Natural Resources Journal

Masthead Logo

59 Nat Resources J. 1

Winter 2019

Instream Flow Rights within the Prior Appropriation Doctrine: Insights from Colorado

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INSTREAM FLOW RIGHTS WITHIN THE PRIOR APPROPRIATION DOCTRINE: INSIGHTS FROM COLORADO

ABSTRACT:

Under the prior appropriation doctrine, water rights are better defined and specified than under the riparian doctrine, but diversion requirements left instream flows unprotected. Primarily in the 1970s and 80s, states sought to extend water rights to include instream flow (henceforth ISF) uses, allowing for new appropriations and market-based transactions to establish ISF rights within the private property system rather than using eminent domain or the public trust doctrine to bolster ISFs. Due to cumbersome administrative processes and other transaction costs, relatively few transfers or appropriations have occurred. Those that have often have rights subordinate (through legal qualifications) or at least junior to earlier diversion rights, leading critics to question the right-based preservation. This article rigorously analyzes the case of Colorado, one of the most active programs in the US within the most regimented water right systems. Despite relatively few acquisitions, the junior ISF appropriations have protected numerous miles of streams by 1) deflecting future diversionary rights, 2) requiring protection of any upstream transfers, and 3) reducing upstream withdrawals from existing diversion rights despite ISF's junior status. The shift to diverting more downstream stems from additional investment in monitoring and enforcement which provides informational externalities to existing water right holders.

INTRODUCTION

Water has long been sought after property in the arid regions of the US.[1] Settlement and economic development in the Colorado region were driven first by

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mining and then to a larger extent by agriculture, both of which required water and the costly investment to divert it where it was needed.[2] In order to provide security and incentivize investment in such endeavors, settlers quickly deserted the riparian doctrine in favor of considerably more complete, independent, and transferable water rights under the prior appropriation doctrine.[3] Under this approach, a water right requires *diverting* water from the stream and applying it to beneficial use.[4] To a large extent, the system worked, leading to 91,637 irrigation enterprises irrigating 21,003,739 acres of land in the Western US by 1940.[5] Now nearly 40 million acre-

1. Generally, this can be seen in the popular book by Marc Reisner. MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER (2006). Further evidence is the expense early diverters were willing to go to establish and defend a water right. *E.g.* Ray Teele, *Water Rights in the Arid West*, 8 J. POL. ECON. 524 (1900) (recounts that a ditch in Montana court fees and lawyer fees accounted for 79.1 percent of their operating budget from 1891-1895. This may also speak to extent transaction costs pervade the water right system). States also faced lengthy battles amongst themselves with multiple conflicts even after long compact negotiations. *See* Edella Schlager & Tanya Heikkila, *Resolving Water Conflicts: A Comparative Analysis of Interstate River Compacts*, 37 POL'Y STUD. J. 367 (2009). Within states tension over water division among rural and urban centers are common, perhaps most famously between Owens Valley and Los Angeles. *See* Gary D. Libecap, *Chinatown: Owens Valley and Western Water Reallocation – Getting the Record Straight and What It Means for Water Markets*, 83 TEX. L. REV. 2055 (2005).

2. For instance, as New Mexico sought to update their water law, Governor Miguel Otero requested the legislation in 1905, stating: "[. . .] the future growth and continued prosperity of our people as a whole, must depend to a great degree upon the extent and success in the development of our agricultural resources. In this region, where the natural rainfall is insufficient to assure a full crop from year to year, it becomes necessary to resort to irrigation." House Journal Proceedings of the H.R. of the Territory of New Mexico, 36th Sess. (Jan. 19, 1905) (statement of Governor Miguel Otero).

3. The riparian doctrine is common law that was transplanted from England to the American colonies and remains in use in the more humid areas of the US. Generally, it provides a correlative water right to all landowners adjacent to the body of water bounded by reasonable use while excluding any non-riparian land owners. *See* Ludwik A. Teclaff, *What You Have Always Wanted to Know About Riparian Rights but Were Afraid to Ask*, 12 NAT. RESOURCES. J. 30 (1972). Due to the vagueness, there has been uncertainty and debate to the extent to which the riparian doctrine permits diversion and diminished water levels. *See* Peter N. Davis, *The Riparian Right of Streamflow Protection in the Eastern States*, 36 ARK. L. REV. 47 (1982); Terry L. Anderson & P. J. Hill, *The Evolution of Property Rights: A Study of the American West*, 18 J. L. & ECON. 163 (1975) (arguing that the process of adopting the prior appropriation doctrine generally aligns with the process described by Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347 (1967) (where the relative scarcity induced entrepreneurs to better define and enforce property rights); Bryan Leonard & Gary D. Libecap, *Collective Action by Contract: Prior Appropriation and the Development of Irrigation in the Western United States* (Nat'l Bureau of Econ. Research, Working Paper No. 22185, 2016) (the authors describe the change as an "abrupt, and deliberate shift," abnormally quick for typical institutional change and that all the Western States had adopted some form of Prior Appropriation by 1891).

4. DAVID GETCHES & ADELL AMOS, WATER LAW IN A NUTSHELL (West Pub., 5th ed. 2015) (noting that the traditional elements of a valid appropriation are 1) intent to apply water to a beneficial use; 2) an actual diversion of water from a natural source; and 3) application of the water to a beneficial use within a reasonable time). Among other reasons, the diversion and application requirements sought to preclude speculative claims to large portions of streamflow, but have incidentally been the ground on which courts invalidated instream appropriations. *See* Terry L. Anderson & Ronald N. Johnson, *The Problem of Instream Flows*, 24 ECON. INQUIRY 535 (1986).

5. U.S. CENSUS OF IRRIGATION, Table 5 and Table 6 (1940), http://usda.mannlib.cornell.edu/usda/AgCensusImages/1940/04/10/1428/Table-07.pdf. After 1940, irrigated acreage expanded greatly owing mostly to groundwater development and to a lesser extent, Federal Reclamation projects *See* Eric C.

feet of surface water are applied to irrigated crops in the West.[6] Agriculture still accounts for 80-90% of the US's consumptive water use.[7]

On top of the existing expansive withdrawals on streams, the natural supply tends to be more variable and generally on the decline amid climactic changes, further increasing the strain on streamflow and the related riparian ecological systems.[8] Meanwhile, agriculture is a dwindling portion of the overall economy while recreation (fishing, rafting, and general enjoyment of natural amenities) increasingly drives economic activity in the West. [9] In addition, the non-use value for healthy ecological systems is increasingly recognized and quantified.[10] Given the already existing property right structure, many advocate for the use of market transactions by which current water right owners can be compensated – rather than regulated – to transfer diversion rights to instream uses (e.g. recreation, fish habitat, aesthetics, water quality, etc.).[11] In response to these shifts in economy and environment, many states have altered water law to permit property rights for instream use but often limit the ownership of these rights to the state (more details provided below in Table 1). In practice, this limitation has allowed governments to enter into a property-right based allocation system, appropriating and acquiring rights for environmental purposes. This institutional innovation of recognizing instream uses such as habitat maintenance is an early development in the landscape of using markets and property rights for environmental or ecological services.

Edwards & Steven M. Smith, *The Role of Irrigation in the Development of American Agriculture*, 78 J. ECON. HIST. 4 (2018).

6. An acre-foot is the amount of water needed to inundate an acre of land to depth 1 foot, or about 325,851 gallons.

7. *See Irrigation & Water Use*, U.S. DEP'T AGRIC. (2010), https://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use/ (finding withdrawals are significantly less, accounting for 38 percent, with the most water being used by thermoelectric power, though this is primarily non-consumptive).

8. While the exact impact on supplies is hard to pin down, generally a consensus is being reached in the hydrological community that climate change is exacerbating the severity of droughts. *See* Darren L. Ficklin et al., *A Climatic Deconstruction of Recent Drought Trends in the United States*, 10 ENVTL. RES. LETTERS 044009 (2015); *see also* A. Park Williams et al., *Contribution of Anthropogenic Warming to California Drought During 2012–2014*, 42 GEOPHYSICAL RES. LETTERS 6819 (2015).

9. *See* Charlton H. Bonham, *Perspectives from the Field: A Review of Western Instream Flow Issues and Recommendations for a New Water Future*, 36 ENVTL. L. REV. 1205, 1211-12 (2006) (asserting that in 2002 anglers in Wyoming spent over $423 million while Colorado, with its many headwaters and mountainous streams, is at the forefront of demand for kayaking and rafting).

10. John Loomis et al., *Measuring the Total Economic Value of Restoring Ecosystem Services in an Impaired River Basin: Results From a Contingent Valuation Survey*, 33 ECOLOGICAL ECON. 103, 103, 114-15 (2000) (finding riparian landowners would each pay up to $252 annually to improve ecological systems along the Platte River, a total of 19 to 70 million when aggregated across pertinent households). This is generally true even for non-riparian landowner. *See* John B. Loomis, *Estimating the Public's Values for Instream Flow: Economic Techniques and Dollar Values*, 34 J. AM. WATER RESOURCES ASS'N 1007 (1998).

11. *See* JONATHAN H. ADLER, WATER RIGHTS, MARKETS, AND CHANGING ECOLOGICAL CONDITIONS (Faculty Publications, Case Western Reserve University School of Law Scholarly Commons, Paper 24) (2012) (arguing that property rights and markets should be embraced to provide reallocation of water rights as demand for ecological protection increases while climate change further alters the supply).

In the mid-20th century, as early as 1925 in Idaho, Western states began to utilize water rights to protect the environment.[12] Generally, there is increasing interest in harnessing market forces rather than government regulations for environmental purposes, though the transaction costs of doing so can be quite high.[13] Broadly, there has been much discussion over the viability of payment for ecological services, which provides for a voluntary agreement between a buyer and seller in which payment is provided conditional on the environmental service – often watershed protection, carbon sequestration, or habitat (biodiversity) maintenance – being adequately provided. It has been widely considered and implemented as a way to deliver ecological gains through the market. [14]

A necessary condition for a well-functioning market is having well-defined property rights, but property rights are generally difficult to define and subsequently lacking for many ecological goods like carbon storage. This lack leads to transaction costs that are up to 66 percent of program costs, though generally, transaction costs are predictably smaller for watershed services.[15] Where markets have been created, the results have been quite powerful. For instance, Sulphur Dioxide levels were drastically reduced under a cap-and-trade market implemented under the 1990 Clean Air Act Amendments in the US. [16] Meanwhile, the regulated businesses can leverage the economic incentives to become more profitable.[17] However, the demand in the Sulphur Dioxide market was based on the government's imposition of an aggregate limit on total pollution. In contrast, studying ISF Rights in the West allows for assessing how effective property rights

12. IDAHO CODE § 67-4304 (1927).

13. Ronald H. Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1, 16-28 (1960) (explicitly pointing out that, net of transaction costs, the market is not always the most efficient form of allocation and that the government may be called upon despite its own bureaucratic inefficiencies).

14. Sven Wunder, *Are Direct Payments for Environmental Services Spelling Doom for Sustainable Forest Management in the Tropics?*, 11 ECOLOGY & SOC'Y 23, 24 (2006).

15. *See* Lee J. Alston, Krister Andersson, & Steven M. Smith, *Payment for Environmental Services: Hypotheses and Evidence*, 5 ANN. REV. RESOURCE ECON., 139, 139-59, (2013) (discussing a survey of the transaction costs and performance of various PES programs). They find transaction costs have been generally high, with the 66% number coming from a carbon sequestration program in Mozambique. The authors do report a range for the existing studies, with the lowest coming in at 1%, which is notably related to the Conservation Reserve Program in the United States targeting watershed and wildlife services. Part of the reason for low transaction costs are 1) the program is large and has economies of scales on that dimension, and 2) the program developed within the US Agriculture Department where much of the necessary institutional infrastructure already existed. More generally, the authors hypothesize that watershed transaction costs are lower on theoretical grounds and find it to hold empirically. *Id.*

16. *See* Robert N. Stavins, *What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading*, 12 J. ECON. PERSP. 69, 70-85 (1998). A cap-and-trade market is where an aggregate allowable amount of a pollutant is determined by a regulatory authority and permits are somehow allocate shares of this total to regulated firms who are subsequently allowed to sell or purchase permits among with permit holders. *Id.*

17. Fred Krupp of the Environmental Defense Fund which helped to spearhead the market recounts the reaction of a PG&E executive: "But now that the law was in place, he had a pile of new proposals, both from his own shop floor and from outside consultants, for how PG&E could profit by reducing sulfur more than the law required. Environmental protection was no longer just a money loser, he realized, but a potential profit center." Fred Krupp, *The Making of a Market-Minded Environmentalist*, 51 STRATEGY+BUS. (2008).

and markets can be when the property rights are already defined and the demand arises from market forces (increasing relative value of ISFs) rather than the demand arising from government regulation.

While many states now have ISF programs within the prior appropriation doctrine, their use and effectiveness are questioned. Some are concerned that private parties remain on the fringe because often only the government can own ISF rights.[18] Additionally, due to low seniority, legislative qualifications, or poor enforcement, ISF rights are seen as weaker or subordinate to diversionary rights and may not accomplish their purpose.[19] For instance, a recent study of ISF rights by Water in the West states: "[T]hey were fairly powerless at improving flows where existing water uses and rights already impaired the aquatic ecosystem. Senior water rights continued to have priority, and new laws held no power to augment streamflow where existing rights caused depleted flows."[20]

The primary purpose of this article is to draw on Colorado's experience and rich data to provide a rigorous analysis on the efficacy of state-owned ISF rights within the prior appropriation doctrine, assessing their impact on other (and potential) water right claimants. Colorado provides a relevant and important case study because water rights in Colorado are the most regimented in the nation and the extant legal structure could host one of the most progressive ISF programs.[21] Certainly, Colorado has been among the most active states, both in terms of general water transactions and in terms of ISF acquisitions and appropriations.[22] On one hand, Colorado's strictly regimented and continuous adjudication through the water court results in ISF rights that are well-defined, secure, and defensible. However, on the other hand, the administrative process increases the transactional costs to

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18. *See* Anderson & Johnson, *supra* note 4, at 536-39; Jack Sterne, *Instream Rights & Invisible Hands: Prospects for Private Instream Water Rights in the Northwest*, 27 ENVTL. L. 203, 213-15 (1997); Cynthia F. Covell, *A Survey of State Instream Flow Programs in the Western United States*, 1 U. DENV. WATER L. REV. 177, 192-93 (1997). All express concern for the lack of private involvement in ISF programs.

19. Sterne, *supra* note 18, at 215; Covell, *supra* note 18, at 195 (specifically noting, "Given their generally junior nature and the requirement that, in some cases, they be subordinated, many have questioned the ability of instream flow rights to actually accomplish their purpose.").

20. LEON F. SZEPTYCKI ET AL., ENVIRONMENTAL WATER RIGHT TRANSFERS: A REVIEW OF STATE LAWS 9 (2015).

21. Though California in Irwin v. Phillips, 5 Cal. 140 (Cal. 1855) made the first move toward the prior appropriation doctrine, Colorado is given credit for perfecting the framework generally used today. *See* Ralph H. Hess, *The Beginnings of Irrigation in the United States*, 20 J. POL. ECON. 807, 821-30 (1912). Colorado is claimed to have the most regimented water rights in the US. *See* Jesse A. Boyd, *A Survey of State Instream Flow Law from the Rocky Mountains to the Pacific Ocean*, 43 NAT. RESOURCES. J. 1151, 1171-73 (2003). Indeed, sometimes the prior appropriation doctrine is called the "Colorado doctrine."

22. BREN SCH. OF ENVTL. SCI. & MGMT., CALIFORNIA WATER TRANSFERS RECORDS (2018), https://www.bren.ucsb.edu/news/water_transfers.htm. According to the Water Transfer Level Data, from 1987-2009, Colorado accounted for 2,228 of 4,407 transfers recorded. *Id.* Colorado Water Conservation Board finds as of 2005 that Colorado and Oregon were by far the most active in ISF rights with Colorado holding the most (1,926) at the time. COLO. WATER CONSERVATION BD., DECADES DOWN THE ROAD: AN ANALYSIS OF INSTREAM FLOW PROGRAMS IN COLORADO AND THE WESTERN UNITED STATES 2 (2005) [hereinafter CWCB].

acquire or appropriate an ISF right, possibly deterring some activity.[23] The evidence from Colorado confirms that transaction costs for acquisitions are high and combined with low funding and high costs, relatively few senior rights are reallocated to ISF protection. However, appropriation of new junior rights is surprisingly effective because the state appears highly capable of defending these new rights which subsequently stymies future diversions and even reduces existing upstream diversions due to better measurement and enforcement of existing downstream diversions.

Section one of this article provides a sketch of water law in the West. Section two traces the development of ISF programs within that legal paradigm, detailing the potential issues. The last section gives a description of the Colorado ISF program and analyzes the available data to assess its impact.

1. WATER RIGHTS

A. Prior Appropriation Doctrine

Water in the western states is allocated primarily within the prior appropriation legal doctrine. Under the prior appropriation doctrine, water users are provided a vested usufruct right to water while the water itself remains property of the state. Typically, the right is defined by the place, amount, and initial date of diversion as well as a beneficial use. In contrast to the riparian doctrine – under which water rights are equally and perpetually reserved for all riparian-land owners, inclusive of instream uses – prior appropriation water rights are 1) conditional on satisfaction of prior claims, 2) require diversion and permit application to non-riparian lands, 3) forces the appropriator to use the water or risk losing it, and 4) allows for the explicit transfer of rights between individuals.[24] The conditionality on prior claims means that in times of low stream flow those with more senior rights (earlier diversion dates) are provided their full allotment before more junior rights receive any. The conditionality is also meant to deal with intra- and inter-year variation of water availability. The conditionality, however, creates heterogeneous rights that lead to some economic inefficiencies in the division of water while also increasing transaction costs of potential efficiency improving water right trades. Still, these water rights provided the security to promote investment in economic activity dependent upon water supply.[25] Meanwhile, the

23. The general concept is that increased specificity and precision of rights are costlier to implement. *See* Demsetz, *supra* note 3, at 355-59; *see also* SZEPTYCKI ET AL., *supra* note 20, at 26-29 (as specifically stated in the context of Colorado's ISF program); STEVEN MALLOC, LIQUID ASSETS: PROTECTING AND RESTORING THE WEST'S RIVERS AND WETLANDS THROUGH ENVIRONMENTAL WATER TRANSACTIONS 52-56 (2005).

24. These essential distinctions were catalogued in Anderson & Hill, *supra* note 3, at 177-78; *see also* GETCHES & AMOS, *supra* note 4.

25. *See* H. Stuart Burness & James P. Quirk, *Appropriative Water Rights and the Efficient Allocation of Resources*, 69 AM. ECON. REV. 25, 25-27 (1979) (showing generally that under this system otherwise homogenous agents secure different amounts of water (meaning unequal marginal benefits) that carry distinct levels of risk). Howe and Goemans demonstrate that part of the problem in reallocating these rights to address the inefficient division is the definition of the water rights themselves, as each right is unique and requires significant due diligence to assess the risk portfolio and address return flow issues relative to how proportional rights can be traded more readily. Charles W.

requirement of diverting the water from its natural source (and the accompanying costs) along with the use-it-or-lose-it condition were stipulations meant to stymie speculation in water.[26] As initially set out, instream uses were not considered valid claims under the prior appropriation doctrine with many cases explicitly rejecting them either due to the lack of meeting the diversion requirement or because the instream use was not considered to be beneficial (especially to settlement and development of the area).[27]

B. ISF across the US[28]

Most western states now have some form of ISF protection. A brief summary of state activity is provided in Table 1. ISF flows were first established in the northwestern states as an outgrowth from the concern over anadromous fish populations and their ability to build upon hydroelectric power related water rights which had instream type characteristics.[29] Accordingly, Washington, Oregon, and Idaho have ISF programs dating back to the mid-twentieth century. By 1998 all 12 western states had some ISF right program, with a mean year of 1982.[30] Legislative acts were generally required to redefine definitions of beneficial uses and/or relax

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Howe & Christopher Goemans, *Water Transfers and Their Impacts: Lessons from Three Colorado Water Markets*, 39 J. AM. WATER RESOURCES. ASS'N 1055, 1056 (2007). Last, evidence that the adoption of the prior appropriation doctrine (in place of the riparian doctrine) led to more private development of irrigation infrastructure in the arid west than otherwise would have occurred is provided by Leonard and Libecap. Leonard & Libecap, *supra* note 3.

26. Schodde v. Twin Falls Land & Water Co., 224 U.S. 107 (1912). Without these requirements, in the extreme case, one could have set sights on a stream and, without investing in infrastructure or applying the water to any beneficial use, claimed the entire flow of said stream. Subsequent settlers would have been compelled to pay monopoly prices to the initial (speculative) claimant in order to secure water because the aridity leaves few substitute sources. Therefore, these legal stipulations were in part meant to provide water to "bona fide" settlers at no charge for the water itself. The aversion to monopolistic claiming and preference for equitable and cheap access were recognized by the US Supreme Court Justices in *Schodde v. Twin Falls Land & Water Co.* as the spirit of the legislation and adjudication of water rights in the West, ultimately denying a large appropriation claim because the majority of the water was not to be diverted or applied to beneficial use, which was counter to the spirit of western water law. *Id.* at 120-26.

27. *See generally* Anderson & Johnson, *supra* note 4.

28. ISF is a dynamic space and worthy of repeated surveys to provide up to date information on status across states, both in terms of legislative and/or judicial activity and acquisitions and appropriations. Indeed, many sources cited throughout have taken on these important efforts from time-to-time. *E.g.*, Covell, *supra* note 18; Boyd, *supra* note 21; CWCB, *supra* note 22; Bonham, *supra* note 9; SZEPTYCKI, ET AL., *supra* note 20. The most recent deals primarily with acquisitions and very little with appropriations. Accordingly, it is time for another update, but this paper does not take on this worthy task in order to provide a rigorous analysis of the Colorado ISF efficacy. Accordingly, this section relies on these earlier sources of information and while I attempt to triangulate the most up-to-date information, the reader is cautioned that data herein may not be strictly comparable or necessarily up-to-date, for the measures of activity across states.

29. Covell makes the claim that concern over the fish first led Idaho, Oregon, and Washington to establish ISF claims. Covell, *supra* note 18, at 179, 182. Anderson and Johnson compare ISF rights to those for Hydroelectricity, though they note these did meet the "diversion" requirement since the water is diverted through manmade structures. Anderson & Johnson, *supra* note 4, at 549-50.

30. Of the other states utilizing the prior appropriation doctrine, Alaska, Kansas, Nebraska, and South Dakota also have ISF protection and only North Dakota and Oklahoma lack ISF protection. CWCB, *supra* note 22, at 8 tbl.3.

the requirement for a physical diversion. Most states now recognize protection of fish as a valid beneficial use, while ISF rights can also be established for other wildlife, recreational use, simple aesthetics, and to help maintain general water quality. On average, each of the 12 states has 4.25 different beneficial uses recognized for ISF rights. In 6 of the 12 states, the rules stipulate that only a government entity may be the claimant or owner of an ISF.

ISF rights often remain weaker in some manner than diversion rights and the strength, or potential strength, of ISF rights varies across states. California and Montana require a review of ISF rights periodically; Arizona, Colorado, and Oregon have stipulations subordinating ISF rights to other types of uses.[31] Not all states designate water rights per se, but instead, rely on ISF reservations, which diverters can no longer appropriate like in Montana and Washington.[32] New Mexico and Nevada interpreted their prior appropriation doctrines to permit instream uses and did not require legislative adjustments.[33] Arizona law allows that any private entity can hold ISF rights, not just government entities, but private is limited to appropriation of ISF rights, only the state can convert current diversionary rights to ISF rights.[34] Nevada, in contrast, permits private ownership through both appropriation and acquisition.[35] Overall, California, boasting 9 of 10 legal components identified by the Water in the West report as "pro" ISF transfers, exhibits the strongest legal foothold and Arizona, with only 3 of 10, has the weakest rights.[36] On average states have 6.25 of the legal components, suggesting in general that ISF rights have garnered legal strength and protection. Notably, however, only half of these states have the ability to appropriate new rights for ISF. As further discussed in section 3, transfers are typically stronger rights, but it turns out the ability to appropriate even junior rights is surprisingly effective in Colorado, making this a potentially important gap between states.

31. Covell, *supra* note 18, at 183, 191-92.

32. Anderson & Johnson, *supra* note 4, at 545; CWCB, *supra* note 22, at 7, 13.

33. *See generally* Boyd, *supra* note 21.

34. *Id*. at 1153-54; CWCB, *supra* note 22, at 12.

35. CWCB, *supra* note 22, at 13.

36. SZEPTYCKI ET AL. defined 10 legal elements that limit or enhance ISF rights. SZEPTYCKI ET AL., *supra* note 20, at 2. To summarize: (1) recognition of ISF as a beneficial use; (2) transfers to ISF are recognized and whether; (3) they are explicitly recognized by statute; (4) if private entities can hold ISF rights; (5) whether transfers can be permanent; (6) and if short-term leases are permitted; (7) whether ISF rights are limited in ways diversion rights are not; (8) whether the law provides some water savings from irrigation efficiency improvements can go towards ISF rights; (9) whether uses can be "stacked" (allowing a single right to go towards diversion or ISF in any given year without an administrative process); and (10) whether short-term ISF application is protected from the loss of the water right due to "non-use." *Id*.

Table 1: State ISF Summary

State	ISF Year[a]	Beneficial Uses[b]	Legal Elements[b]	Appropriations[c]	Private ISFs[c]	Transfers/ Leases[b]	Transfers/ Leases[d]	Total ISF rights[e]	ISF Volume (AF)[d]	ISF/Total Activity (volume)[d]	ISF Sales/ ISF Activity[d]
Arizona	1976	F, W, R	3	N	Y	0/0	8/3	51-100	48,380	1%	42%
California	1991	F, W, RA, R, A, N, WQ	9	N	Y	34/15	5/110	.	3,877,614	29%	1%
Colorado	1973	F, RA, EP	7	Y	N	34/7	26/31	>1000	520,318	32%	41%
Idaho	1925/1978	F, W, R, A, N, WQ	5	Y	N	30/0	6/48	51-100	3,653,197	56%	4%
Montana	1973	F, W, R, WQ	8	Y	Y	50/0	1/31	101-500	55,867	59%	0%
Nevada	1988	F, W, R	5	N	Y	57/0	40/0	11-50	58,011	17%	100%
New Mexico	1998	F, W, R, EP	5	Y	N	1/0	8/59	0	433,833	64%	6%
Oregon	1955/1987	F, W, RA, R, A, WQ	7	Y	N	113/1800	21/56	>1000	889,070	60%	39%
Texas	1985	RA, R, A, N, CM, WQ	8	N	Y	20/0	0/4	0	49,559	2%	0%
Utah	1986	F, R, EP	6	N	Y	8/0	0/2	1-10	2,825	1%	0%
Washington	1949/1971	F, W, R, A, WQ	8	N	N	532/586	9/12	101-500	156,381	48%	61%
Wyoming	1986	F	4	Y	N	1/0	2/0	51-100	194	0%	100%
Average or Total	1983	4.25	6.25	6	6	74/201	11/30	N/A	812,104	31%	33%

Notes: [a] ISF year based primarily on CWCB (2005), Figure 7. Various sources (Bonham (2006), Boyd (2003), https://www.owrb.ok.gov/supply/ocwp/pdf_ocwp/ISF/WesternStatesSummaryTable.pdf) were also considered. Idaho, Oregon, and Washington provide two years (Washington and Idaho earlie years are sourced from Bonhom (2006) and Boyd (2003) respectively) to account for the earlier hydro-related instream flows and the more modern environmental ISF program.

[b] F=Fish, W=Wildlife, RA=Riparian Areas, R=Recreation, A=Aesthetics, EP=Environmental Protection, N=Navigation, CM=Channel Maintenance, and WQ=Water Quaility. Data comes from

[c] These tallies come from "Environmental Water Right Transfers: A Review of State Laws" (2015), prepared by Water in the West. They identify ten legal dimensions that our defined as "friendly" to ISF rights. New appropriations and private use are two specific categories. I altered Arizona to including private citizens as they are able to appropriate, though not transfer, a ISF right (CWCB 2005).

[c] These are diversion rights transferred or leased to ISF use. Counts from Water in the West report (2015).

[d] Data are from the Water Transfer Data Level Data Set, created by Gary Libecap and Zach Donohew available at https://www.bren.ucsb.edu/news/water_transfers.htm. The data set includes water transfers recorded in the *Water Strategist* from 1987 to 2009. Those transferes coded as "Environmental" are treated as ISF rights.

[e] This measure of total rights (inclusive of transfers and appropriations) come from CWCB (2005), Table 15 and 16

Drawing from the information in Table 1, from 1987 to 2009, across the 12 states, nearly 1 billion acre-feet of water have been transferred, at least temporally, for ISF protection. There is considerable variation across states and the underlying legal strength (as measured by the number of pro-ISF legal elements) is only weakly correlated with actual ISF transfer and appropriation activity. Although Arizona and Wyoming stand out for having low legal protection and also low activity, the correlation between legal components and volume is only 0.08. In general, it is worth noting that environmental transfers have made up a relatively large share of the recorded activity, accounting for 31% of a state's water market activity on average. However, it is also notable that only one-third of ISF are sales and the remainder are shorter leases. For instance, though California has the most acre-feet transferred to environmental uses, only 1 percent of it is permanent. In terms of total rights as well as permanent ISF transfers specifically, Oregon and Colorado lead the nation with the most acre-feet protected.[37]

C. Challenges for ISF

Property rights to water are already defined under the prior appropriation doctrine and transaction costs to appropriate and acquire ISF are already greatly reduced. However, the water rights are not perfectly delineated and water markets, even among diversionary rights, remain thin and lumpy (few options exist when "shopping" for rights and transactions tend to occur for only very large quantities)

37. Though not presented in Table 1, the figures were calculated by multiplying the percent of ISF sales times the total ISF volume. Oregon has 347,790 AF and Colorado recorded 215,434 AF.

for a number of reasons.[38] First, because the rights are all unique and carry their own risk portfolio, ascertaining and pricing that risk is difficult.[39] Second, the administrative or judicial process can be lengthy and expensive as other water right holders may object on grounds of the transfer injuring their own right.[40] Third, the water rights were not originally designed to accommodate ISF, increasing the transaction costs relative to more typical diversion uses.

In dismissing earlier attempts to appropriate ISF, courts cited fear of monopolistic control over water, the failure to meet the diversion requirement, and describing instream use as wasteful (even if arguably beneficial).[41] The twin requirements of diversion and beneficial use were seen as a way to thwart speculative claims by requiring an upfront investment and actual use. In more contemporaneous times, many rivers have already been significantly appropriated, and limits exist on the amount of water that can be claimed, reducing the risk of monopolistic control of water. Still, opportunistic behavior could abound if claims, even quite junior, were made and then leveraged to receive payoffs for upstream transfers that would injure the newer ISF right, providing some justification for limiting ownership to government agencies.[42]

Opportunistic behavior by junior irrigators is prompted by the fact that water rights are defined in diversion terms, yet lower levels of actual consumption create return flows that can be diverted again downstream. These return flows are protected as subsequent water rights rely on them. This means transfers must be conducted as to not injure third-parties impacted by the return-flows.

Researchers Ronald C. Griffin and Shih-Hsun Hsu show in their economic model that both diversion and instream rights can be efficiently allocated in a decentralized market if water rights were defined and allowed for the trade of both diversion and consumption rights. Not only would efficiency of the decentralized market be required to define both diversion and consumptive rights (only the former is defined in practice), but also the calculation of return flow coefficients between every pair of diverters, and the formation of water districts to represent the

38. ERIC C. EDWARDS & GARY D. LIBECAP, *Water Institutions and the Law of One Price*, *in* HANDBOOK ON THE ECONOMICS OF NATURAL RESOURCES, 442-73 (2015) (generally documenting that for multiple reasons, transaction costs included, water markets are not efficient even if most observed transfers do move towards higher valued uses because many transactions are not pursued).

39. *See generally* Howe & Goemans, *supra* note 25. This contrasts with proportional rights in which shares of a total flow are traded, making all rights fungible. This has been found to lower transaction costs considerably, resulting in more and smaller amounts being traded.

40. John S. Harbison, *Waist Deep in the Big Muddy: Property Rights, Public Values, and Instream Waters*, 26(2) LAND & WATER L. REV. 535, 545-46 (1991). "[W]ater has more in common with the wind. In constant motion, not easily captured or measured, water generates many transaction costs that cannot be reduced, much less eliminated." *Id*. at 546. Specifically, Harbison cites identifying legal and hydrologic characteristics, negotiating price, arranging financing, satisfying state laws in transfer procedures, title searches, hydrological studies to transfer impacts. *Id*. at 545-46.

41. *See* Anderson & Johnson, *supra* note 4, at 537.

42. *See id*. at 540 (showing that within their model, junior ISF rights create a binding constraint that wound not otherwise exist).

public demand for ISFs.[43] The extent of the costs to do so makes this market unlikely to be realized.

But even within the current framework, ISF rights have transaction costs beyond the typical diversion right. When diverting water, the amount of water claimed is readily definable. To appropriate an ISF, one must determine the amount that can be reasonably claimed under beneficial use. To the extent that most ISF rights relate to ecological provisions, states often limit claims to the minimum amount of water necessary to accomplish its stated ends.[44] Determining that threshold requires some scientific inquiry, and the initial bar of appropriation is higher than for a diversion, though notably, traditional diversionary claims are not themselves precisely limited to "beneficial" use owing to possible inefficiencies.[45]

Administering and enforcing ISF rights is also more difficult. A diversionary right holder can readily assess whether their diversion is being fully met and issue a call if need be (although it may remain a challenge to be aware of activity at other diversions). But an ISF right extends through a stretch of the stream, requiring not just one, but multiple points of measurement, making it difficult to assess the need to place a call.[46]

The transaction costs are high, so private involvement may be difficult in practice. In Arizona, where anyone can own an ISF right, the sophisticated process to establish and administer the right is often out of reach of the average citizen and only the Arizona Nature Conservancy, Bureau of Land Management, and the Tonto National Forest had undertaken the arduous process.[47] In California, where citizens can now secure ISF rights under Section 1707 of the California Water Code, Carlton H. Bonham says the number of transactions can be counted on just two hands, blaming administrative processing hurdles, costs (satisfying the no injury rule related to return flows), and that the entire process remains convoluted.[48]

One primary argument for the use of state-run ISF programs, besides avoiding speculative private claims, is that in many cases the provision and support of healthier ecological systems are public goods and that public goods risk being under-provided for by private entities (this is not to say that private provision does not occur.[49]) However, there is also a general concern the public entities are incapable of delivering such public goods. Some have suggested that the state could manage the initial appropriation but then assign it to a private entity that

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43. Ronald C. Griffin & Shih-Hsun Hsu, *The Potential for Water Market Efficiency When Instream Flows Have Value*, 75 AM. J. ECON. 302, 292-303 (1993).

44. *See, e.g.*, Covell, *supra* note 18, at 363-65.

45. Under the "use-it-or-lose-it" principal, irrigators face little incentive to conserve water and instead seek to maintain higher levels of consumption. Encouraging conservation by allowing and facilitating ways for irrigators to sell water freed up from investments in efficiencies could yield a greater amount of water available both instream and other higher valued uses. *See* Boyd, *supra* note 21, at 1210.

46. Covell, *supra* note 18, at 356.

47. *Id.* at 366.

48. Bonham, *supra* note 9, at 1225.

49. *See generally* Ronald H. Coase, *The Lighthouse in Economics,* 17 J. L. & Econ. 357 (1974) (showing the treatment of private provision of public goods); *see also* Bryan Leonard & Shawn Regan, *Legal and Institutional Barriers to Establishing Non-Use Rights to Natural Resources*, 59 NAT. RESOURCES J. 135 (2019) (showing applications in the conservation context).

would be nimbler to respond to market conditions.[50] Jack Sterne most succinctly summarizes the overall concerns with state provision of ISF protection specifically:

> First, as a general rule, most publicly held instream rights have junior priority dates. Second, state legislatures have failed to adequately fund instream programs. Third, state agencies have not been vigorous enforcers of the instream rights they hold. Fourth, these agencies are saddled with highly inefficient and expensive bureaucratic processes for establishing instream rights.[51]

The rest of this article sets out to assess the validity of these concerns and potential issues with ISF rights uniquely through the Colorado experience. It will explore how well Colorado has done to appropriate and acquire water rights and how the timing and placing of these rights correlate with patterns in other diversionary rights. The latter is assessed in terms of deterred new claims, impact on transfers between diversion rights, and the impact on relative changes to upstream and downstream diversions.

2. COLORADO INSTREAM FLOW PROGRAM

A. Background

In 1973, Colorado passed Senate Bill 97 which allowed for the Colorado Water Conservation Board (CWCB) to appropriate instream water rights on behalf of the public to "preserve the natural environment to a reasonable degree."[52] No longer did a water right require a diversion, and the definition of beneficial use was expanded to include ISFs, as long as the state was the owner. Notably, the state has not been explicitly granted nor attempted to exercise eminent domain or to curtail existing rights under the public trust doctrine.[53] As junior appropriations, the ISFs are subordinate to existing water rights, though fear remained that these junior ISF

50. Anderson & Johnson, *supra* note 4, at 551. But in line with the general concern over the public good nature of the ISF, one may still be concerned that this private owner would sell too quickly, prioritizing private gains while discounting public losses. *Id.*

51. Sterne, *supra* note 18, at 215.

52. Act of April 23, 1973, ch. 442 Colo. Sess. Laws 1521 (codified at COLO. REV. STAT. § 148-21-3(1963)); *see also* Boyd, *supra* note 21 (noting that other governmental entities may now own "recreational in-channel diversion" which is seen as a "diversion" because it does require a man-made structure to control the stream).

53. California famously asserted the Public Trust Doctrine applied to water diversions. *See, e.g.*, Nat'l Audubon Society v. Superior Court, 658 P.2d 709 (Cal. 1983) (declaring the state did not have the authority to convey vested water rights that harmed the public resource, and more narrowly, reduced the diversions from tributaries to Mono Lake); *see also* Covell, *supra* note 18 (pointing out that in Aspen Wilderness Workshop v. Colorado Water, the opinion originally justified the ruling largely on the public trust doctrine, but ultimately these references were removed to form a similar finding but on different grounds. 901 P.2d 1251 (Colo. 1995)); *see also* Dan Merriman & Anne M. Janicki, Presentation at Colorado Riparian Association Conference, *Colorado's Instream Flow Program: How It Works and Why It's Good for Colorado Colorado* (Oct. 2005), http://coloradoriparian.org/conferences/conf2005/DMerriman.pdf (emphasizing that Colorado's ISF program does not seek to utilize eminent domain).

rights could impinge on the ability to transfer existing water rights upstream.[54] In 1986, the CWCB's authority was expanded to include acquisition of ISFs by "grant, purchase, bequest, devise, lease, exchange, or contractual agreement" with any person or entity.[55] This expanded authority now permits the CWCB to take an active place in the water market for ISF, gaining more senior rights not only to maintain the environment, but to also improve the environment, which it was explicitly vested to do in 2002.[56]

The acquisition market is not terribly active since the CWCB does not always have the funds to act as a buyer.[57] However, this lack of funds does not preclude groups like the Nature Conservancy (TNC) or a local municipality acting as the buying agent and donating the right to the CWCB. This ability to buy and donate the right does mean the water right is relinquished and the donating group would not be able to sell back the right if the economic value of the water altered. However, given the aims of these groups, it is unlikely they would take that course of action, though the relinquishment has allegedly made the program less popular.[58]

In practice, though only the state can own ISF rights, anyone in Colorado may propose an appropriation. This proposal is done at the annual February meeting. Over the next year, staff analyzes the recommendations to assess resource value, hydraulic requirements, and whether the physical and legal water is available to meet those needs without causing material injury to existing water rights.[59] Notice is then given and public input is accepted for around 1 year. If deemed appropriate, the CWCB files for the ISF right in the relevant water court. In total, the CWCB process, as intended, takes up to 28 months to complete.[60] After filing for a right, it is up to the courts whether or not the right is perfected. Once the CWCB establishes or acquires a right, they actively seek to enforce it. This enforcement is done by reviewing potential injury to their rights by proposed transfers as well as installing and monitoring stream flow on critical reaches of the stream, seeking calls when appropriate.[61]

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54. Early on this was the focus of enforcement, since few rights were junior to the ISF, their limited resources were dedicated to challenging transfers. *See* Steven J. Shupe, *Colorado's Instream Flow Program: Protecting Free-Flowing Streams in a Water Consumptive State*, NAT. RESOURCE. L. CTR., UNIV. CO. SCH. L. 5 (1988) (the author accounts that through 1987, of the 100 transfers CWCB initially objected to, about half were altered to protect the ISF).

55. 1986 Colo. Sess. Laws 1095. The act also clarified the CWCB remains the only entity to lawfully own an ISF, but the ISF is enforceable by both the CWCB and the other party in the exchange; *see also* CWCB, *supra* note 22 (stating that Colorado is the only state where the donating party can retain enforcement rights).

56. *See* Bonham, *supra* note 9, at 1212-13; *see also* Boyd, *supra* note 21, at 1171-72.

57. Covell, *supra* note 18, at 203.

58. Boyd, *supra* note 21, at 1172.

59. Merriman & Janicki, *supra* note 53, at 2.

60. *New Appropriations Processing Timeline*, CWCB (2011), cwcb.state.co.us/environment/instream-flow-program/Documents/Appropriations/NewAppropriationsTimeline.pdf (illustrating the CWCB's appropriation timeline).

61. Merriman & Janicki, *supra* note 53, at 2 (detailing these two important tools that utilized subsequent to acquiring and appropriating ISF rights).

3. ACTIVITY AND IMPACT OF THE COLORADO INSTREAM FLOW PROGRAM

A. Data:

Data used to analyze Colorado's ISF program are all publicly available from the Colorado Division of Natural Resources. This data includes specific information from the CWCB on the ISF Program, GIS (Geographic Information Systems) data through the Colorado Decisions Support System (CDSS) website, information on water rights obtained through the Colorado Information Market Place, as well as surface diversion records through bulk download from Hydrobase, a data tool from the CDSS.[62]

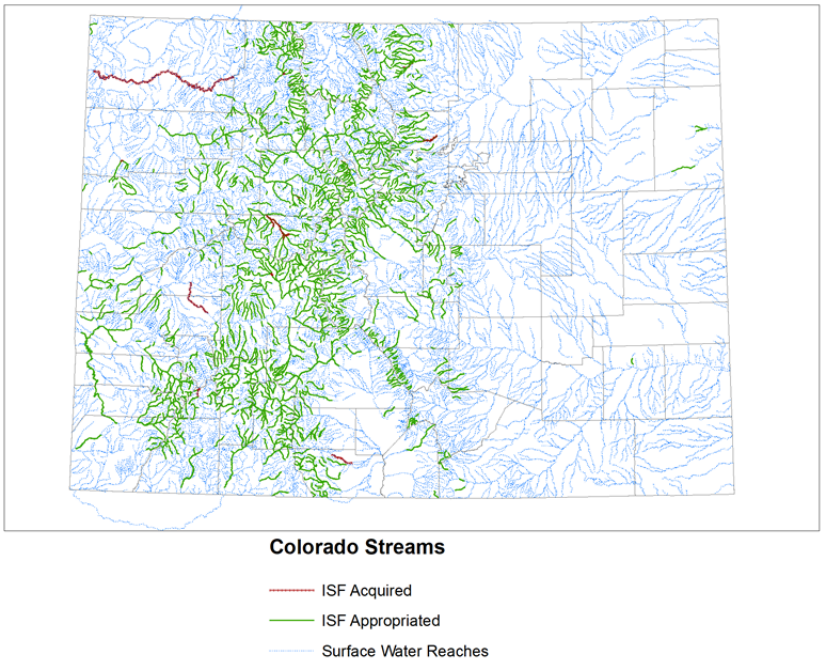

Figure 1: Map of Colorado Streams and Instream Flow Reaches. Map generated in ArcGIS from shape files of ISF reaches and streams in Colorado from the Colorado Decision Support Systems

B. Activity:

In terms of activity, the Colorado ISF program has been broadly successful in obtaining rights. In total, 10,291 miles of streams in Colorado are encumbered by some ISF right, constituting just under 20% of the stream miles in

62. *See generally Instream Flow Program*, CWCB (2018), http://cwcb.state.co.us/environment/instream-flow-program/Pages/main.aspx; *Geographic Information System Data*, CWCB CO. DECISIONS SUPPORT SYS. (2017), http://cdss.state.co.us/GIS/Pages/GISDataHome.aspx; *Water Right Net Amounts, Water Right Transactions, and Calls History*, CO. INFO. MKT. PLACE (2018), https://data.colorado.gov/browse?category=Water.

Colorado.[63] Figure 1 provides an overview of streams that have ISF rights. Notably, most of the rights are held in the more mountainous regions. This geographic pattern could arise because most agricultural production occurs in the Eastern plains, which remains the dominant use of water, making for higher opposition or prices for rights in these areas.[64] However, it is also true that headwaters, having fewer tributaries to feed in, are the streams that are exposed more to the risk of running low absent ISF rights. Furthermore, ISF rights are still dominated by appropriations, with relatively few stretches being protected by acquisition of more senior rights. Statewide, acquired rights constitute only 5 percent of CWCB's ISF portfolio in terms of miles protected.

As defined by the state, nearly one-quarter of the streams have some ISF right. Of those that do, on average about two-thirds of the length is protected. However, the mere presence of ISF rights within the priority system does not necessarily mean that the objective of protecting and enhancing the environment is being obtained. Figure 2 charts the number of new claims (rights) by year in Colorado distinguishing diversion surface rights from ISF rights. The number of ISF rights, independent of time, remains swamped by the number of diversion rights. ISF rights represent only 3.5 percent of total surface water flow claimed by surface diverters, most of which are quite junior. While the bulk of diversion claims harken back to the 19th century, the ISF rights predominantly carry priority dates of 1970 or later. The average ISF priority year is 1982 while the other surface rights come from 1933 on average. Some acquired ISF rights do date all the way back to 1859, but this is the exception rather than the rule.

63. *See* Table 2. For purposes of analyses, I have excluded instream rights that were granted to the US National Forest. These were established by *United States v. Denver*, 656 P.2d 1 (Colo. 1982) (stating that Federal Lands were afforded water rights necessary to achieve the purpose of the reservation with priority dates harking back to the date of the reservation). In the 303 of these in the Colorado records, all adjudicated in 1999, 1905 and 1907 are by the far the most common priority years. *Water Right Net Amounts*, *supra* note 62.

64. For instance, according to figures in the 2007 US agricultural census, though the eastern counties (those with some land east of the Rocky Mountains) contained just 57 percent of the farmland in Colorado, they produced 76% of the crop value. *See generally* MICHAEL R. HAINES, HISTORICAL, DEMOGRAPHIC, ECONOMIC, AND SOCIAL DATA: THE UNITED STATES, 1790-2002 (2010) (providing digitized data from 2007 U.S. Agricultural Census; this data was utilized for county tabulations). Meanwhile, the U.S. Geological Survey (USGS) reports that 87 percent of water withdrawals in Colorado went towards irrigation as of 2015. *See* Cheryl A. Dieter et al., *Estimated Use of Water in the United States in 2015*, USGS CIRCULAR 1441, 9 (2018).

Table 2: Summary of Colorado ISF Stream Miles

Variable	State Total	Stream Average	Stream Average ISF Streams Only
Miles of ISF	10,291.47	2.50	10.53
Acquired	533.34	0.13	0.55
Appropriated	9,758.13	2.37	9.99
Proportion of Stream Miles with ISF	19.30%	15.87%	66.99%
Acquired	1.00%	0.23%	0.98%
Appropriated	18.30%	15.64%	66.01%
Proportion of ISF Miles Acquired	5.2%	1.1%	1.1%
Observations	1	4,123	977

Note: Data tabulated from Colorado Division of Water Resources data and ISF rights includes decreed and pending claims. Acquired ISF miles include donations and purchases. Appropriated include new claims made by the Colorado Water Conservation Board. Streams are defined as DWR defines them in their database.

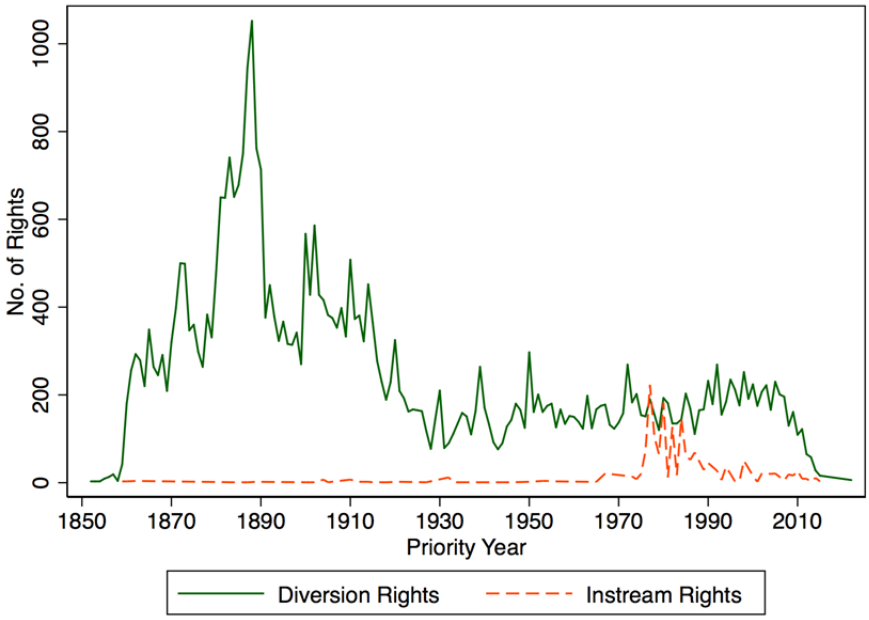

Figure 2: Total number of water rights claimed in a given year. Diversion rights include ditches, pipelines, and pumps and are based on the DWR net water right database.

C. Appropriated v. Acquired ISF Rights:

Roughly 94% of the observed ISF rights in Colorado are appropriated (see Table 3 below). While that process is open to all, it has been recently dominated by few. From 2011 to 2018 the Colorado Parks and Wildlife, the Bureau of Land Management, and the US Forest Service have made 95 percent of the

recommended appropriations (225).[65] For any given year, the average success rate (whether or not the recommendation is appropriated) is just around one-third, though many are recommended again, and ultimately 55 percent have been appropriated sometime before 2018.[66] This number may yet be low, as some denied in 2017 or 2018 may yet be appropriated. However, of those appropriated, nearly 90 percent do so on their first try.[67] The number of recommendations has been steadily growing over this time period, up from 26 in 2011 to 67 in 2018.[68]

The ability to acquire rights, granted in 1986, expands the ability to draw on market transactions and donations to reallocate water towards environmental protection and improvement. But this mechanism remains relatively underutilized. As seen in Table 2 above, only 5 percent of ISF rights are acquired. The activity in donations and acquisitions, shown in Figure 3, appears slow and steady, though a relative flurry of activity was seen in 2012-2014. But the rights that are acquired are generally superior to those appropriated on most dimensions. Summarized in Table 3, priority dates are nearly 60 years earlier for acquired rights, the amount of water claimed through acquisition is more than 50 percent higher, and the length of stream protected is a mile (or 17 percent) longer than appropriated rights. More acquisitions could be the primary tool to increase environmental quality rather than simply maintain the status quo and better enforce downstream senior rights. These deals, however, remain challenging and expensive.

65. Tabulation from the data from 2011 through 2018. *See generally Instream Flow Appropriations*, CWCB, DEP'T NAT. RESOURCES, http://cwcb.state.co.us/environment/instream-flow-program/Pages/InstreamFlowAppropriations.aspx (last visited Mar. 2018).

66. *Id.*

67. *Id.*

68. *Id.*

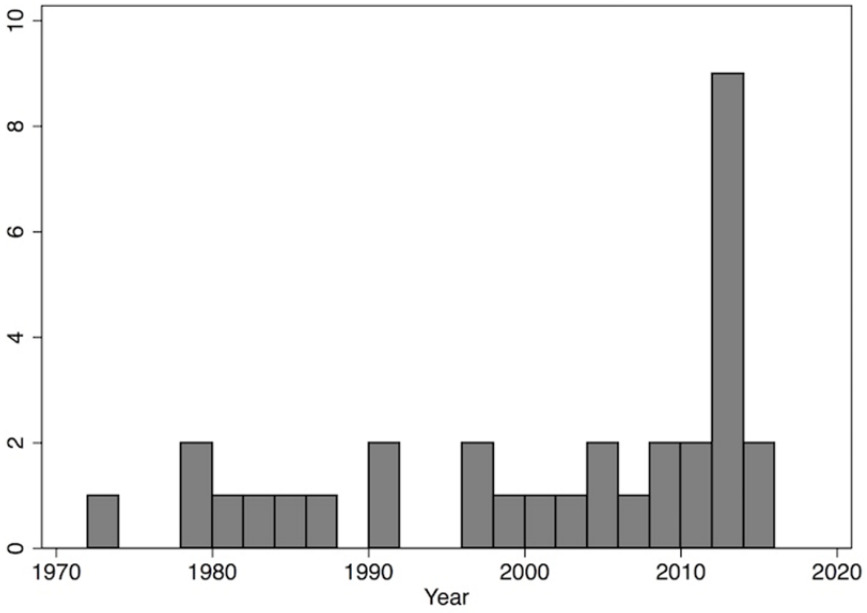

Figure 3: Timing and frequency of the number of ISF acquisitions since 1973 including leases. Bars represent 2-year periods. Tabulated from http://cwcb.state.co.us/environment/instream-flow-program/Pages/CompletedTransactions.aspx

Table 3: Acquired and Appropriated ISF Rights

	Mean		Difference
	Appropriated	Acquired	
Priority Year	1986	1928	57.69 ***
Cubic-Feet per Second	9.63	15.70	-6.08 *
Lower Terminus Mile	18.98	15.53	3.45
Length (miles)[a]	6.16	7.23	-1.08 *
Observations	1601 to 1610	79 to 99	

Note: Data tabulated from Colorado Water Division Resources data on all ISF rights. [a]Includes decreed and pending ISF claims. Observations vary based on availability of the variable being analyzed. *** p<0.01, ** p<0.05, * p<0.1

With many of the acquisitions coming from donations, the court documents do not reveal the expenses involved.[69] However, two cases' court documents do provide a glimpse of the costs. In one, the Colorado Water Trust

69. *Instream Flow Program: Completed Transactions*, CWCB, DEP'T NAT. RESOURCES, http://cwcb.state.co.us/environment/instream-flow-program/Pages/CompletedTransactions.aspx (last visited June 2017) (providing information on completed acquisitions, including court documents). The author thanks his research assistant, Tomas Matias, for diligently reading all the available court documents.

(CWT) sought to acquire 5.45 cubic-feet per second (CFS) on Washington Gulch in 2010. The price tag was $400,000 for the water right itself while transaction costs (CWT time, counsel, consulting, etc.) tallied $80,000, or 20 percent of the price.[70] The CWCB was requested by the CWT to reimburse $335,000 of the total expenses.[71] In the other case with documented price information, TNC and the CWCB combined forces to purchase 1 CFS on Boulder Creek in 1978. Though not as meticulously accounted for, the contract stipulated that the state pay the owner of the water right $7,500 and the TNC $8,500 of which the TNC would pay $7,000 to the original right holder.[72] While not explicitly stated, the arithmetic implicitly suggests the water right cost a total of $15,500 while $1,500 (or 10 percent) covered some transaction costs. Perusal of other court documents did not provide additional information in the way of prices and transaction costs. However, the process of selling or donating a water right for ISF protection can be costly and there is "evidence that both the real and perceived burdens of the administrative process in California and Colorado have been significant obstacles to the transactional work in these states."[73] In time alone, the prior 8 long-term transactions in Colorado took 6.52 years on average (about 4 years with the CWCB and 2.5 years in the water courts).[74]

The state is advancing more ways to create a more active and short-term market. In lieu of donating a water right, diversionary rights can be leased to the CWCB in the short- and long-term. In 2004, the legislature approved that owners of agricultural water rights could loan them to the CWCB for the irrigation season, affording appropriators a way to protect their right in times of non-use.[75] At the time of writing, the CWCB holds 9 long-term leases and 11 short-term leases or active loans.[76] The loans remain relatively restrictive in that they can only be loaned 3 out of 10 years and can only be utilized in a location with an existing ISF decree.[77]

Outright acquisitions remain rare on account of the expense, particularly in transaction costs, meaning most ISF rights in Colorado remain relatively junior.

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70. Memorandum from the CWCB, Bd. Meeting, Stream and Lake Protection Section, Proposed Water Acquisition on Wa. Gulch and the Slate River (Jan. 26-27, 2010), http://cwcb.state.co.us/environment/instream-flow-program/Documents/WaterAcquisitions/BreemDitch/January/Breem%20FINAL%20signed%20Board%20Memo%20JAN%202010.pdf.

71. *Id.*

72. CWCB, CONTRACT WITH TNC FOR THE PURCHASE OF G. BERKLEY DITCH (1978), http://cwcbweblink.state.co.us/WebLink/DocView.aspx?id=62217&page=1&&dbid=0.

73. SZEPTYCKI ET AL., *supra* note 20, at 18.

74. *Id.* at 28.

75. S.B. 04-032, 64th Gen. Assemb., 2d Reg. Sess. (Colo. 2004) (enacted). The loan may only be made during the irrigation season (up to 180 days) during three out of ten years, precluding this as a long-term strategy to maintain ownership during extended periods of non-use. COLO. REV. STAT. § 37-83-105 (2012).

76. Long-term loans are listed along with the completed transactions: Information on completed acquisitions, including court documents, is available from the CWCB website. CWCB, *supra* note 69. While short-term leases and loans are listed here: CWCB, INSTREAM FLOW PROGRAM: TEMPORARY LOANS AND LEASES OF WATER RIGHTS FOR INSTREAM FLOWS http://cwcb.state.co.us/environment/instream-flow-program/Pages/TemporaryLoansWaterRightsInstreamFlows.aspx (last visited Dec. 2018).

77. SZEPTYCKI ET AL., *supra* note 20, at 27 (discussing these obstacles).

On paper then, the program would appear to have accomplished very little in directly reallocating diversion rights to instream uses. However, the ability for the state to claim property rights to instream flows, even junior ones, may still have an impact on diversions. As mentioned above, the claims may: 1) deter future diversions, 2) prevent upstream transfers that would reduce flows, and 3) cause upstream junior diverters to curtail diversions. The next sections consider whether the presence of ISFs dissuades other potential claimants from new diversions, blocks other market transactions, or impacts the amount of water being diverted upstream.

D. New Diversion Claims:

If staking a claim now to an ISF right prevents a future diversion from occurring, the ISF is effective in maintaining minimal flows. Because decisions to not divert water are not observed, indirect evidence is necessary to compare claims on ISF-encumbered streams to streams where ISF rights are not present. Figure 4 plots the average total flow claimed on a stream by year bifurcated by whether or not an ISF right is ever present on that stream. Activity on both types of streams has fallen off since the 19th century, but it is also notable that the ISF streams generally have more water claimed. This is suggestive that ISF rights are being deployed and claimed where there is more competition for water.

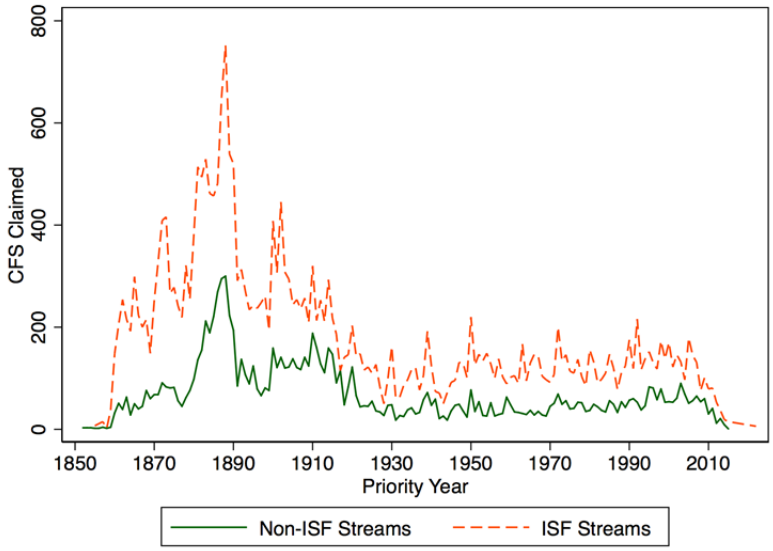

Figure 4: The total CFS claimed on a given stream by year, calculated separately for streams that eventually have an ISF right and for those that do not. Tabulations based on the DWR net water right database.[78]

Little more can be gleaned from the visualization of the rights. Instead, the use of a regression framework helps to explain the relative level of activity of water rights on post-1973 at the stream-year level. Regression analysis provides a way to analyze the data with statistical precision. This application draws upon a difference-in-differences (DiD) framework to estimate what claims would have occurred had the stream not been encumbered by an ISF. Inherently unobservable, the DiD framework essentially estimates how much more or less eventual ISF-streams experienced new claims in a given year than non-ISF-streams for the period before ISF rights were established. The difference is then estimated between the two types of streams for the second period when ISF rights could be established. It is the difference in these two differences that is used to estimate the change in new claims associated with the presence of ISF rights. For this to be a causal estimate (i.e. the ISF rights caused the change), one must assume that whatever the initial difference in claims was before ISF rights would have remained the difference if not for the ISF rights. The regression framework helps with this assumption as it allows the estimates of the differences to be adjusted for other factors that could explain them, making the assumption more plausible.[79] Specifically, the estimating equation is:

78. This database is footnoted at the beginning of the data explanation in footnote 62. COLO. INFO. MKT. PLACE, *supra* note 62.

79. *See* JOSHUA D. ANGRIST & JÖRN-STEFFEN PISCHKE, MOSTLY HARMLESS ECONOMETRICS: AN EMPIRICIST'S COMPANION ch. 5 (Princeton Press 2008) (discussing an explanation); *see also* David Card & Alan B. Krueger, *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania*, 84(4) AM. ECON. REV. 772, 772-93 (1994) (detailing an earlier application of the methodology).

$$Claims_{iy} = \alpha + \beta_1 ISF_i \times PostISF_y + \beta_2 ISF_i + \beta_3 Post1973_y + \beta_4 Agg\_claims_{iy-1} + \beta 5(Agg\_claims_{iy-1})^2 + \varepsilon_{iy}$$

Claims are measured both by the number of new claims and the total additional CFS claimed on a stream in a given year.[80] β_1, the coefficient for an indicator for a stream that receives an ISF and that the observed year is after its first ISF right (sometime after 1973), is the coefficient of interest, capturing the relative change after 1973 on these streams to the change on non-ISF streams. To capture other general forces such as supply and demand for water from that stream, a second-order polynomial of the total amount of existing claims on the stream is also included. The results, using years 1882-2017, are provided in Table 4. In contrast to Figure 4, ISF streams, in general, attract less activity once conditioned on prior activity. Both in terms of the number of claims and the amount of water claimed, streams with ISF rights after the establishment of that right are relatively less active than streams without ISF rights.[81] Meanwhile, post-1973, there is a general uptick in activity for non-ISF streams. This rise in activity is suggestive that while diversion rights were increasingly likely to be claimed after 1973, they were done so mostly on non-ISF streams. As cautioned above, this empirical framework does not necessarily establish causality; the ISF right may not have caused the decline. It could be that the CWCB targeted areas already waning in activity due to reduced opposition. However, the results are consistent with the story that ISF rights could be effective by dissuading future diversions.

80. The most commonly observed claim is zero. Accordingly, for the number of claims, which is count data, a poisson model is utilized. For the total CFS claimed, a continuous variable, a tobit model is utilized to account for the many zeros.

81. Limiting the sample to include only 1930 through 2005, which removes the early influx of rights seen to be more expansive on eventual ISF streams in Figure 4 and the precipitous falloff near 2010, the point estimates remain similar and statistically significant.

Table 4: New Claims on Surface Streams in a Year

VARIABLES	(1) No. Claims	(2) CFS Claimed
ISF Stream x Post ISF	-0.371**	-27.18***
	(0.154)	(9.689)
ISF Stream	-0.857***	-40.19***
	(0.0870)	(10.85)
Post 1973	0.581***	33.55***
	(0.0769)	(11.42)
Observations	229,160	229,160
Pseudo R-squared	.	0.027
Wald Chi^2	3128.4	.
Streams (clusters)	1,685	1,685

Note: Coefficient estimates of the number and flow of new diversion rights on a stream in a given year. Number of claims is estimated by a poisson model, CFS claimed is estimated by a tobit model. ISF claims themselves are excluded. ISF Stream indicates the stream eventually has an ISF right on it. Post 1973 is an indicator for when the ISF program was available. ISF Stream x Post ISF is after the stream received its first ISF right. Additional controls not shown consists of the aggregated lags of the dependent variable and that variable squared. Standard errors, clustered by stream, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

E. Impeding Upstream Transfers:

Another way in which ISF rights may be effective (and as some senior right holders feared) is to block upstream transfers that would reduce the flow in the section of stream between the parties of the transaction. In this manner, they can be effective despite being generally junior and unable to reduce existing diversions. Prior to being able to acquire senior rights, most of the CWCB's efforts were on this front.[82] Going back and looking at more court cases could update the propensity of CWCB to thwart transfers as well as their relative success, but this would miss any transfers that were never attempted given the additional hurdle of navigating the ISF right. So again, the raw transaction data is used to assess if the presence of an ISF impacts the propensity to see an upstream transaction. In particular, it is helpful to consider the number of transactions bifurcated by whether the transaction is up or downstream and whether the buyer is above an ISF lower terminus. Essentially, this employs a DiD framework by comparing how the

82. Shupe, *supra* note 54, at 11-12.

difference between upstream and downstream transfers is different when the buyer of the right is or is not above an ISF right. If the ISF right is reducing upstream transfers, there should be relatively fewer upstream transfers observed where the buyer is above an ISF right.

The frequencies are presented in Table 5. Notably, the sample, which is limited to surface water transactions, across time reduces to around 5,000 non-ISF transactions.[83] Given 62,000 surface water right records and over 160 years of possible trades, this number generally speaks to the low level of market activity in the water market.[84] Overall, more transfers do move downstream. But more to the point at hand, the propensity to make an upstream transfer does not differ whether or not there is intervening ISF reach. When the buyer is below the ISF, 37 percent of transfers are upstream, when the buyer is above an ISF, it is also 37 percent. Therefore, there is little evidence the ISF right adds much in the way of blocking upstream transfers occurring beyond what other intervening right holders block on other stretches of streams. Thus, on this metric, there is little evidence that ISF rights decrease the propensity for upstream transfers despite their documented efforts.[85] Though the ISF rights may not decrease the propensity to transfer upstream, they still do actively exercise their right to non-injury by negotiating terms and conditions to protect their rights in over 99% of the cases it enters without blocking transfers entirely.[86]

83. Without a clear category for "surface", the author keeps structure types "Ditch", "Ditch System", "Pipeline", "Reservoir", and "Minimum Flow", removing structures like "Wells", to proxy for surface water rights. Once the adjudication type is limited to "TT" (or "transfer to"), the number of non-ISF transfers is 5,238. For location analysis, the sample is reduced to 4,809 due to lacking location data. Data on transactions and rights are contained in the data set. *See* CO. INFO. MKT. PLACE, *supra* note 62.

84. *Id.*

85. It is also feasible that rates of upstream transfers happened to be higher on ISF sections prior to their appropriation or acquisition and the CWCB efforts brought this down to equal upstream transfers elsewhere. Transfer dates were not uniformly coded making a more detailed analysis to assess this possibility prohibitively costly in terms of time to seek out court documents on the 4,809 transfers.

86. Merriman and Janicki (2005) report this 99% figure. Merriman & Janicki, *supra* note 54. It is considerably higher than "half" that Shupe (1988) reported earlier in time. Shupe, *supra* note 55, at 15. Shupe details the other half, with 31 of which the CWCB determined injury was minimal and did not accrue additional expenses to seek protection, 10 others were withdrawn, and the remaining 12 were determined to be initiated prior to the ISF establishment, giving them no legal standing. *Id.*

Table 5: Frequency of Surface Right Transfers in Colorado

		Buyer Position from ISF		
Transfer Direction		**Above**	**Below**	**Total**
Down Stream				
	Number	2,142	894	3,036
	Percent	63.19	63.00	63.13
Upstream				
	Number	1,248	525	1,773
	Percent	36.81	37.00	36.87
Total				
	Number	3,390	1,419	4,809
	Percent	100.00	100.00	100.00

Note: Data tabulated from Colorado Water Division Resources data on all water right transfers bought by ditches, pipelines, and reservoirs (excluding, for example, well permits). Buyers are considered above an ISF if they are above the lower terminus.

F. Upstream Diversions:

The presence of an ISF, either through calls directly or better enforcement of all downstream rights with the improved monitoring, could impact diversion rights by actually reducing the amount diverted, particularly upstream from the ISF. To assess this, all available annual diversion records from 1970 through 2015 for each surface diversion available was collected. The annual totals, bifurcated by non-ISF and ISF streams, are shown in Figure 5. Over this time period, not only did ISF streams divert considerably more water, the trend was also increasing. Meanwhile, diversions on non-ISF streams have remained nearly constant. However, the location of diversion within a stream could have been impacted even while the stream totals increase. For this reason, a regression framework is necessary to test the how diversions changed for surface diverter above and below the ISF lower terminus once the ISF right was established. It is another application of the basic DiD framework utilized above, this time meant to create a credible counterfactual for how diversions upstream of an ISF would have looked had the ISF right not been acquired or appropriated.[87]

87. Priority dates are utilized for establishing the timing of the ISF right unless the right was acquired. In that case, if the priority date is prior to 1973, I give the right a 1973 implementation. Though the actual date of the transaction is preferred, I have not located this information for all transactions. To the extent the date is too early and there is an impact, this assumption will bias the result towards zero. In addition, the results are robust to excluding the acquired rights.

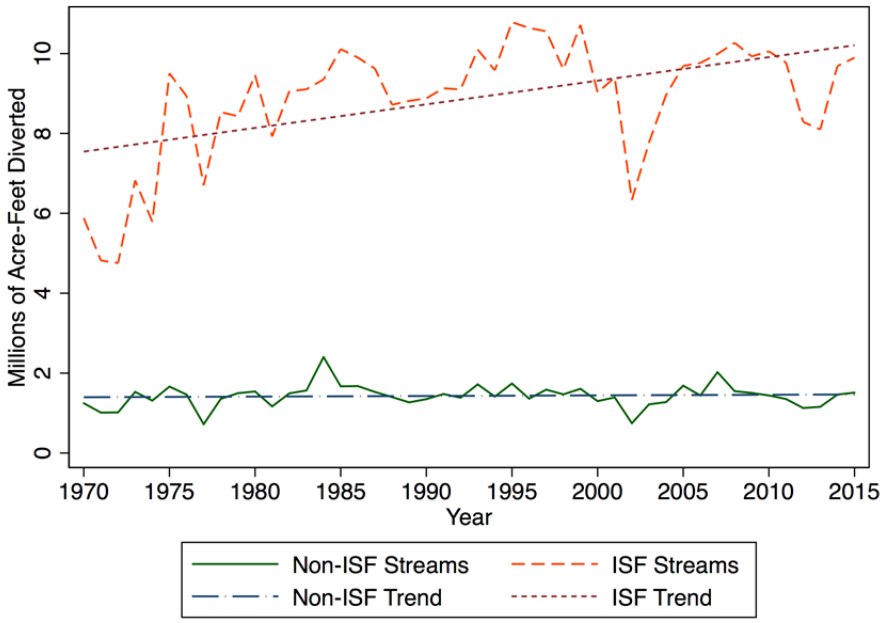

Figure 5: Total acre-feet diverted by year from ISF streams and non-ISF streams. Data comes from a bulk download of monthly diversion records for all surface diversion structures using the CDSS's Hydrobase tool.

The specification in this instance is:

$$\ln(AF)_{dsy} = \alpha + \beta_1 upstream_d \times ISF_{sy} + \beta_2 upstream_d + \beta_3 ISF_{sy} + \beta_4 Date_d + \beta_5 CSF_d + \tau + \varepsilon_{dsy}$$

Diversions are measured in acre-feet and the log transformation allows for the estimated coefficients to be interpreted more as percentage changes in diversions.[88] The sample is limited to streams that have at least one ISF right. The indicator variable $upstream_d$ is of the ISF right. ISF_{sy} is an indicator for whether or not the stream has an ISF right active in that year. Hence the interaction term $upstream_d \times ISF_{sy}$ is equal to one for a diversion point upstream after the ISF right goes into effect and the coefficient on this variable is the main estimate of interest because it captures how the difference between diversions upstream and downstream of an ISF right change after the ISF was established. For additional controls, the total flow claimed and the priority year (mean weighted by relative share of total water right in the case of multiple rights) are included. A row vector

88. A log transformation can convert non-linear data transformed into linear data. In other words, rather than treating a reduction in diversions of 1 AF the same for a ditch that diverts 5 AF on average as for a ditch that diverts 100 AF on average, the log transformation adjusts so that the former reduction is treated as a larger reduction. Mathematically, for a log-level regression, a coefficient β indicates that for a 1 unit change in independent variable, the percent change of AF diverted is equal to $100 \times (e^{\beta} - 1)$. When β is small (between -0.1 and 0.1), the coefficient itself is a good approximation for the percent change of AF diverted. Below in the text I convert the coefficients from the table to the percentage change in AF diverted.

of year indicators, , and their coefficients are included to absorb statewide climactic trends that would influence diversions at all diversion points in a given year. Also included, in an alternative model, are ditch level fixed effects, which account for all time-invariant factors that influence diversion totals, including volume claimed and priority date.[89] Finally, another specification includes an indicator for a diversion right that is junior to the ISF right on the stream and all relevant interactions to make a triple-difference. This approach identifies whether diversions for junior appropriators upstream from an ISF right change distinctly from how upstream senior appropriators are impacted following the implementation of the ISF right, but identification of the triple interaction is limited to the instances when rights acquired.

The results, found in Table 6, indicate that ISF rights *do* alter the upstream/downstream portfolios of actual diversions. On average, upstream diversion points divert 30 percent more water than downstream diverters on average. However, post ISF, downstream diversions divert an average of 72 percent more while upstream diverters see no statistical change. But while the extent and date of the water right significantly predict diversions, there remains a plethora of factors that may impact diversions and may very well correlate with placement and timing of ISF rights. For this reason, I prefer the fixed-effect model where the estimates are based only on within ditch variation. Presented in specification (2), these estimates suggest that diversion points below an ISF right see their diversions increase by 8.4 percent. Relative to this increase, upstream from the ISF right, diverters receive 15.7 percent less water (suggesting an absolute decrease of 7.3 percent). So, while diversions on average may not have changed, less water is being diverted upstream and more is being diverted downstream, consistent with the program actually increasing the instream flow through the stretches being targeted. This reduction of upstream diversions is despite many of the ISF rights being relatively junior. As seen in specifications 3 and 4, the effect is similar for those that are senior to the ISF right to those that are junior, though data and the empirical design make this distinction difficult to estimate.[90] Regardless, the bulk of the effect is experienced by rights that are senior to the ISF right, which is surprising given that they should receive their water before the junior ISF right is satisfied.

89. The ditch fixed-effect limits the identification of the coefficients to only within-ditch variation. More concretely, the inclusion of the ditch level fixed effect essentially converts all the other variables to deviations from the ditch average. In this model, β_1, the coefficient of interest, captures how much more or less water is diverted at a given ditch compared to the average amount it diverts over time once an ISF right is established downstream (in percentage terms due to the log transformation). Because this limits identification to deviations from the ditches average, any variable that does not deviate from that average is no longer identifiable, such as volume claimed and priority date. The benefit, however, is absolutely everything that does not change over time (whether data is available for it or not) is now controlled for.

90. Overall, only 8 percent of diversions are junior to an ISF-right and even fewer that were active prior to the ISF implementation (where they would have been subject to same ISF right in its prior diversion form), meaning the sample is somewhat small and difficult to estimate, hence the large standard errors.

Table 6: Acre-Feet Diverted by Ditches (1970-2015)

VARIABLES	(1) Acre-Feet (logged)	(2) Acre-Feet (logged)	(3) Acre-Feet (logged)	(4) Acre-Feet (logged)
Junior x Upstream x Post ISF			0.0502	0.0236
			(0.250)	(0.187)
Upstream x Post ISF	-0.524***	-0.146***	-0.515***	-0.146***
	(0.0792)	(0.0431)	(0.0785)	(0.0431)
Post ISF	0.547***	0.0802*	0.539***	0.0803*
	(0.0780)	(0.0422)	(0.0773)	(0.0422)
Upstream	0.255***		0.256***	
	(0.0740)		(0.0742)	
Junior to ISF			0.229	
			(0.415)	
Junior x Upstream			-0.288	
			(0.478)	
CFS right	0.00161***		0.00160***	
	(0.000327)		(0.000327)	
Priority year	-0.00793***		-0.00795***	
	(0.000706)		(0.000793)	
Constant	20.35***	5.388***	20.40***	5.387***
	(1.352)	(0.0342)	(1.516)	(0.0351)
Observations	244,638	244,710	244,638	244,710
R-squared	0.051	0.049	0.051	0.049
Ditch Fixed Effects	No	Yes	No	Yes

Note: Coefficient estimates regressing annual acre-feet (logged) diverted by surface water users, primarily irrigation ditches but also those using pipelines and pumps, 1970-2015. Post ISF is an indicator equal to one if the stream has an ISF established prior to the observed year based on the adjudication date. Upstream is an indicator equal to 1 if a ditch is below the lowest ISF terminus. Junior is an indicator equal to 1 if the ditch has a priority date that is junior to the first ISF priorirty year on the stream. CFS right is the ditches cumulative decreed flow water right. Priority year is the ditches average priority year weighted by the amount of water assoiciated with each year. Year fixed effects are suppressed. Robust standard errors, clustered by wdid, in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This reduction of upstream diversions is an unexpected result. In detailing the Colorado ISF Program, researchers Dan Merriman and Anne M. Janicki explicitly state that "new instream flow appropriations cannot affect or impact existing uses on a given stream."[91] Absent the ability to directly curtail senior water users upstream, the observed reduction must come through different channels.

91. Merriman & Janicki, *supra* note 53; *see, e.g.*, SZEPTYCKI ET AL., *supra* note 20; *see also, e.g.*, Sterne, *supra* note 18, at 216.

Though seemingly unaware of the possible influence, Merriman and Janicki identify a possible mechanism: "The CWCB provides physical protection for decreed instream flow rights by installing stream gages and monitoring stream flow on critical reaches of the stream."[92] Notably, monitoring and enforcement are not uniformly sought across all states with ISF rights, but Colorado is among the best.[93] It is not always financially feasible to install and monitor gauges on all water rights; some states, such as Idaho, rarely monitor flows.[94] Even in Colorado, costs prevent complete monitoring and the CWCB partners with others, like the USGS, to measure streams throughout the state.[95] Because the ISF rights are seldom in a position to place a call (where a senior appropriator demands upstream juniors cease diversions), the reduction in upstream diversions, then, suggests that better measurement and enforcement due to the presence of ISF rights may simply be enforcing the existing relative rank of the diversion rights, forcing those junior to downstream appropriators to reduce their (unlawful) diversions, ultimately providing more water for downstream diverters.

Data on gauges and calls can be considered to partially corroborate the theory that ISF rights have induced stricter imposition of existing rights, and thus partially explain why even senior rights may reduce diversions once the ISF right is present. First, shown in Figure 6, the number of gauges added to Colorado streams begin a marked increase right around 1973, now with over 1,000.[96] Of those gauges now in place, only 30 percent were present in 1973 and 40 percent have been placed since 2000.[97] Furthermore, the density functions (capturing the observed probability of when gauges were likely to go in on that type of stream), shown in the same figure, further indicate that while non-ISF streams and ISF streams below the ISF saw an uptick in new gauge placement, the areas above ISF rights have a greater proportion of monitors appear after 1973.[98] This correlation indicates that ISF appropriations are closely followed by new gauges to monitor and enforce that right. The additional gauges may have resulted in better enforcement of existing downstream rights, helping to explain why upstream diversions that are senior to the ISF right reduced their diversions as was found to be the case above. As supportive evidence, shown in Figure 7, there was a remarkable increase in the propensity to enact calls after 2000, particularly on streams with ISF rights. The number of calls seemingly parallels the growth in the number of stream gauges (also shown in Figure 7).

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92. Merriman & Janicki, *supra* note 53.

93. Colorado, Kansas, Montana, Oregon, and Washington are among the better monitored enforced systems according to CWCB (2005). *See generally* CWCB, *supra* note 22; *see also supra* Table 3.

94. *See* CWCB, *supra* note 22, at 26.

95. *Id.* at 29.

96. Gauge data is from the Colorado Market Place Data center, limiting structures to those that are either "Stream Gage" or "Measuring Point." *See supra* Figure 6; *see also Data by Category*, CO. DECISION SUPPORT SYS., http://cdss.state.co.us/GIS/Pages/AllGISData.aspx (last updated 2017) (containing additional, downloadable data for when records started).

97. *See supra* Figure 6.

98. The Colorado Data Set only provides stream location for a subset of gauges (477), limiting the analysis to this subset. There is no statistical distinction between the timing of gauges with and without location data, consistent with the subsample being representative of overall activity. *Id.*

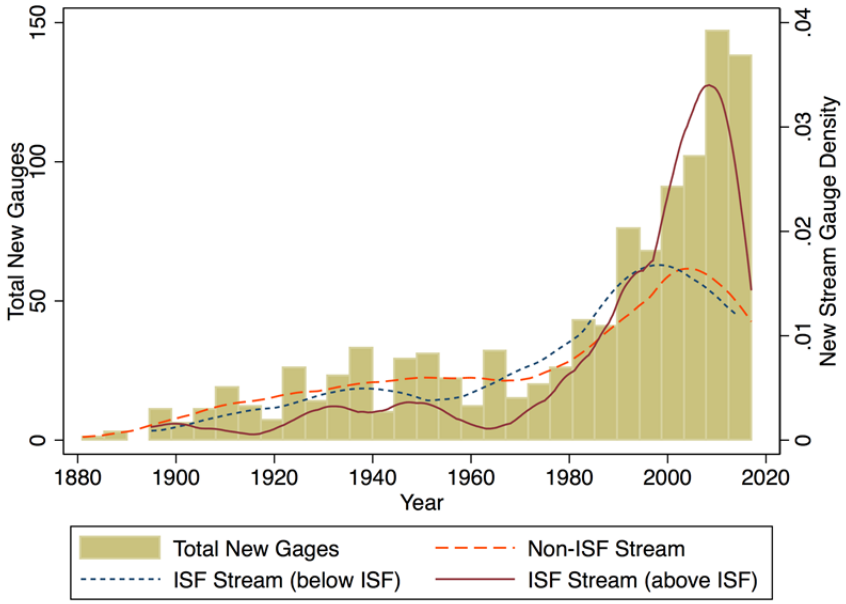

Figure 6: Stream Gauge Timing and Location.

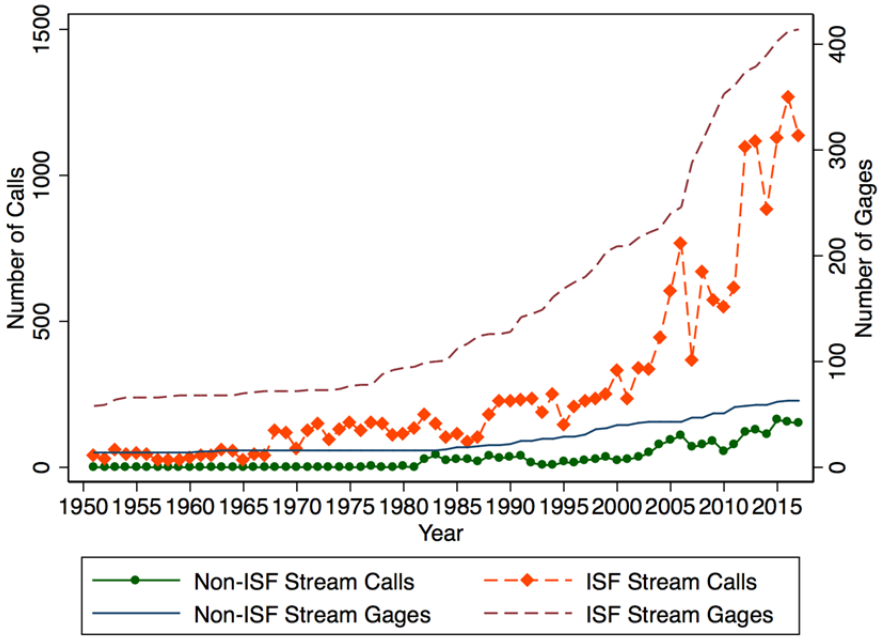

Figure 7: The number of formal calls made on streams each year according to call records from the Colorado Information Market Place and the total number of gauges for those with location data.

While the graphical evidence is strong, statistical support can be provided by running Poisson regressions for the number of gauges and the number of calls placed on a given stream in a given year.[99] Once again, the DiD framework is utilized. The equation estimated is similar to the one utilized above to estimate the change in new diversions. The $ISF_i \times PostISF_y$ interaction term indicates the stream is an ISF stream and it is after 1973. The estimated coefficient for that variable captures the change after 1973 for the difference in the average number of new gauges (or calls) between streams eventually encumbered by an ISF right and streams that remain unencumbered today.

As presented in Table 7, after controlling for the extant number of gauges on stream, there is a greater proclivity to place new gauges on ISF streams after the ISF right established even beyond the increased likelihood ISF streams have to begin with and the general increase after 1973. Results for the number of calls placed on a stream in a given year are presented in column (2). As an additional control, the total number of CFS claimed on that stream is included, as more claims are expected to independently increase the number of calls of placed. Because ISF streams do tend to have more claims, this actually removes the gap in calls that appears in the raw numbers shown in Figure 7. But there remains a large uptick post 1973 and ISF streams experience even more calls following the appropriation of the ISF right. Given the slowdown in new diversion claims on these streams, the relative increase in calls are unlikely driven by a proliferation of new junior diversion that did not earlier exist.

The CWCB may not typically be in a position to make a call (placing only 9 and 7 in 2017 and 2016 respectively)[100], but ISF rights and their correlation with gauges, calls, and reduced diversions provide strong suggestive evidence that investment by the CWCB in protecting ISF rights indirectly influences diversion patterns by providing better measurement for all water right holders. It could be argued that the state should already be monitoring and enforcing existing rights, but the fact remains that enforcement is costly and prohibitively so to enforce perfectly. Therefore, the state's interest in protecting its own right can make it more worthwhile to invest in monitoring, meaning the property right claim provides external benefits to other claimants and incidentally protects the ISF right as well by increasing downstream water deliveries.

99. A Poisson model is utilized because the outcome variables are count variables (non-negative whole numbers), meaning the data likely come from a Poisson distribution.

100. Tabulated from 2018 CWCB data. *See Instream Flow Administrative Calls,* CWCB, DEP'T NAT. RESOURCES, http://cwcb.state.co.us/public-information/instream-flow-administrative-calls/Pages/main.aspx (last visited Aug. 5, 2018).

Table 7: Monitor Installation and Calls

VARIABLES	(1) Gauges	(2) Calls
ISF Stream x Post ISF	0.477**	2.364***
	(0.201)	(0.458)
ISF Stream	1.716***	-0.508
	(0.355)	(0.445)
Post 1973	1.337***	4.196***
	(0.291)	(0.700)
Total Gauges	0.272***	
	(0.0115)	
Total Gauges^2	-0.00223***	
	(0.000134)	
CFS Claimed		0.000405***
		(0.000118)
Constant	-8.658***	-8.382***
	(0.334)	(0.699)
Observations	287,912	112,895
Chi-Squared	2,777	104.5

Note: Regression estimates for the number of new gauges and calls placed on a stream in a given year. Estimates are from a Poisson model. Gauge data is from 1881 to 2017, Calls go back only to 1950. ISF claims are not included. ISF Stream indicates the stream eventually has an ISF right on it. Post 1973 is an indicator for when the ISF program was available. ISF Stream x Post ISF is after the stream received its first ISF right. Standard errors, clustered by stream, in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

CONCLUSION

Although private involvement and market activity remains low, by leveraging the existing water right structure in Colorado the CWCB has been able to appropriate and acquire a number of rights that appear to be delivering on providing protection of ISFs. The evidence suggests that placement of these rights correlate with reducing new diversionary claims while appearing to not impose to a greater degree on upstream transfers beyond other water right holders potentially injured.

Surprisingly, given the overall junior status of the ISF rights, actual diversions upstream from a newly appropriated or acquired ISF right do decline on average. The evidence suggests that this is because the state has stepped up its enforcement of these rights when possible, but also their presence may have also induced other parties to make calls given better information about the state of the stream and its flow. Together, these outcomes suggest that the state is delivering on protecting the stream ecological systems acting within the existing prior appropriation doctrine, though a portion of the protections stems not so much from the ISF right itself, but the investment to monitor and enforce that right.

Still, none of this claims the CWCB is securing the efficient outcome. Acquired rights remain superior in many dimensions and these acquisitions remain relatively rare. Whether or not private involvement would improve on any shortcomings is not immediately clear, as private parties can currently (and have) secure a water right and then donate it to the CWCB. The downside is that the private party can no longer sell this back to another use should the value of that right become larger in a different use by a different user. Notably, the CWCB is generally also in charge of water development, so it could theoretically sell back an ISF if it appeared economically prudent, though politically this would likely meet considerable opposition.

The CWCB and Colorado should continue to work to make the water market function better overall so that water can find the highest value, be it ISF or development. The evidence suggests that the state has been active in acquiring and enforcing ISF rights, giving a glimpse of what property-rights can do for the environment. The experience in Colorado indicates that the transaction costs and funding for ISF acquisition and appropriation are high, but that a state can vigorously defend their ISF rights from injury, stymie future diversions, and even impact the pattern of existing senior diversions through better measurement and enforcement of existing rights.