WETLANDS

Supplementary Material

Managed flood effects on beaver pond habitat in a desert riverine ecosystem, Bill Williams River, Arizona USA

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Consider a stream reach with no subsurface inputs or outputs. Given that the reach has length L (units = m), average depth D (m), surface water area A (m^2), total water volume G (= A*D, m^3), and average current velocity V (m/s), then the average time that a unit volume of water is in the reach, E, is

$$E = \frac{1}{2} * (L/V) = (L/2V), \textit{units} = s \quad (1)$$

Assume that all radiation striking the water surface is absorbed. Given radiant energy input level I ($J\ m^{-2}\ s^{-1}$), then the total energy absorbed by the volume of water during its passage through the reach, H, is

$$H = I * A * E, \textit{units} = J \quad (2)$$

The energy absorbed per unit water volume, H_V (*units* = $J\ m^{-3}$), is

$$H_V = H/G = [I * A * (L/2V)] / (A*D) = (I * L/2V) / D = (I * L) / (2V*D) \quad (3)$$

In comparing H_V for a reach of length L with and without a beaver pond, I and L will both be constant, so the difference in the value of H_V is due to variation in 1/(V*D). As the product (V*D) gets smaller, the amount of energy absorbed per unit volume of water, and thus the water's heat gain, will increase. When a lotic reach becomes a beaver pond, V is reduced but D is increased, so it is the proportional change in these two values that determines whether the presence of the pond leads to an increase or decrease in the heating of the water passing through it. Figure S1 shows values of (V*D) recorded in beaver ponds and in adjacent lotic reaches of the Bill Williams River in Arizona.

The values overlap broadly, suggesting that creation of a beaver pond does not necessarily result in increased heat gain by the water as it moves through the pond. Nevertheless, the mean V*D value for beaver ponds (0.06 m^2/s, $n = 28$) was less than that for lotic reaches (0.12, $n = 15$; 1-tailed t-test assuming unequal variances, $P < 0.001$), suggesting construction of a dam will likely lead to a reduction in V*D and thus an increase in heat gain.

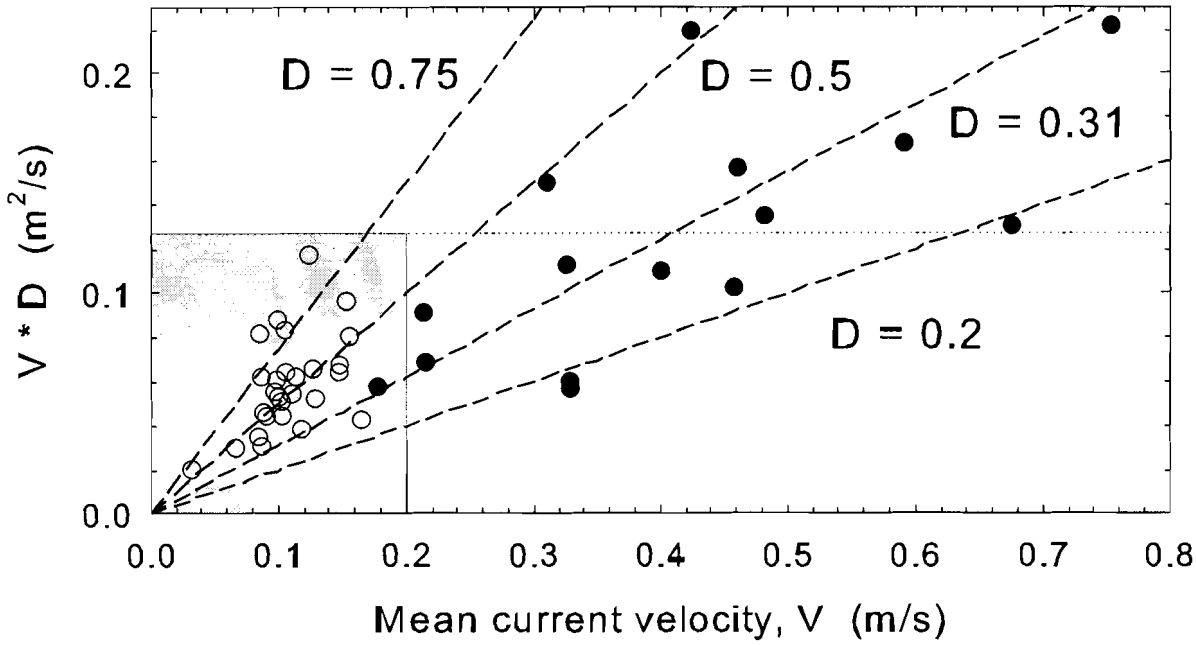

Fig. S1. Scatterplot showing the product of mean current currently velocity (V_{AVE}) and mean water depth (D_{AVE}) plotted against values of V_{AVE}. The product (V_{AVE}*D_{AVE}) is inversely proportional to volumetric surface water solar heat gain. Data are from the Bill Williams River cross-channel velocity transects through beaver ponds (open circles, n = 28) and in nearby non-pond reaches (filled circles, n = 15). Note that only one non-pond transect had a mean current velocity < 0.2 m/s. The smaller the value of (V*D), the greater the radiative heat gain per unit volume of water. Sloping lines show (V*D) values versus V for three constant D values (units = m). The horizontal line represents the value of (V*D) for a hypothetical lotic reach with average mean current velocity (V = 0.41 m/s) and average mean depth (D = 0.31 m), the overall lotic reach averages found on the Bill Williams River. If beaver dammed the reach and the resulting shifts in V and D in the impoundment (where by definition V < 2.0 m/s) reduced (V*D) to a value in the gray area, the water traveling through the reach would be absorbing more energy and thus gaining more heat that it would have had the reach remained lotic.