentious the issue can be. When several dams begin the relicensing process, infrastructure may become the over-riding issue in water resource management in Oregon and possibly the western United States.

### **Conflict-Cooperation Intensity**

Generally, several aspects of event distribution along the conflict-cooperation spectrum mirror results previously found at the international scale in Yoffe (2001). At both the state and international scale, cooperative events outnumber conflictive events and a low proportion of events are of extreme intensities. Additionally, at both scales of analysis a large proportion of events are verbal interactions (intensities 1, 0, and -1). However, a higher proportion of verbal actions are conflictive in Oregon and cooperative at the international scale (Yoffe et al. 2003).

These results illustrate the commonplace for stakeholders to speak out against initiatives in Oregon- especially in the form of opinion and editorial columns. However, the low frequency of conflictive events illustrates that this verbal expression does not often progress into conflictive action. This research shows that in Oregon, conflict over water resources is more likely to be mild and verbal, than extreme and cooperation composes a significant portion of water resource actions, countering common ideas that water resource conflict is prevalent in Oregon.

This research also shows that case studies alone do provide a whole picture, because they are not set in the broader spatial and temporal setting. For example, the conflictive outbreak in Klamath basin in 2001 may be the most prominent water resources event in Oregon, but it certainly is not representative of the range in intensities and issues of water resource management.

### **Institutional Influence on Conflict and Cooperation**

Institutional change was the only variable that appeared to be related to temporal changes in the frequency of high intensity cooperative and conflict events across the state of Oregon. This supports analysis by Yoffe (2001) that institutional mechanisms have a prominent impact on water resource conflict and cooperation. The institutional change enacted in 1997 did not aide in explaining variation in conflict or cooperation. However, events surrounding this institutional change were divided between 1996 and 1997, thus the temporal aggregation of calendar years may have decreased the appearance of any affects (Shellman 2004).

Time-lagged analysis results give evidence that major conflicts lead to major cooperation. This is an indication that government and institutions are responding to stakeholder concerns and dealing with high levels of conflict. However, this also indicates that mare can be done to resolve these disputes before conflict reaches a high level

### ***Research Implications and Policy Recommendations***

Given that conflict is linked to below average water supply and institutional change, how do policy makers adapt to improve dispute resolution and foster cooperation in Oregon. Federal water resource managers are currently spending at least 50% of their time managing conflict (USBOR 2006). Given this large devotion to conflict management, new effective methods are needed and desired by these managers since they have not been exposed or trained in conflict resolution techniques (Lan 1997). Below are recommendations to increase government's ability to manage conflict focused on the core of conflict management: the engagement of key stakeholders (Tyler 1999). They are meant to inform policy directions and highlight programs that foster full stakeholder engagement, and encourage government use of institutions to foster cooperation. The overall goal is to provide water resource managers with the tools to manage conflict, not make it disappear entirely.

### **General Considerations for Conflict Management**

The discussion and implementation of conflict mitigation policies should include some general considerations. Conflict management is a process; no static set

of policies will work in all areas through time. Adaptable management structures must allow for changing needs of society and new information (Giordano and Wolf 2002). Also, these conflict and resource management strategies cannot be created at the national or state level and be expected to work the same way in every area (Tyler 1999). Thus, systematic dispute resolution strategies must not be too rigid when implemented.

Managing conflict and managing a natural resource in a way that conflict never occurs are two very different goals and the distinction between the two must be made. No single policy or project will prevent conflict from occurring; conflict is inevitable (Tyler 1999). Resource management schemes without conflict resolution tools are not going to prevent conflict and will most likely result in disappointment, wasted funds, and ultimately, conflict (Tyler 1999). This ideology also neglects to acknowledge the benefits of conflict and the dispute resolution process including; establishing group identity, cohesiveness and loyalty; stimulating interest; promoting innovation and providing opportunities for better natural resource management (Lan 1997).

Two examples of mistaking resource management for conflict management, increasing water supplies and implementing technical solutions, have been prevalent in the American west (Lan 1997; Tyler 1999; Conca 2006). Water resource disputes have continued and even increased during times of increasing water supplies (Conca 2006). It is more appropriate to attribute this conflict to the changing needs and desires of society. Secondly, data collection and analysis to produce technical solutions has extensively been used to mitigate conflict, especially to establish allocation rules between resource uses (Lan 1997; Tyler 1999). These tasks provide comprehensive understanding of water systems and may be used as benefits or compensation in negotiations, but used alone are often unsuccessful at conflict reduction. Neither water projects nor allocation rules provide resource managers with conflict mitigation tools; they are both resource management techniques that were faulty believed to end conflict (Tyler 1999).

## **Integrating Conflict Management and Natural Resource Management**

The increase public administrators devotion to conflict management indicates that a dual focus on water resource management and conflict management is needed (Wolf et al. 2006). Combining aspects of water resource management and water resource conflict management is possible with the examination of current policies, connection with key stakeholders, coordination increases, information sharing, and political will to modify a few traditional roles of government. Additional concerns must be addressed for alternative dispute resolution techniques to succeed including: the use of neutral mediators, external support, clear definitions of stakeholder issues and goals, and time.

Recognizing that current policies may be drivers of conflict and altering them is a first step to mitigating conflict. Of specific concern are government actions that are directly at odds with the needs or values of local citizens or the marginalized poor (Tyler 1999). In Oregon, this indicates relationships between national or urban goals and rural agricultural or tribal needs. This government-citizen collision caused large conflict in the Klamath basin in 2001. The national interest of protecting salmon at the outright expense of local farmers spurred an extremely intense conflict affecting national discourse on water resource and endangered species management.

Prejudiced distribution of resource use may also be a driver of conflict, especially when these policies reflect historical inequities in wealth or political power (Tyler 1999). The water rights structure under the prior appropriation doctrine holds historic water use firmly in place without consideration of Native American and environmental needs. Current basin adjudication efforts ease this problem when the concerns of Native American tribes are equitably institutionalized, alleviating historical inequities. Recognizing and altering these specific policies that contribute directly to stakeholder dissatisfaction with government is a first step in reducing future conflicts, and increasing trust between stakeholders (Tyler 1999).

Water resource conflicts are often perceived as what Lan (1997) refers to as pure conflict, in which one party's resource use diminishes other party's resource use. When conflicts are portrayed in this win-lose scenario alternative dispute resolution techniques, such as negotiations often fail to mitigate conflict (Lan 1997).

Replacement of the resource use with compensation or other benefits and the alternative dispute resolution process is much more likely to succeed (Lan 1997). This equitable distribution of benefits, as opposed to the distribution of the resource itself, is an institutional framework available to create allocation rules while at the same time, mitigating conflict (Giordano and Wolf 2002).

Public administrators are already skilled at resource management, now they need conflict management skills. Training courses in dispute resolution, negotiations and equitable distribution of benefits are in short supply even though Bureau of Reclamation surveys indicate there is a great need for them (Lan 1997; USBOR 2006). Enhancing these skills is especially important because these officials are constantly involved in contentious resource disputes with a variety of stakeholders.

Currently water resource management is highly fractured and uncoordinated between several governmental agencies (Gerlak 2006). This fragmented resource management scheme increases tensions between the agencies, and leads to uncoordinated planning, investment, reform and consultation, each with potential to stir-up intense conflict (Tyler 1999; Gerlak 2006). Thus, government coordination is needed to mitigate resource conflict. Networking programs aid governments, especially local agencies, identify best management practices and needed resource materials (Tyler 1999). Discussion of successful management practices in one local area and their possible implementation in similar or different circumstances allows for agencies to learn from each other (Tyler 1999). The state water agency is the best institution to bring local groups from across the state to facilitate discussion of local program successes, failures and possible implementation in other areas (Michaels 2001). An information-sharing and communication program can increase transparency, build trust, resolve issues of fact, and distinguish these from issues of interest (Tyler 1999; Kameri-Mbote 2007). Oregon is a prime candidate for a strategic networking system since common trends in conflict levels and surface water supplies were found across and within basin groups and due to the strength of local agencies. Oregon could benefit from this type of coordination since local areas have responded

to the Klamath crises with increased local management. The desire for a networking component exists, needed is a framework and a facilitator.

### **Alternative Dispute Resolution: Stakeholder Involvement**

The core of natural resource conflict management is the ability to actively engage key stakeholders (Tyler 1999). The use of formalized stakeholder interactions to manage conflict and resources, generally referred to as alternative dispute resolution, is a process. These interactions can come in a variety of forms including multi-stakeholder consultations, roundtables, formal negotiations, mediation or collaborative working groups (Tyler 1999). The choice of which to use depends on the circumstances and actors involved. Additionally, these stakeholder dialogues must recognize and work through difficult disagreements rather than just agreeing upon general principles (Conca 2006).

Traditionally, public administrators serve as both a resolver of and party to conflict (Lan 1997) and has been a source of tension for other stakeholders. Additionally, these multiple roles confuse government officials and create unrealistic expectations (Lan 1997). Thus these roles need to be altered for the use of alternative dispute resolution techniques. Successful dispute resolution at the local level requires government officials to be facilitators, rather than directors (Tyler 1999; Wolf et al. 2006) Government becomes a participant, rather than an authoritative director and decision maker, when consultative roles such as guiding stakeholders in collecting facts, identifying common interests and reaching consensus are strengthened. Making government more of a participant than a decision maker decreases animosity towards government agencies and allows stakeholders to reach solutions and manage resources collaboratively. Of course, this is very difficult to accomplish, since few agencies easily give up their decision-making power (Tyler 1999).

Often the desire to designate a government employee as group mediator is strong, but must be avoided because impartiality and trust are very important (Tyler 1999). The use of a neutral mediator in the conflict management process is strongly supported in the literature (Tyler 1999; Michaels 2001; Wolf et al. 2006). As seen in Michaels (2001), non-mediated groups with a high involvement of government



officials were not able to make policy recommendations without being seen as authoritative, undermining the collaborative process. Conflict management policies must include a provision for hiring external professional mediators (Tyler 1999).

A related and equally essential component to the stakeholder collaboration process is that all parties understand the risks and benefits of mutual responsibility. If the solution reached by consensus fails to fulfill the expected goals, all parties must take responsibility for the failure and face the repercussions (Tyler 1999). Group tensions and process hindrance occurred when only government agencies were held accountable for group decisions (Michaels 2001). The creation of a mechanism holding all stakeholders responsible is needed for this type of conflict management scheme to succeed. To avoid group dissolution after a perceived failure, evaluate the solutions successes and misses, re-evaluate the process used to reach the decision, and reaffirm or alter the goals of the group.

Reaching a resource management agreement while preventing conflict requires involving all the stakeholders (Kameri-Mbote 2007). Stakeholder analysis identifies the interests, attributes, goals, and relationships of each stakeholder, and also their capacity for research, implementation and support (Ramirez 1998; Tyler 1999). This process also strengthens a mediator's ability to guide the management process (Tyler 1999). Stakeholder identification and analysis is one task government agencies can take on to ensure stakeholder inclusion and to increase their participatory role in conflict management.

Currently, political frameworks fostering and supporting stakeholders in collaborative decision making and solution design are limited. External support is important for several reasons. High-level government directive solution forming will continue without external support because without it stakeholders are unwilling to take on the responsibility of resource management (Tyler 1999). External support from state and federal agencies, can come in many forms including technical and research assistance, data analysis, information sharing, resource or program monitoring, or feedback (Tyler 1999). External support must continue through the duration of the stakeholder group existence because the management process is destroyed by its

removal (Tyler 1999; Michaels 2001). Additionally, external support is best utilized after a collaborative group has clearly defined their goals. If the group does not have well defined, issue specific goals- such as water quality or groundwater depletion it will search for purpose even with ample support (Michaels 2001). It is also needed to bolster weaker stakeholder's positions, decreasing the risk that powerful, wealthy stakeholders will dominate the process, a common critique of alternative dispute resolution techniques.

The final component of a conflict management collaboration group is time. Trust building between previous contentious parties delay reaching collaborative decisions. Also, natural resource concerns often require complicated, long-term solutions that take a long time to reach, or process results may be difficult to measure or not immediate (Wolf et al. 2006). After the original conflict is resolved a maintained coherence will allow quick action when another conflict begins to surface or the new management issues begins to alter in the face of a changing society (Tyler 1999).

The governmental transition away from making professional judgments to participating in collaborative decision making can be eased by emphasizing certain traditional roles of high-level government. Specifically, increasing the importance of coordination positions, information validation and distribution, outcome monitoring of collaborative decision making process, and external support (Tyler 1999). This does not come at the expense of upholding the law. Government agencies still hold power in enforcing sweeping regulations like the Endangered Species and Clean Water Acts (Gerlak 2006). Government still must ensure the public's long-term interests, and ensure due process, social justice and legality (Lan 1997). However, since problems are encountered face to face at the local level, a critical function of the states is to build and support local collaborative, managerial, financial, and technical capacity (Michaels 2001). However, how much intra-state program variation is acceptable, is a major question for state agency consideration when embarking upon these tasks (Michaels 2001).

In conclusion, several policies are available to foster dispute resolution and natural resource management. Several policy options were discussed including training resource managers in conflict management techniques, allocating resource use based upon the equitable distribution of benefits and most importantly actively engaging stakeholders in the resource management process. When working closely with stakeholders several options for governmental action are included: increasing agency coordination, providing external support, and performing stakeholder analysis. Implementation of these techniques should accomplish the true goal of water resource governance: solving a watershed's ecological problems while managing stakeholder conflict (Gerlak 2006).

## Conclusion

This study provides details of water resource conflict and cooperation in Oregon between 1990 and 2004 by using an event database methodology. The spatial and temporal distribution of conflict and cooperative water resource events were explored. Then correlations were tested between these distributions to social (institutional change, consumptive use), demographic (population density change) and physical variables (water quality and surface water supply). A time-lagged analysis was performed to understand how conflict and cooperation evolve over time. Next, Oregon results and international scale results were compared. Lastly, policy recommendations to increase resource manager's ability to manage conflict were presented.

The geographic distribution of conflictive and cooperative events is as follows. Four administrative basins: the Willamette, Mid Coast, Klamath, and Malheur, accounted for 270 of the 393 events (68.7%). The Malheur and Mid Coast basins had the most news events per capita, while the Willamette basin had one of the lowest event per capita rates. Most western basins had relatively high cooperative weighted average intensities. Eastern basins had a greater range of cooperative intensities ranging from the very high (Umatilla, 16) to three basins with no cooperative events (Grande Ronde, Malheur and Malheur Lake). No geographic pattern was seen in the distribution of conflictive intensities among the basins in Oregon.

The distribution of issue types among the basins was highly variable. Water rights events were more widely distributed than other issue types among Oregon's basins; no basin had more than 25% of the water rights events. The Klamath basin held an overwhelming majority of instream water resource events (78%). Extremely cooperative events (intensity 5) comprised five issue types; water quality, infrastructure, navigation, intergovernmental and fish passage. Extremely conflictive events (intensity -5) only concerned instream issues.

Comparing Oregon results to international results revealed both similarities and differences. Overall, cooperative events outnumber conflictive events and a low proportion are of extreme intensities (-5 and 5), at both the intra-state and international

scale (Yoffe 2001). Fewer events involved water quantity in Oregon (78, 20%) than at the international scale (824, 45%). The occurrence of water quality events increases as the scale decreases. In Oregon, most events revolved around water quality issues (158, 40%) but only accounted for only 6% of the international events.

Correlation strengths among the social, demographic, and hydrologic variables to water resource conflict and cooperation varied. Population density, consumptive use, and water quality did not explain spatial variation in conflict or cooperation, as measured by weighted average intensity or frequency of high intensity events. Temporal analysis did not indicate a relationship between water quality and conflict or cooperation. However, in years of below average surface water availability, higher cooperative intensity averages occurred in all basin groups. Eastern basins also exhibited higher conflictive intensity averages during dry years. Fluctuations in surface water supply explained some of the variation in conflict and cooperation, but not the level of conflict or cooperation in any one year. Institutional changes were associated with peaks in the frequency of high intensity cooperation, (in 1991, 1999, and 2004) and conflict (in 1991, 2001, and 2004).

This research supports the proposed conceptual framework for water conflict and cooperation at the state and local scale. First, hydrologic and demographic variables play a role in stakeholder relations and affect overall levels of conflict and cooperation. Surface water supply levels correlated the best with overall conflict and cooperation levels as measured by weighted average intensity. However, major conflictive outbreaks or cooperative breakthroughs are correlated to institutional changes in the social system as measured by the frequency of high intensity events. These institutional changes may act as either an instigator or resolution of resource conflict. Water resource conflict was shown to intensify over time, and major conflictive events lead to major cooperative events. Additionally, this process is unique to conflict; cooperative processes are not easily undermined by a conflictive action.

Since conflict is inevitable, conflict management must be viewed as a process. Luckily, several policies are available to natural resource managers to foster dispute

resolution. Most importantly is to increase government's ability engage key stakeholders. When working closely with stakeholders several options for governmental action are included: increasing agency coordination, providing external support, and performing stakeholder analysis. Implementation of these techniques should provide water resource managers with the tools to manage conflict, not make it disappear entirely.

## APPENDIX

### *Event data sources and data searching*

Appendix Table 1: Newspaper titles, locations and earliest date newspaper articles were available. Column heading ‘database’ references the online search source used to collect articles; ‘n/a’ indicates the online search source was independently managed by the individual newspaper. Of the 21 newspapers a majority of the events were collected from The Oregonian, The Associated Press, The Argus Observer and The News Times. See Figure 8 on page 23, for a map of newspaper locations.

Newspaper Title	Location	Database	Earliest Date	Events
Albuquerque Journal, The	Albuquerque, NM	Lexis-Nexis	Jan 1995	2
Argus Observer, The	Ontario, OR	n/a	Jan 2004	46
Associated Press State and Local Wire, The	All US	Lexis-Nexis	Aug 1998	69
Bend Bulletin, The	Bend, OR	n/a	Dec 2004	3
Blue Mountain Eagle, The	John Day, OR	n/a	Jan 2004	4
Business Press of California, The	San Bernardino and Riverside, CA	Lexis-Nexis	Jan 1990	1
Daily Journal of Commerce	Portland, OR	Lexis-Nexis	Mar 2001	3
Columbian, The	Vancouver, WA	Lexis-Nexis	May 1994	2
Curry County Reporter, The	Gold Beach, OR	n/a	Dec 2004	1
Eureka Times-Standard	Eureka and Arcata, CA	Lexis-Nexis	Oct 2004	1
Lewiston Morning Review	Lewiston, ID	Lexis-Nexis	Jun 1991	8
News-Review, The	Roseburg and Douglas Counties, OR	n/a	Jan 2004	6
News Times, The	Newport, OR	n/a	Jan 2004	71
Oregonian, The	Portland, OR	News Bank Info Web and Lexis-Nexis	Jan 1990	135
Recorder, The	San Francisco, CA	Lexis-Nexis	Jan 1991	1
Rocky Mountain News	Denver, CO	Lexis-Nexis	Jan 1994	1

**Appendix Table 1: Continued**

<b>Newspaper Title</b>	<b>Location</b>	<b>Database</b>	<b>Earliest Date</b>	<b>Events</b>
Rogue River Press, The	Rogue River, OR	n/a	Jan 2004	3
San Francisco Chronicle, The	San Francisco, CA	Lexis-Nexis	Jan 1990	4
Seattle Times, The	Seattle, WA	Lexis-Nexis	Jan 1990	5
Register Guard, The	Eugene, OR	Lexis-Nexis	Sept 1997	15
Ventura County Star, The	Ventura County, CA	Lexis-Nexis	July 1997	1
Western Farm Press	CA	Lexis-Nexis	Jan 2001	1

**Appendix Table 2: Terms used in keyword search modified from Yoffe (2001). Asterisks (\*) indicate a wild card where any suffix derivative of the word is collected, commas (,) indicate different searches.**

<b>Database</b>	<b>Focus</b>	<b>Search Terms</b>
Lexis Nexis Academic	U.S. News-Western Regional Sources	Oregon and: river or groundwater or water and: quality or quantity or rights and: conflict* or disput* or fight* or battle or war or stalemate or clash* or cooperat* or agre* or uni*
NewsBank InfoWeb	The Oregonian	Oregon and: river or groundwater or water and: quality or quantity or rights and: conflict* or disput* or fight* or battle or war or stalemate or clash* or cooperat* or agre* or uni*
News-Review, The	n/a	water quality (conflict* or cooperat*)
Blue Mountain Eagle, The	n/a	water quality, water rights, river quality, river rights, groundwater quality
News Times, The	n/a	water or river or groundwater and: quality or quantity or rights
Rogue River Press, The	n/a	water and quality, water
Argus Observer, The	n/a	water or river or groundwater and: quality or quantity or rights
Curry County Reporter, The	n/a	water
Bend Bulletin, The	n/a	water



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