**SETS:**

j – represent barriers at location j (or alias i)

k – barriers between two sets of barriers j (i)

months – months to model each scenario /1\*12/

s – budget scenarios to loop across /s1\*s22/

w – weights on the objective function to cycle through each scenario and month /w1\*w48/

rad\_infl – the dispersal thresholds or radius of influences to cycle through /r1\*r4/

**BINARY VARIABLES:**

CR\_up(i,j) – binary choice of choosing a reach. 1 when connected reach between patch i and j is free of barriers, 0 if there is one or more barriers.

B(k) – binary removal decision of barriers on path i to j (1 is remove, 0 is maintain)

**VARIABLES:**

WEIGHT – dual objective function value

IIC – environmental objective function value

D(i,j) – distance variable of actual distance in km (not weighted)

AREA\_MONTHS – area for each month (the total quality-weighted habitat in the stream network for that month)

A\_MONTHS(j) – habitat or area above each barrier to loop through

IICNUMERATOR – The IICnum value by month with all the barriers. The numerator of the IIC calculation for each month without any barriers removed (sum(2\*(A\_MONTHS.L(j)\*A\_MONTHS(i))/Lij). This is used to normalize the data so it is between 0 and 1 and comparable to the water scarcity costs in the objective function.

ECO\_months(k) – months used to calculate the economic loss in dollars ($) of barriers removed k.

ECO\_LOSS\_months(k) – to calculate the economic loss in dollars ($) of barrier removed k.

ECO\_LOSS – the output/actual value of economic loss of barrier removed k.

QU – length of quality habitat without penalty

HABITAT\_MONTHS(k) – the quality-weighted habitat for each month above barrier k.

WT – weights to cycle throught (w1\*w48) \*NOTE: also in SETS as w.

BUDGET – different budgets to loop throught \*NOTE: also in SETS as s.

ROL – the different dispersal thresholds to cycle through. NOTE: also in SETS as rad\_infl.

**PARAMETERS:**

barriers\_on\_path\_sum(i,j) – barriers on path in the upstream direction (path\_up)

ObjFunc(months, w, scenarios, rad\_infl) – objective function values (habitat)

Barriers\_Removed(k, months, w, scenarios, rad\_infl) – barriers removed in each scenario.

spent(months, w, scenarios, rad\_infl) – how much was spent in each scenario.

CR\_upstream(months, i, j, w, scenarios, rad\_infl) – to save the output of the CR\_upstream value in the loop.

CR\_downstream(months, i, j, w, scenarios, rad\_infl) – to save the output of the CR\_downstream value in the loop.

dam\_economic\_loss(months, w, scenarios, rad\_infl) – to save the output of the economic loss functions.

ecoObj(months, w, scenarios, rad\_infl) – to save the output from the IIC objective.

Quality\_Length(months, w, scenarios, rad\_infl) – the quality length of habitat (doesn’t have the penalty function).

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\*calculate the number of barriers between i and j. This is used to determine if a reach CRij is an unimpeded reach or not.

Barriers\_on\_path\_sum(i, j) = sum(k, path\_up(i, j, k));

**EQUATIONS:**

Weighted – the objective function value

CRterm(i, j) – defining the CR term so that you divide by the total barriers in the reach to count. This is the upstream file.

Financial – the budget constraint

economic\_loss – the economic loss in $

qual – quality habitat without passability (no penalty incorporated)

\*constrain\_num\_B – constrain the number of barriers that can be removed in each scenario