Title: Catch And Release Runoff to Cool the Watershed

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Abstract: Cooling a watershed requires restoring natural processes that were in place for centuries prior to human intervention. The grazing, timbering, mining, and irrigated agriculture industries of the West have disrupted the natural processes. Unaided recovery would take centuries even if mankind did no further harm. Managing recovery involves catching runoff and releasing the water on an assigned portion of the watershed. The release system, a nominal "irrigation" system, is designed to assure that the water will evaporate (cooling) or infiltrate. The released water can be caught again further downstream and re-released. It is more valuable than trout.

A group of sites sized to catch and release a total of 10 AF per day would have a daily environmental value received of $216,630 to $284,420 depending on site evaporation to infiltration ratio. A hundred day season would be worth $21.6 million. The impact on neighboring areas would be worth an additional $20.7 million per season to them.

Every mile of stream should be evaluated for possible implementation.

Catch And Release Runoff to Cool the Watershed

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Cooling the watershed to improve the fishery and the environment is a need I perceived last August fishing Montana tailwater fisheries, the Missouri and the Beaverhead. High water temperatures and irregular hatches made for poor fishing. The fish were there.

We have the same problem back east. And we have not begun to address the problem. My proposed solution is simplistic and natural. Restore watershed cooling and groundwater levels by taking water from streams and dispersing it where it will infiltrate and evapotranspire. It will take years to restore and recover from the years of misuse and destruction.

Previously I have generated (eastern) prices for evapotranspirative cooling ($42,000 per AF) and for infiltration ($1,320 per AF). I realize water costs vary significantly with area and recommend using your local cost basis in assessing project value.

The concept is simple, "catch" water in selected spots where it can be fed to a "release" area for infiltration and evapotranspiration.

Catch snowmelt high in the watershed and disperse the water along the hillside. Design the catch site to assure that summer flows are maintained. The hillside provides short term storage for the groundwater portion of the catch. The release area where the water is dispersed should have natural vegetation to enhance the amount of evaporative cooling. The release area becomes an oasis, delightfully cool. An example of the cooling effect is the Madison Bend, tackle shop, grocery, RV site, cabins, laundry, etc on route 287, north of Lyons bridge. It is open 3 months each year, pumps well water to a 13 stage distribution system and its front porch is shady and cool in late July.

Catch streamflow where deliverable to a release site. Gravity fed applications may be less expensive but pumped water is still quite cost effective. Siphoned water may be appropriate at some sites.

An Example: Grand Coulee Dam and Columbia Basin Project as Catch and Release

The Grand Coulee Dam and Columbia Basin Project functions like a Catch and Release site. Water is pumped from the Columbia river up to the Columbia plateau where it flows through a few thousand miles of canals, laterals, drains, and wasteways. In 1992 they irrigated 530,000 acres that had a crop value of $1,210 per acre with total value of $641.3 million dollars. In 1996 2.5 million AF were pumped from the Columbia River and a possible 0.5 million AF returned to the Columbia River. The 2 million AF went to crops, infiltration (the aquifer), and evapotranspiration (cooling). If 1 million AF (each) went for evapotranspiration and for infiltration the values received would have been $42 billion and $1.32 billion respectively. If the crops utilized half the water (and it was shipped along with the crops) the preceding values would be halved. Note that the infiltration (@ eastern USA water value) would be worth more than the crops. In addition, the value of the evapotranspiration to other watersheds would be an additional $41.4 billion (or $20.7 billion). (See the section: good neighbor policy.)

The following sections develop value received for the catch and release site and for areas that receive benefits from the catch and release site.

Catch and Release Runoff Mathematics

Managing environment recovery involves catching runoff and releasing the water on an assigned portion of the watershed. The release system, a nominal "irrigation" system, is designed to assure that the water will evaporate (cooling) or infiltrate. The released water can be caught again further downstream and re-released. It is more valuable than trout.

The rudimentary approach taken here is provided to develop interest in a significant environmental problem of the area, and effective cooling of the infiltrating water. Table 1. Catch and Release Values provides an estimate of the value received by the site implementing the concept. Table 2. Do Unto Others provides an estimate of the value received by others from the released evapotranspiration. Scale the value from table 2 in proportion to the amount of evapotranspiration released and add it to the value from table 1.

Table 1. Catch and Release Value
Tables of Potential Daily Value versus Catch; 1. Rate in (CFS) and 2. Volume (AF/Day)

Catch Rate	Volume	Potential	Potential Value/Day	
Ft^3/Sec	AF/Day	ET Value/Day	ET = Infil.	ET = 2 * Infil.
1	1.98347	$83,305.79	$42,967.90	$56,413.86
2	3.96694	$166,611.57	$85,935.81	$112,827.73
3	5.95041	$249,917.36	$128,903.71	$169,241.59
4	7.93388	$333,223.14	$171,871.62	$225,655.46
5	**9.91736**	**$416,528.93**	**$214,839.52**	**$282,069.32**
6	11.90083	$499,834.71	$257,807.43	$338,483.19
7	13.88430	$583,140.50	$300,775.33	$394,897.05
8	15.86777	$666,446.28	$343,743.24	$451,310.92
9	17.85124	$749,752.07	$386,711.14	$507,724.78
10	19.83471	$833,057.85	$429,679.05	$564,138.65

Catch Rate	Volume	Potential	Potential Value/Day	
Ft^3/Sec	AF/Day	ET Value/Day	ET = Infil.	ET = 2 * Infil.
0.5042	1.00000	$42,000.00	$21,662.99	$28,441.99
1.0083	2.00000	$84,000.00	$43,325.97	$56,883.98
1.5125	3.00000	$126,000.00	$64,988.96	$85,325.97
2.0167	4.00000	$168,000.00	$86,651.94	$113,767.96
2.5208	**5.00000**	**$210,000.00**	**$108,314.93**	**$142,209.95**
3.0250	6.00000	$252,000.00	$129,977.91	$170,651.94
3.5292	7.00000	$294,000.00	$151,640.90	$199,093.93
4.0333	8.00000	$336,000.00	$173,303.88	$227,535.92
4.5375	9.00000	$378,000.00	$194,966.87	$255,977.91
5.0417	10.00000	$420,000.00	$216,629.85	$284,419.90

Each release area will have its specific characteristics: infiltration rate, evaporation rate, effective cooling of the area, and effective cooling of the infiltrating water. The Catch and Release table provides an opportunity to estimate the value received by implementing the concept.

Sections are enumerated from 1 through n. The total water withdrawn from the stream is the sum of the withdrawals. The cooling achieved is the sum of the evapotranspiration from the release areas, nominally expressed in acre feet and dollars. The infiltration is sum of the infiltration from the release areas the expressed in acre feet and dollars. A portion of the infiltration will add to the baseflow and the rest goes to the aquifer. The net water withdrawal is the total withdrawn minus the returned baseflow.

For instance: Constructing 20 catch sites that would catch a total of 5.04 cubic feet per second would allow release of 10.0 acre feet of water each day. Depending on release site specifics the value received could be $216,630 or $284,420 each day. A hundred day season would be worth $21.7 million or $28.4 million to the sites.

Table 2. Do Unto Others

Study of Doing Unto Others**.** **Values Are Per Acre Inch**

Step 1	Evaporate 1 AI from site.			$3,500.00	$3,500.00	Doer
		1				
Step 2	Rainfall of 1 AI on neighbor		Delta T = 10	**$33.13**		
	ET of .5 AI	0.5		$1,750.00		
	Rchrg of .5 AI	0.5		$55.00	$1,838.13	DoUnto #1 $1,838.13
Step 3	Rainfall of .5 AI on neighbor		Delta T = 10	$16.57		
	ET of .25 AI	0.25		$875.00		
	Rchrg of .25 AI	0.25		$27.50	$919.07	DoUnto #2 $2,757.20
Step 4	Rainfall of .25 AI on neighbor		Delta T = 10	$8.28		
	ET of .125 AI	0.125		$437.50		
	Rchrg of .125 AI	0.125		$13.75	$459.53	DoUnto#3
Step 5	Rainfall of .125 AI on neighbor		Delta T = 10	$4.14		$3,216.73
	ET of .0625 AI	0.0625		$218.75		
	Rchrg of .0625 AI	0.0625		$6.88	$229.77	DoUnto #4 $3,446.50
				$6,946.50	$3,446.50	Value of Doing Unto (per AI)
Total	ET	Recharge	Diffusion			
	$6,781.25	$103.13	$62.12	$6,946.50	Catch & Release Value (per AI)	

The Good Neighbor Policy: Do Unto Others

The Good Neighbor Policy is the old do unto others (DUO) as you would have them do unto you. The catch and release runoff policy is a Good Neighbor Policy in that it sends shade clouds and cooling rain to a neighbor. The neighbor is being given the opportunity to receive and utilize additional rain. The neighbor in turn releases evapotranspiration to a subsequent neighbor. The neighbor taking the opportunity to receive and utilize bestows these benefits on another set of neighbors. Values for these happenings are in Table 2. Do Unto Others.

A day's water vapor from the preceding example would be worth $206,790 to neighbors, for a total of $20.7 million per season.

The Bottom Line

The Catch of 1000 acre feet of water provided local Release value received of $21.7 million and a Do Unto Others value received of $20.7 million, totaling $42.4 million, at a cost of the loss 500 acre feet of Catch water. The other 500 acre feet remained in the Release area and replenished the aquifer and groundwater. Forty two million for 500 acre feet. **Forty two million dollars for 500 acre feet of water!**

A Hydrologic Cycle Sequence of Events

Precipitation falls on an area to mark the end of a hydrologic cycle and the beginning of a new hydrologic cycle. Precipitation that falls on water is immediately available to evaporate again. Precipitation that falls on land will infiltrate, evapotranspire or runoff. Runoff leaves the area, entering the waterways. Infiltration enters the ground with a portion adding to the baseflow and the rest going to the aquifer. Evapotranspiration begins a 5 phase journey that is basic to keeping the earth surface cool.

The evapotranspiration process converts water to water vapor, taking heat (latent heat of vaporization) from the site, making the site cooler.

Water vapor is a greenhouse gas that rises into the atmosphere. As a greenhouse gas it reflects a portion of the earth radiation back to earth. This reduction of the natural radiative cooling is a warming effect.

As the water vapor rises it reaches conditions that require it to release its latent heat to the atmosphere, allowing it to become water droplets and form clouds. Clouds reflect incoming insolation (rays from the sun), keeping the insolation from warming the earth surface, a cooling effect. Clouds reflect earth radiation back to earth, a warming effect. (Net cooling.)

Subsequently, clouds precipitate the moisture, nominally cooling the receiving surface. Breezes leaving the cooler areas are cooler.

Evapotranspiration cools the area it leaves, allows some greenhouse warming of the adjacent area, provides a neighbor clouds for shade to prevent warming, and prevent some radiative cooling, and provides cooling rain to a neighbor, as an encore to end the "net cooling" journey. This brilliantly conceived environment conditioning system is dismantled when water that would have been cooling evapotranspiration is discarded as runoff.   This environment conditioning system is dismantled when water that would have been cooling evapotranspiration is incarcerated as infiltration.

Rebuilding this system is the only feasible means we have to recover our environment.

Release Area Cooling

The release area is fed water that is then dispersed, drizzled, throughout the area so that it will infiltrate and evapotranspire with no direct runoff. The caught water is at stream temperature when it begins flowing to the release area. Upon release it diffuses into/with the moist soil with a possible warming effect. As some water evapotranspires the moist soil is cooled. The cooler moist soil provides cooler water to baseflow and to the aquifer.

The Release Area As Short Term Storage

Terrain characteristics dictate site selection. Catching water and getting it into storage and pipe for transfer to the release area is possible via gravity or by pumping, hydraulic rams or powered units. The release area is selected to meet local needs criteria. Distance from the release area to the stream will be a factor in establishing the feasibility of using a site as a short term storage facility.

Opportunities

The Madison runs some 40 miles from Quake Lake to Ennis, MT. Forty miles of foothills crossed by many streams, Mill Creek, Indian Creek, Wolf Creek, Moose Creek, Deadman Creek, Horse Creek, etc. that could have catch sites and release water onto the hillsides and flatland to infiltrate and evapotranspire. In addition, the section immediately below Quake Lake could receive water from Quake Lake via pump/siphon as done for the Columbia Basin Project. (A modest elevation change of 50 feet could get water into a long release field.) The valley area is many times the area of Ennis Lake, use it for storage.

The Gallatin, the Snake, the American, the Yellowstone, the Bitterroot, the Platte, the Mississippi all have miles and miles of streambank that is accessible for catching water for release and natural use before it returns to oceans. Eastern rivers are also candidates. The problem is taking the first step.

Having demonstration projects working here would make the concept more marketable world wide.

I'm hoping that Valley Creek, Chester County, PA will receive grant money to initiate a project soon.

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Valley Forge Trout Unlimited web site: www.valleyforgetu.org