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Utilizing the Washington Water Markets for the Preservation of Columbia River Basin Salmon Stock

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Abstract:

Salmon preservation efforts in Washington State demonstrate the competitive and interconnected nature of water management issues in a water scarce environment. The decline in stream flows in Washington State and the negative impact of low stream flows on anadromous species has severely hindered rehabilitation of endangered Columbia River Basin salmon stocks. Through examining the National Marine Fisheries Service (NMFS) anemic efforts to preserve endangered stocks, primarily through the Endangered Species Act, and through analyzing the Washington Department of Ecology's (DOE) regulatory structure for water market transfers, I propose several changes in the regulatory structure for water that may positively impact the preservation of Columbia River Basin salmon stocks. Decentralizing DOE regulatory authority to enable local water basin planning groups to approve water transfers will decrease transaction costs and improve security of water rights. In turn, programs such as the Washington Water Trust and the incentive based Water Acquisition Program will encourage water rights holders to divert less water from the river. Also, the development of an options market for water transfers will provide further security for water rights holders and will eliminate the need for the antiquated use it or lose it clause. These improvements to Washington State's water markets will help salmon preservationists by easing the process with which the Washington Water Trust can purchase or lease water for in-stream use.

(I) Introduction

Washington State and the majority of the American West have water scarce environments. Cities and farmers, public utility districts and environmentalists alike share an overlapping and competitive interest in the limited water available. Salmon preservation efforts in particular demonstrate the competitive and interconnected nature of water management issues in a water scarce environment. A recent Seattle Times article entitled "Fish to Survive Dam Plan, Agency Says," highlights the multiplicity of competing interests in which the government mediates. As Associated Press writer Jeff Barnard illustrates, managers of dams such as the Bonneville Power Administration must consider the impact of dams on salmon habitat, salmon runs, salmon predation, etc (2007). In effect, all interests in the available water in Washington State must respond and work within a regulatory quagmire of agencies which have competing interests and goals. Ultimately, parties with an interest in water, salmon preservationists and public utility districts alike, accept concessions which may dilute or undermine their goals.

Given the endangered status of Columbia River Basin salmon stock and the negative impact of declining stream flows in Washington State, there is an increasing need to find viable ways to protect these stream flows while preserving the rights of competing water users. The development of a more effective water market in Washington State could secure increased stream flows for salmon preservation while protecting the rights of water property rights holders. The Washington Department of Ecology's (DOE) complete regulatory control over water transfers, insecurity of water rights, and antiquated legal requirements on water rights are major barriers to the salmon restoration efforts in the Columbia River basin. The development of water markets in Washington and improvements in the regulatory structure of the DOE could restore natural stream flows and aid in the restoration of the endangered salmon stock.

In Section II, I explain how salmon regulation was developed and I explore current salmon restoration efforts. Section II also explains how stream flows impact the restoration of the Columbia River Basin salmon stock. Section III explores how water rights were created in the American West and how they have evolved. In particular, Section III provides a discussion of the Washington DOE "beneficial use" clause, "the use it or lose it" clause, and the no-harm requirement. Section IV examines the barriers to the creation of water markets in Washington State. Section V proposes some changes that can be made to the current regulatory model in order to improve the water market and explains how these changes to regulation on water transfers will help salmon preservation. Section VI criticizes some of the underlying assumptions of my thesis, and suggests an alternative to further measure the preservation of the Columbia River Basin salmon stock. Also, Section VI provides an alternative to using water markets to increase stream flows. Finally, Section VII concludes.

(II) Salmon stock in the Columbia River Basin

(2.1) The Tragedy of the Commons

Columbia River Basin salmon stocks are negatively impacted by a market failure related to poorly defined property rights and by the construction the hydroelectric system in the Pacific Northwest. In the absence of regulation or clearly defined property rights, natural resources such as the salmon stocks in the Columbia River Basin are negatively impacted by a tragedy of the commons (Garret, 1968). In a tragedy of the commons scenario, there are a number of parties who wish to use a scarce resource and property rights are not clearly defined. Due to the nature of or particular quality of a resource, it is difficult or impossible to exclude others from using the resource. All parties will seek to maximize their own welfare by using a particular resource up to the point that the value of the marginal product of the resource is equal to the marginal extraction cost of the resource. If the marginal extraction cost of a resource is relatively low, then individuals may deplete a resource or push it towards extinction as in the case of CRB salmon stocks.

The plight of Columbia River Basin salmon stocks is, in part, illustrated by a tragedy of the commons scenario. Salmon are commercially and culturally important in the PNW, and it is difficult to assign the property rights to a salmon stock to a particular party because of the highly migratory, anadromous life-cycle of salmon (Goodman, 2001) (Jaeger & Mikesell, 2002). Ocean and river fishermen are the most obvious party with an interest in salmon. At the height of production in the Columbia River Basin salmon industry, salmon canneries produced approximately 25 million pounds of salmon annually (Goodman, 2001). However, the consumption of salmon as a marketed foodstuff is not the only value that salmon have. Native American tribes have a spiritual and cultural interest in salmon, and gain utility through consuming salmon as food and enjoying their presence in streams (Jaeger & Mikesell, 2002). Also, environmentalists and some economists argue that salmon stocks are ecosystem capital (Wu, Boggess & Adams, 2000). The service that salmon provide to the Columbia River Basin ecosystem is valuable and necessary to protect (Costanza et. al., 1998). It is apparent that there are a plethora of groups and people who value salmon for diverging reasons. However, the tragedy of the commons is not the only factor contributing to the failure in the salmon market.

Competition for use of water and the proliferation of hydroelectric systems in the PNW has significantly contributed to the decline of CRB salmon stocks (Watanabe, 2006). Hydroelectric dams negatively impact salmon stocks in several ways related to salmon's anadromous life-cycle. Primarily, the presence of damns renders access to certain tributaries and breeding grounds impossible. Chief Joseph Dam, Hells Canyon Dam and the Dworshak Dam alone are responsible for blocking tens of thousands of square miles of historical spawning ground (Paulsen, 1995). In addition to preventing access to river-ways, hydroelectric systems are damaging to downstream migrating juvenile salmon populations known as smolt. According to a study by the Northwest Power Planning Council, the smolt downstream mortality rate is 20% at each dam (Booth, 1989). Salmon stock populations that have historically spawned in Idaho and Eastern Washington have been significantly impacted by dams due to the significant number of dams on the Columbia River and its many tributaries.

The proliferation of hydroelectric systems in the PNW coupled with overharvesting has severely impacted CRB salmon stocks. By 1991, 106 of 320 known salmon stocks were declared extinct and over 101 were at high risk for extinction (Huppert, 1999). The depletion of salmon stock in the Columbia River Basin inevitably resulted in government intervention attempting to correct the tragedy of the commons market failure and the mortality of migrating salmon due to the construction of hydroelectric dams.

(2.2) Introducing Salmon Regulation

The National Marine Fisheries Service (NMFS) under the Department of the Interior is the primary salmon regulatory authority. Arguably, the NMFS's first significant salmon regulation was established in 1990 by the Northwest Power Act which created the Northwest Power Planning Council (NPPC) (Goodman, 2001). One purpose of the NPPC was to analyze the ecological and economic impact of dams on salmon runs and to help aid salmon runs. Assessing the depletion of the salmon stocks from hydroelectric dams, the NPPC provided only limited protection to salmon. Environmentalist and Native American interests quickly called for more comprehensive protection of salmon stocks. In 1991, Snake River sockeye salmon became the first Columbia River Basin salmon stock to be listed under the Endangered Species Act (ESA) (Goodman, 2001).

The listing of a salmon stock under the ESA was a watershed moment in the preservation of salmon. The ESA has strict criteria for determining what species may be listed as endangered. The most relevant criterion for economists is that a species must satisfy a safe minimum standard in order to be listed as endangered. A safe minimum standard states that “a species should be preserved unless the social costs of preservation are unacceptably large” (Huppert, 1999). Columbia River Basin salmon stocks are unique in that while salmon as a species are not at risk of extinction, Columbia River Basin salmon stocks represent a distinct population segment that are listed as endangered (Goodman, 2001). The anadromous life-cycle of salmon, which gives salmon amazingly accurate navigation and memory of a birthplace, make particular salmon stocks legally unique and protected, even though they are genetically similar to other salmon species elsewhere in the world. The issue of specifically listing Columbia River Basin salmon stocks when salmon globally are not endangered is critical. Columbia River Basin salmon stock may not satisfy the safe minimum stand if, as some critics suggest, distinct population segments are a superfluous designation. For now, I will assume that distinct population segments are a legitimate designation and will address possible critiques in section 6.1.

The listing of Columbia River Basin salmon stocks under the ESA is the most meaningful government regulation on the salmon market in the United States. Presently, Washington State and the Federal government spend approximately $500 million a year on Columbia River Basin salmon, most of which is allocated to hatchery programs (Goodman, 2001) (http://www.nmfs.noaa.gov/). In accordance with the ESA, most Columbia River Basin salmon may not be harvested due to its endangered status or because a salmon run may be a hybrid of several endangered and non-endangered salmon stock.

Causes of salmon depletion include the inability to pass through hydroelectric dams and changes in the ecosystem of small streams due to these hydroelectric dams. As a response, the NPPC funded the creation of so-called salmon ladders to aid the passage of migrating salmon (Northwest Power and Conservation Council, 2007) (Huppert, 1999). In extreme cases, the US Army Corps of Engineers drive salmon barges around dams and deposit fish up or downstream (Huppert, 1999). Advocates of salmon ladders and salmon barges argue that these programs aid salmon in their migration from spawning areas to the ocean and from the ocean back to spawning grounds. However, salmon ladders and salmon barges do not always achieve their intended goal.

(2.3) The Shortcomings of the Current Salmon Management System and Benefits of Increased Stream Flows

The hatchery programs, as well as the salmon management system concerning salmon ladders and barges, have been failures since their inception. A US Department of the Interior study on the replacement rate of salmon has determined that since the listing of Columbia River Basin salmon stocks on the ESA, the hatchery programs have sustained a 10% generation decline (see diagram 4) (Goodman, 2001). In other words, the salmon that are returning to spawn are failing to fully replace the previous generation. One potential reason for this reproductive failure is negative externalities related to salmon ladders. To explain, salmon ladders from the NPPC are designed to divert a minimal amount of stream flows away from hydroelectric dams and turbines. Outward migrating salmon tend to clump at the top of salmon ladders and ecologists have noted increased predation of salmon near salmon ladders from sea-lions and other predators (Goodman, 2001). Another explanation for the failure of the hatchery program is that salmon ecosystems in the Columbia River Basin have introduced new predators. For example, lower stream flows at the mouth of the Columbia River have created new islands which are now home to the largest Caspian Tern population in the US. The Caspian Tern, a seagull like bird, predation of salmon has been compared to the mortality rate of sending salmon through a major hydroelectric turbine (Goodman, 2001). The hatchery program has mostly been a money drain on the Northwest, artificially maintaining salmon with no clear long-term solution.

While ESA funded efforts to preserve Columbia River Basin salmon have been unsuccessful on the whole, there have been some sporadic stocks of salmon which have been regenerated, rehabilitated and which now do not need further government help. Sockeye salmon from the Okanogan River and Wild Fall Chinook salmon are examples of stocks that have recovered primarily due to repair of their freshwater habitat (Jaeger & Mikesell, 2002). The National Academy of Sciences rephrases this finding to offer an explanation why other salmon stocks have not been successfully rehabilitated. They declare there is “substantial evidence that reductions in [stream] flows have contributed to the decline of salmon stocks” (National Academy of Sciences, 1996). Stream flows, or the volume of water flowing through a river over a given time may be critical to repairing salmon stocks as well as maintaining the health of salmon stocks and the ecosystem.

There are numerous explanations for why stream flows impact the population of salmon in a river. Most Columbia River Basin salmon stocks spawn in smaller streams and tributaries of the Columbia River Basin. One obvious impact of low stream flows is that as streams are depleted, these streams dry up and cannot support aquatic life. Salmon spawning streams have been particularly impacted, as the elimination of streams has disoriented stocks which rely upon their homing skills to return to their breeding grounds (Jaeger & Mikesell, 2002).

Another impact of low stream flows is that lower levels of water on all points of the river tend to increase the temperature of the river. In some spawning locations, the temperature of the water is now lethal to salmon. In other instances, the increase in the temperature of the water has introduced new fish species into areas that were previously uninhabitable. Salmon stocks who return to spawning locations may unknowingly endanger their eggs by breeding in an area with new predators (Jaeger & Mikesell, 2002).

Finally, stream flows have a direct impact on the riparian[1], streamside vegetation. As the level of stream flows decreases, the eco-system around the stream may begin to lose riparian tree cover, plants, and the gravel streambeds may become exposed. The loss of this valuable ecology directly impacts the ability for salmon to successfully spawn (Huppert, 1999).

To summarize, Columbia River Basin salmon stocks are quasi-public goods that have been negatively impacted by ecological changes such as the construction of dams, changes in stream flows and increases in water temperature. The US government has attempted to protect salmon through legislative regulation in the Northwest Power Act, and the National Marine Fisheries Service has successfully listed many salmon stocks under the ESA. Regrettably, government programs focusing on hatcheries and restoring historic salmon runs have been very costly and a failure. Biologists agree that restoring stream flows offers great hope to rehabilitating salmon stock (National Academy of Sciences, 1996). Increased stream flows could restore historic paths to spawning grounds, reduce mortality due to lethal water temperatures, and could repair damaged riparian vegetation.

The next section of this paper will focus on water, how rights to water have been established, and will address why stream flows are and continue to be low and damaging to salmon stocks.

[1] Riparian - of, pertaining to, situated or dwelling on the bank of a river or other body of water

(III) The Development of Water Rights

(3.1) Water and the Tragedy of the Commons

The scarcity of water, barriers to excluding others from enjoying water, and the difficulty of assigning property rights, in the absence of regulation, creates a tragedy of the commons failure in the market for water (Garret, 1968). Water is a highly scarce good in the American West. To illustrate, the American West has rainfall in many areas of less than 16 inches per year, compared to an average of over 40 inches of rainfall a year in most areas east of the Mississippi (Wilkenson, 1992). In the Pacific Northwest (PNW), hydroelectric, salmon, recreational, and other interests compete for a share of the limited water supply.The legal structure of water property rights in the American West first developed with miners in the 1850's (Ruml, 2005). The overarching doctrine for water rights in the West is encompassed by the prior appropriation doctrine which states the first in time is the first in right (Goldstein, 2007). This doctrine was intended to emphasize local control over government oversight. However, the further development of a state regulatory structure has shifted regulatory control away from water basin authorities into the hands of state agencies such as the Washington Department of Ecology (DOE). The DOE controls all allocations of and transfers of water rights in the State of Washington. In regarding water transfers, the DOE has established several criteria for holding and maintaining a right to water. These criteria include: reasonable and beneficial use requirements, the use it or lose it clause, and a no-harm requirement. These criteria may create insecurity to water rights holders and inhibit the development of an efficient water market which transfers rights to water its most beneficial use.

(3.2) Reasonable and Beneficial Use Requirement

The Washington DOE requires that parties that hold a water property right use the water in a legally defined way. Classically, a water right legally defines the location of a diversion of water, the use of the water, the amount to be diverted and the precedence of the right (Brewer et. al., 2007). Until recently, the only legally protected rights to water required users to divert water away from the stream. These legally protected usages included farming, industry, and municipalities, to name a few. The DOE notably excluded a right to use the water for an in-stream purpose (e.g. recreation, salmon hatcheries). However, the DOE relaxed its legal code which requires diversions in the past two decades. In 1991, the legislature approved the Trust Water Rights statute which allowed appropriative rights holders to dedicate a portion of their water right to in-stream use (Scarborough & Lund, 2007). In 1998, the Washington Water Trust (WWT) was created. The purpose of the WWT is to purchase and hold water in the public trust for in-stream use (Scarborough & Lund, 2007). Now it is possible for appropriative rights holders to partition their water rights and lease or sell water to the WWT. The capability to hold water for in-stream use and the WWT efforts to purchase water for in stream use has numerous potential benefits for salmon (see Section 2.3).

A subset of the reasonable and beneficial use requirement is rules regarding wasteful use. Typically waste of water is narrowly defined and typically not a source of insecurity in water rights. For instance, water loss due to evaporation or seepage out of unlined irrigation ditches generally does not constitute legal waste (Ruml, 2005). In the latter instance, seepage from unlined irrigation ditches may return back to streams as return flows. In most cases, waste is defined by a community norm standard. A community norm standard requires that "an appropriator's usage of water not egregiously depart from the practices of nearby appropriators"

(Ruml, 2005). For example, a farmer may not use an irrigation method which creates an unreasonable amount of water loss from the point of diversion.

(3.3) The Use it or Lose it Clause

The Washington DOE also has legal requirements which describe the abandonment of a water right and forfeiture of a water right. Water policy experts euphemistically call these provisions the use it or lose it clause (Goldstein, 2007). Abandonment is a "common law doctrine involving the occurrence of (1) intent to abandon and (2) an actual relinquishment of surrender of the water right" (Ruml, 2005). Historically, abandonment of a water right has been challenging to prove because the intent of the holder is difficult to determine. Conversely, forfeiture places a relatively low burden on plaintiffs to prove. In most states, forfeiture provides that a water right may be lost if a user fails to use it in the beneficial use as defined by the appropriative right (Ruml, 2005). For example, a farmer has a right to divert water from a stream to grow barley. At some point in the future, this farmer decides that he or she would rather use the water to grow hops rather then grow barley. Although the diversion of water has stayed the same, the use of the water may negatively impact other users downstream if the new crop alters the amount of return flows to the river. This danger that other users may be negatively impacted is the rationale behind forfeiture.

Historically, the use it or lose it clause was created in order to ensure that water was still being used by a rights holder. However, this clause may encourage an inefficient allocation of water resources. Consider the case of a water rights holder who does not need to use all of his or her water allocation during most years. However, fearing he or she will lose some of that water, the rights holder will continue to use the water even if it is unnecessary to do so. It is not hard to imagine how the use it or lose it clause may lead to inefficient water use. To illustrate, the next most beneficial use for that water may be in-stream use for salmon rehabilitation. Continuing to use the water in a non-useful way impacts the social welfare of salmon preservationists and negatively impacts salmon. In other words, when rights holders do not bear the full opportunity costs of using a water right, social welfare may be hurt as a result.

(3.4) The No-Harm Requirement

A final relevant provision for water rights is the no-harm requirement. The no-harm requirement states that a water transfer may not negatively impact other appropriative rights holders unless an owner can be given just compensation (Ruml, 2005). To illustrate, consider that appropriative rights holders are connected to one another because a diversion changes the amount of water in a stream. Some amount of that water diverted from the stream that is not fully utilized will eventually flow back to the river as return flows (Ciriacy-Wantrup, 1985). Return flows are an important source of water for streams, augmenting flows along smaller streams and tributaries. .A user may transfer a right so long as it does not impact the ability of an appropriative rights holder farther down the river to use their allocated amount of water.

The reasonable and beneficial use requirement, use it or lose it clause, and no-harm requirement are fundamental provisions in Washington's prior appropriation doctrine. They are also some of the key barriers to the creation of efficient water markets.

(IV) Barriers to Water Markets in Washington State

(4.1) Introduction to Barriers to Water Markets in Washington State

In 1971, the DOE mandated minimum in-stream flow requirements for rivers in Washington State (Scarborough & Lund, 2007). In the late 1990's, Washington implemented a Watershed Planning law which created local water basin planning committees to ascertain how much water was being appropriated from Washington River basins (Goldstein, 2007). Most water basin planning committees discovered that too much water had been allocated away from streams. Consequently, the DOE suspended the creation of new, original appropriative rights. For simplicity, I will assume that the discussion of the water market in Washington State refers to the secondary market for permanent water sales, and the secondary market for short or long term water leases.

Secure water property rights would protect against physical uncertainty due to seasonal variability and tenure uncertainty due to lawful use of water (Ciriacy-Wantrup, 1985). The DOE's regulatory control of water does not provide rights holders with adequate security for their water rights and users are not confronted with the real opportunity costs associated with water. This regulatory atmosphere is not conducive to efficient water transfers. As Richard Posner asserts, secure property rights systems are fundamental to the creation of functioning markets (Posner, 1998). Accordingly, the DOE complete regulatory control and antiquated requirements are some of the major barriers to developing water markets in Washington State. This section will examine how the beneficial use requirement may weaken security of water rights and will review the problems with the use it or lose it clause.

(4.2) Reasonable and Beneficial Use

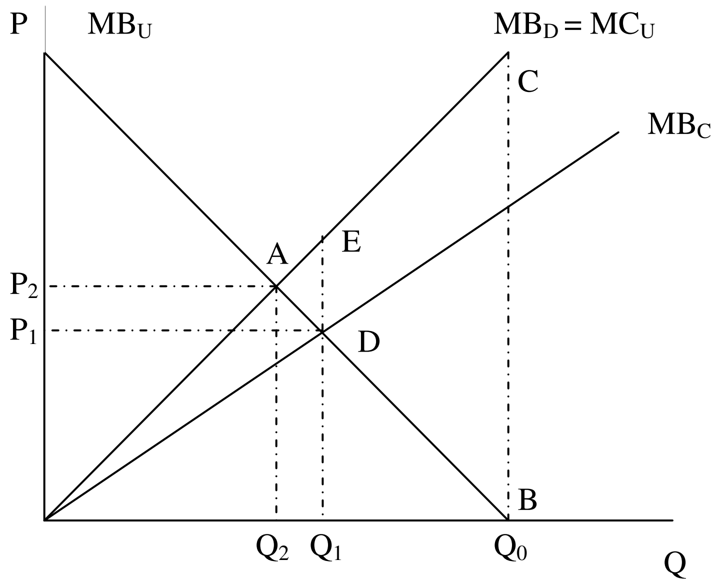
One of the fundamental reasons why water transfers do not occur is because of high transaction costs associated with the diversion requirement. Recall that the usage of water must meet a community norm standard in order to ensure that water is not being unduly wasted. Generally, accusations of waste never arise until a party begins the regulatory transfer process *(Santa Fe Trail Ranches Prop. Owners Ass'n v. Simpson,* Colo.1999). This is primarily due to and water scarcity. Local appropriators have an incentive to claim that a rights holder seeking a transfer is wasting the water. In a scenario in which a rights holder has been accused of waste, the respondent has the burden to prove that the water has not been wasted. Not surprisingly, the litigation for water transfers is both time intensive and costly. According to Barton H. Thompson, author of "Institutional Perspectives on Water Policy and Markets," transfers may cost upwards of $50,000 and take six to eighteen months (Thompson, 1993).

Current regulatory transfers are, at best, costly and time intensive. In the worst case scenario for a rights holder seeking a regulatory transfer, he or she will lose their right and not be compensated. Consequently, transactions may not occur for pragmatic reasons; transactions costs are simply too high. The danger and cost associated with a regulatory transfer may discourage water rights holders from attempting to sell or lease a portion of their water right. The lack of participation in the water market greatly hinders efforts by salmon preservationists and the WWT. Even if a transfer may ultimately improve social welfare for all parties involved, the barrier that insecurity creates hinders transfers from occurring.

(4.3) The Use it or Lose it Clause

The use it or lose it clause does not force rights holders to realize the opportunity costs associated with the use of water. Consider the discussion in Section III which suggests that social welfare is harmed by the use it or lose it clause. To illustrate, figure 1 represents a hypothetical market for water with Q units of water available to be diverted from a river on the x-axis and price P labeled on the y-axis. The line MB_U represents the marginal benefit to upstream users for each additional unit Q of water. The line MB_D represents the marginal benefit to all downstream users, diversionary and in-stream users, and is equal to the marginal cost for upstream diversions (MC_U). The line MB_C represents the marginal benefit to all consumptive or diversionary users downstream.

Figure 1



The equilibrium diversion rate is represented by point A, where Q_2 units of water are diverted and the marginal benefit of diversions is equal to the marginal cost. However, in a market with the use-it-or-lose-it clause, the market does not reach this equilibrium point. While transfers can occur, the risk of losing water due to the use-it-or-lose-it clause will prevent agents from holding water due to the fear of loss. The market equilibrates at the suboptimal point D, in which Q_1 units of water is diverted from the water. The welfare loss due to the use-it-or-lose-it clause is represented by the triangle ADE.

There are several conclusions that could be drawn from this model. First, users do not realize the opportunity cost of water and thus waste water. Second, the use it or lose it clause appears to crowd out entrants to the market who could put the water $Q_2 - Q_1$ quantity of water to non-consumptive use. The entrance of new buyers for in-stream flows in the market would increase the price of water and more efficiently allocate use of the water. This result is consistent with economists Charles Howe et al. work which suggest that a competitive market will set an efficient, market-clearing price if water users are confronted with real opportunity costs (Howe, Schurmeier & Shaw, 1986). A competitive market for water would be beneficial to salmon preservations. If all or part of $Q_2 – Q_1$ quantity of water was apportioned for in-stream use, the augmented stream flows would aid salmon. Nevertheless, because $Q_2 – Q_1$ is not reallocated the use it or lose it clause creates a social welfare loss equal to triangle ADE.

(4.4) Benefits from the No-Harm Requirement

Despite some behavior which inhibits markets, the Washington State DOE is taking some actions which positively impact the development of water markets. The development of the Washington Water Trust (WWT) in 1998 was a major development in water markets. In effect the WWT removed a market barrier to entry for environmentalists, recreational water users, and other parties who value in-stream flow. Additionally, in 2000 the DOE created a Water Acquisition Program that is a "voluntary, incentive based program designed to encourage water right holders in Washington State to sell, lease or donate some or all of their water rights to increase in-stream flows for the purpose of salmon restoration" (Scarborough & Lund, 2007). While these leases may not completely solve the free-rider problem, this program provides a valuable, market-based method for salmon preservationists to increase stream flows.

The insecurity of water rights and the problems associated with the use it or lose it clauses are major barriers to the development of efficient water markets in Washington State. In the following section, I will suggest several changes which would overcome these problems, help develop water markets, and will note how these changes will positively impact salmon restoration efforts.

(V) A Model for Improving Water Transfers and Water Markets in Washington State

(5.1) Introduction

The regulatory structure in Washington State has several significant flaws that inhibit the development of efficient water markets. Assuming there is a high demand for in-stream flows derived in part from the high social and economic value of salmon restoration, improving the efficiency[2] of water markets would improve social welfare. The Washington DOE should cede its complete regulatory control of water transfers to individual water basin authorities, allowing individual water basin authorities to approve water transfers and should encourage the development of contingency contracts which would eliminate the necessity for the use it or lose it clause. First, I will examine the existing framework for a decentralized DOE and will explore the theoretical cost-effectiveness of this plan. Second, I will explain why the introduction of contingency contracts eliminates the need for the use it or lose it clause to exist. Finally, I will assess how the decentralization of DOE power will aid salmon efforts both by improving the efficiency of water markets, but also through improved information for salmon preservationists and the Washington Water Trust.

(5.2) Decentralizing Regulatory Authority

Water basin authorities, such as the Yakima River Water Transfer Group, have more complete information on all appropriators in their water district then the DOE does as a central regulatory power. In the late 1990's the DOE implemented a watershed planning law to discover how much water was appropriated from every water basin in Washington State. To achieve this goal, the DOE structured water basin planning groups basin by basin. Each group integrated all interested parties: hydrologists, farmers, lawyers, politicians and ecologists. One of the primary

[2] Efficiency for water markets is defined in terms of the ease and cost of reallocating the resource to a new use (Ciriacy-Wantrup, 1985).

criticisms of giving local districts control over water transfers is that they have insufficient resources and information with which to make decisions that comply with transfer provisions such as the no-harm requirement. However, over the past decade these planning groups developed arguably the most complete perspective on the management of their particular water basin that has been compiled (Goldstein, 2007). Groups like the Yakima Water Transfer Group already compile the information that the DOE utilizes in its decision making. It is reasonable to assume that these planning groups could now function effectively as water transfer authorities.

Local water basins not only have sufficient information with which to make decisions, but intra-district transfers also have lower transaction costs and more transfer security. To explain, assume a farmer wants to make an intra-district transfer of water to the WWT. As C. Carter Ruml explains, because the transfer occurs entirely within a district, the farmer can reduce his expenses due to statutory transaction costs associated with the DOE (Ruml, 2005). Secondly, the water basin has well documented information on return flows and can easily assess how third parties may be affected. Consequently, a rights holder seeking a regulatory transfer will be more secure because of enhanced information. Again, this saves both time and expense typically associated with regulatory transfers (Ruml, 2005). One example of a water district with regulatory authority and relatively low transaction costs is the Northern Colorado Water Conservancy District (NCWCD) (Howe, Schurmeier & Shaw, 1986). The NCWCD handles more individual water transfers a year then any water markets in the Western US. Of note, the NCWCD implicit conversion rate (ICR), the percentage cost of reallocating water from one source to another, is .5%. The Washington DOE ICR is 7% (Brewer, 2007). This evidence suggests that intra-district originating water transfers have significantly lower transaction costs then water transfers that occur at the state level.

Intra-district water markets may provide more title security for water rights as well because of enhanced information. As discussed earlier, when an appropriative owner of a water right wishes to transfer water they must prove that their transfer will produce no-harm to other appropriators. Additionally, competitive appropriators may attempt to levy claims of waste and forfeiture. Under a more decentralized water transfer authority scheme, such claims seem unlikely to be a credible threat to legal appropriators. In effect, title security for water rights would be strengthened under a decentralized regulatory regime. If courts can accurately assess how water is used and it complies with the community norm standards, water basin authorities can effectively secure water rights.

(5.3) Options Markets for Water Transfers

The use of contingency or options contracts in water sales or leases may eliminate the need for the use it or lose it clause. Abandonment and forfeiture clauses historically were created to stop speculators from holding onto water when another user may be lacking water due to seasonal variability (Anderson & Snyder, 1997). This rationale is not economically sound however. Given the high social value for in-stream use of water in activities such as salmon propagation, it is more logical-to view not diverting water as the opportunity cost for in-stream flows.

While the use it or lose it clause may not be economically sound per se, it does provide some security for rights holders from seasonal variability. The development of contingency contracts for water sales or leases would provide security from seasonal variability and eliminate the need for the antiquated use it or lose it clause. A contingency contract, or options contract, is an agreement between a water transfer authority and the buyer of a water right. With an options contract, a water transfer authority provides a party the opportunity to purchase a contract for a fee. This contract allows a holder the option to divert a specific amount of water for a fixed cost in a future season. If the contract holder does not need to purchase the water, then he or she is not required to purchase the water. Also, if the price of water in a future time period is less than the option contracts specified cost then the contract holder does not need to purchase the water at the options contract price. However, if a contract holder needs to purchase water in a later time period and the price of water in the market is greater than the options contract price, then he or she will purchase the water at the options contract price. In effect, options contracts, allow water rights holders to hedge their risk against the uncertainty of seasonal variability of water supply. Options contracts allow appropriators to use the necessary amount of water in the present time and to protect against uncertainty in a future time period, eliminating the waste from the use it or lose it clause.

There is currently no options market for water transfer rights in Washington State. The creation of an options market would positively impact appropriators, especially farmers and salmon preservationists, by eliminating the need to wastefully divert excess water in all years to guard against seasonal uncertainty in dry years. As Richard Howitt and Kristiana Hansen describe, options markets for water transfers have benefited water users in California in several ways. First, buyers avoid last minute negotiations for water which may be relatively high in particularly dry years. Second, buyers can lower transactions cost if they purchase multiple year option contracts (Howitt & Hansen, 2005). The use of options contracts in local water districts in Washington State would eliminate the necessity of the use it or lose it clause, and also provide lower transactions costs associated with continual negotiations of water.

(5.4) Benefits to Columbia River Basin Salmon Stocks from Regulatory Change

The decentralization of regulatory transfer authority in water markets as well as the elimination of the use it or lose it clause would increase the efficiency of water markets in Washington State. One of the primary beneficiaries of more efficient water markets and the increased use of contingency contracts would be salmon preservationists. Recall that the National Academy of Sciences cites low stream flows as the major factor inhibiting the rehabilitation of endangered salmon stock. Using the Washington Water Trust and salmon-friendly water acquisition program, salmon preservationists could use more efficient water markets to augment stream flows. Sellers, especially agricultural sellers, could utilize contingency contracts to hedge their risk due to seasonal variability.

Another benefit of utilizing local water basin authorities over the DOE is that salmon preservationists can better utilize local experts to discover where augmenting flows will be most effective. According to natural resource economists William Jaeger and Raymond Mikesell, "augmenting stream flows at the wrong time in the wrong place could actually be harmful to salmon or have no effect" (Jaeger & Mikesell, 2002). Under the DOE, the WWT has focused on augmenting aggregate stream flows – purchasing water at low value to augment streams that may not need increased stream flow. However, buying low-priced water during a period in which the stream can sustain salmon while avoiding high cost water during a period in which the stream flows cannot sustain salmon is not an effective policy. If the WWT utilizes local experts of water basins and transfers are less costly and timelier, salmon preservation efforts will benefit. The potential benefits to increased stream flows for salmon are clear. If water markets are improved, all users of water will benefit from decreased transactions cost, increased title security, and from market-clearing prices which reflect the real opportunity costs associated with using water. The potential for efficient water markets to aid salmon preservation efforts is profound.

The next section will consider possible alternatives to improving markets to aid salmon preservation efforts.

(VI) Alternatives to Salmon Preservation

(6.1) Call in the God Squad

One perspective on current salmon restoration efforts is that the social costs of preserving salmon do not satisfy the safe minimum standard (Huppert, 1999). Recall that a safe minimum standard states that a "species should be preserved unless the social costs of preservation are unacceptably large (Huppert, 1999). Some critics claim that the cost to society to rehabilitate Columbia River Basin salmon stocks is an unacceptable burden on society and the social welfare maximizing decision is to stop government statutory efforts to preserve Columbia River Basin salmon stocks. However, once an animal has been listed as endangered or threatened under the Endangered Species Act (ESA), the process of de-listing or exempting an animal or plant from protection is complex.

In order to exempt an endangered species from protection de facto, a party must apply for an exemption to section 7(a)(2) of the ESA. In the past, several groups have applied for exemption. For instance the Bureau of Land Management applied for an exemption to section 7(a)(2) in order to hold timber sales on tracts of land critical to the Northern Spotted Owl. When a group seeks an exemption, a cabinet level Endangered Species Committee (ESC)[3] is assembled to determine the validity of the exemption. The ESC is often characterized as the God Squad (Weston, 1993). The term God Squad is a reference to the fact that the ESC's determination to

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[3] The ESC is composed of: the Secretary of Agriculture, Secretary of the Army, Chairman of the Economic Advisory Committee, Administrator of the EPA, Secretary of the Interior, Administrator of the National Oceanic and Atmospheric Administration, and one person appointed by the US President (16 U.S.C. 1536 (1988) Section 7)

exempt a listed animal from protection under the ESA will often lead directly to the extinction of a species. In the case of the Columbia River basin salmon stocks, a decision by the God Squad to eliminate protectionist salmon programs such as hatcheries, fish ladders or the moratorium on fish harvesting, would likely extinguish the threatened salmon stock.

How probable is it that a federal agency or Northwest society would determine that Columbia River Basin salmon stock does not meet the safe minimum standard, and that an ESC would be assembled to terminate salmon protection? Economist Daniel Huppert argues that a determination to use the ESC is unlikely for most species, even when the costs to society for preserving a species are significant (Huppert, 1999). In other words, society may believe that the economic costs of preservation pale in comparison to the cost imposed on society when a species, or salmon stock, goes extinct. Although benefits to harvesting Columbia River Basin salmon stocks are minimal, the Pacific Northwest draws significant cultural and societal utility, as well as ecosystem capital from salmon. Consequently, it is unlikely that a God Squad will be assembled to terminate salmon preservation programs under the ESA.

(6.2) Fixing Problems in the Farm System

An alternative method to increase the volume of stream flows is to improve irrigation efficiency on farms. Farms utilize 80% of all consumed water resources in the American West (Brewer, 2007). Some of the water that is diverted from streams is lost due to the method of irrigation and evaporation. In the Northwest, the most common irrigation system known as surface irrigation is also the most inefficient irrigation system available. According to some estimates, the efficiency of surface irrigation is 32% to 57% (Jaeger & Mikesell, 2002). This data implies that only 32% to 57% of water diverted away from a stream is captured by plants. In theory if farmers improve their irrigation efficiency, they will draw less water away from the river and this will increase stream flows and aid in salmon rehabilitation efforts. Many Western States support this plan to increase stream flows by improving irrigation efficiency. State legislators have passed legislation which provides incentives to invest in new irrigation technology (Jaeger & Mikesell, 2002). Unfortunately, improved irrigation will not necessarily improve stream flows.

Improving irrigation efficiency may reduce the aggregate amount of water being diverted from a river, but it will also decrease the amount of return flows to the river. Recall that a return flow is water which is not consumed or lost and flows back to the river. I propose a hypothetical situation in which improved irrigation technology will not improve stream flows.

Assume that Farmer Z has an appropriative water right which allows him or her to divert 500 acre-feet of water in time 1. Farmer Z's irrigation efficiency is 40%, of which 10% of the water diverted is permanently lost due to evaporation, and 50% of the water flows back to the river. Thus, the farmer consumes 200 acre-feet of water, 50 acre-feet is lost, and 250 acre-feet of water flows back to the river. In the future time 2, Farmer Z decides to install new irrigation technology which improves his irrigation efficiency to 60%. Accordingly, Farmer Z also decides he only needs to divert 400 acre-feet of water. 10% of water is still permanently lost to evaporation, and 30% of the water is a return flow which ends up back in the river. Farmer Z will now consume 240 acre-feet of water, lose 40 acre-feet, and 120 acre-feet will flow back to the river. Adding 120 acre-feet to the 100 acre-feet no longer diverted from the river, a total of 220 acre-feet remain in the stream in time B. To summarize, the net-effect of increasing irrigation efficiency in this scenario is to reduce stream flows by 30 acre-feet over a given period of time.

This hypothetical situation for Farmer Z illustrates that the simplistic assumption that increasing irrigation technology will increase stream flows is misleading. In order for improvements in irrigation to increase stream flows, an appropriative user must reduce the amount of water he diverts initially to a particular threshold. This threshold could be determined with the follow inequality:

$$a-b + r_2(b) \geq r_1(a)$$

a = Amount of water diverted in time 1
b = Amount of water diverted in time 2
r_1 = Irrigation efficiency in time 1
r_2 = Irrigation efficiency in time 2

In the case of Farmer Z, he or she would need to divert 357 acre-feet or less water in order to increase stream flow in the stream. If Farmer Z wanted to consume the same amount of water in time 2 as in time 1, he could only consume 333.37 acre-feet of water. Using the same method as above to discover the net effect to in-stream flows, Farmer Z would increase flows from time 1 to time 2 by 17 acre-feet.

This analysis questions the cost-effectiveness and social welfare enhancing capabilities of only improving irrigation technology. While improving technology may have potential positive net effects on stream flows, it also may have the opposite effect of decreasing stream flows. Given the lack of literature assessing the success of failures of legislative programs to provide incentives for irrigation technology, it is uncertain whether irrigation subsidies are a significant option for improving stream flows.

(VII) Conclusion

Current salmon preservation efforts are not achieving their goals of rehabilitating endangered Columbia River Basin salmon stock. Salmon programs like salmon ladders, salmon barges, and hatcheries cost the public $500 million a year and have not produced measured improvements for salmon. As biologists have indicated, improving stream flows offers great promise for rehabilitating salmon.

The benefits to improving water markets through decentralizing transfer authority in the State of Washington, such as decreasing transaction costs, would aid salmon preservationists. The Washington DOE should take better advantage of the water basin planning committees it formed with the Watershed Planning Law. Giving these groups transfer authority would make transfers more secure and efficient. Eliminating the use it or lose it clause and creating a market for options contracts would provide a market based method with which rights holders could protect against risk due to seasonal variability of water supply. Finally, improving the functionality of water markets will benefit not only salmon but will also provide ancillary benefits for other in-stream users. Water recreation users, hydroelectric power interests and land owners will all benefit from streams with increased flows.

Increasing stream flows is a vital component to the success of rehabilitating endangered Columbia River Basin salmon stocks. As more and more parties enter the market for water, the Washington DOE must grow and adapt. Developing a competitive market which provides security for water rights holders is difficult but necessary. The DOE’s current regulatory structure for water transfers is slowly choking efforts to save Columbia River Basin salmon stocks.

Glossary of Terms:

Acre-Foot – the amount of water necessary to cover an acre of land with one foot of water

Anadromous - relating to fish, such as salmon or shad that migrate up rivers from the sea to breed in fresh water

Community Norm Standard – a requirement that an appropriator's usage of water not egregiously depart from the practices of nearby appropriators

Department of Ecology (DOE) – the Washington Department of Ecology controls all allocations of and transfers of water rights in the State of Washington

Ecosystem Capital – a flow of materials, energy, and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare Some ecosystem capital includes: gas regulation, climate regulation, water regulation, water supply, etc. (Costanza et. al. 1998).

Implicit Conversion Rate – the percentage cost of reallocating water from one source to another

National Marine Fisheries Service (NMFS) - the NMFS is the primary regulatory authority for salmon

Prior Appropriation Doctrine – water property right doctrine, overarching theme of the doctrine is "the first in time is the first in right"

Riparian - of, pertaining to, situated or dwelling on the bank of a river or other body of water

Salmon Ladders - a series of pools arranged like ascending steps at the side of a stream, enabling migrating salmon to swim upstream around a dam or other obstruction

Use it or Lose it Clause – clause that encompasses legal forfeiture and abandonment requirements of water

Washington Water Trust – non-profit group created to hold water in the public trust for in-stream use

Water Acquisition Program – incentive based water acquisition program for the purpose of salmon restoration

Watershed Planning Law – DOE initiative to record all water that was appropriated from water basins in Washington State

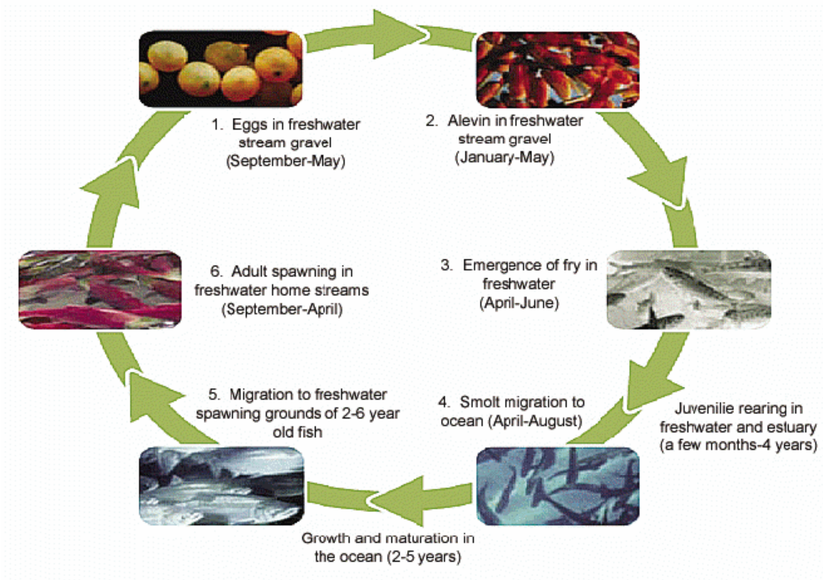
Diagram 1 – The Columbia River Basin

[4]

Columbia River Basin – The Columbia River Basin encompasses the Columbia River and many rivers, streams and tributaries, including the Okanogan River, Snake River, and Willamette River. The Columbia River Basin stretches across parts of British Columbia, Washington and Oregon.

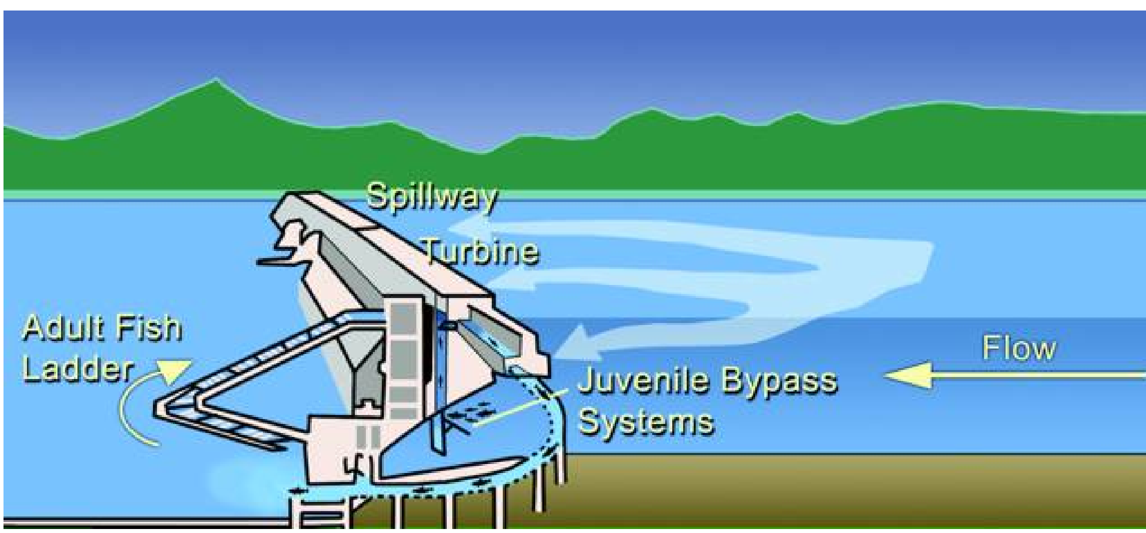
[4] "Columbia River Basin." Online Image. 21 November 2003. U.S. Army Corps of Engineers – Northwest Division. Columbia Basin Water Management Division. 22 November 2007. <http:// www.nwd-wc.usace.army.mil/images/columbia.gif>

Diagram 2 – Illustration of the Anadromous Life-Cycle of Salmon



[5]

Diagram 3 – Salmon Ladders and Juvenile Bypass Systems



[6]

Salmon Ladders - A series of pools arranged like ascending steps at the side of a stream, enabling migrating salmon to swim upstream around a dam or other obstruction

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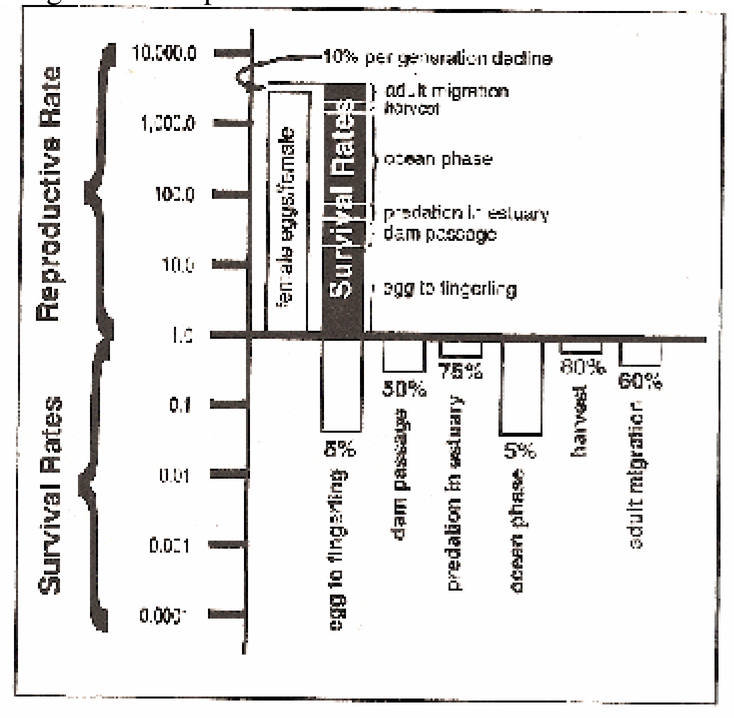
[5] "Anadromous Life-Cycle of Salmon." Online Image. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.13 November 2007, <http://swr.nmfs.noaa.gov/recovery/life_cycle.gif>

[6] "Salmon Ladder Diagram." Online Image. Northwest Power and Conservation Council. 20 November 2007. <http://www.nwcouncil.org/library/2003/2003-20/turbine.jpg>

Diagram 4 – Replacement Rate from Salmon Hatcheries



[81]

This diagram illustrates the replacement rate of salmon compared to the amount of salmon that are spawned from a hatchery. The diagram illustrates the survival rate of salmon during various stages of development and during various stages of salmon's anadromous life-cycle. Currently, there is a 10% per generation decline under the current salmon management system.

[81] Goodman 149

Table 1 – Farmer Z's Irrigation Efficiency Problem

	r	l	f	H20	R	L	F	F*
Time 1	40%	10%	50%	500 a.f.	200 a.f.	50 a.f.	250 a.f.	250 a.f.
Time 2	60%	10%	30%	400 a.f.	240 a.f.	40 a.f.	120 a.f.	220 a.f.

r = irrigation effiency (percentage)
l = permanent loss from water diversion (percentage)
f = return flow (percentage)
H20 = total water diverted from stream
R = water consumed from H20
L = lost water from H20
F = return flows from H20
F* = total return flows + net-effect of reduction in H20

Assume that Farmer Z has an appropriative water right which allows him or her to divert 500 acre-feet of water in time 1. Farmer Z's irrigation efficiency is 40%, of which 10% of the water diverted is permanently lost due to evaporation, and 50% of the water flows back to the river. Thus, the farmer consumes 200 acre-feet of water, 50 acre-feet is lost, and 250 acre-feet of water flows back to the river. In the future time 2, Farmer Z decides to install new irrigation technology which improves his irrigation efficiency to 60%. Accordingly, Farmer Z also decides he only needs to divert 400 acre-feet of water. 10% of water is still permanently lost to evaporation, and 30% of the water is a return flow which ends up back in the river. Farmer Z will now consume 240 acre-feet of water, lose 40 acre-feet, and 120 acre-feet will flow back to the river. Adding 120 acre-feet to the 100 acre-feet no longer diverted from the river, a total of 220 acre-feet remain in the stream in time B. To summarize, the net-effect of increasing irrigation efficiency in this scenario is to reduce stream flows by 30 acre-feet over a given period of time.

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