**Table A. Studies used in the synthetic analysis.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Sites | |  |  | Dependent variablesc | |
| Source*a* | RT introduced | RT native | Fish | Markersb | PRTA | PFRT |
| [1] | 27 | 0 | 751 | M | 13.3 (0–91.6) | 0(0)d |
| [2] | 0 | 3 | 143 | M | 78.8 (54.3–96.8) | 79.5 (56.3–96.8) |
| [3] | 22 | 10 | 751 | M | 4.7 (0–76.0) | 10.6 (0–97.4) |
| [4] | 25 | 0 | 248 | M | 52.2 (0–100) | 56.9 (0–100) |
| [5] | 50 | 0 | 1188 | M | 22.1 (0–90.0) | 40.3 (0–100) |
| [6] | 56 | 0 | 1462 | M | 9.3 (0–98.0) | 19.4 (0–100) |
| [7] | 0 | 17 | 839 | M | 35.4 (0–90.1) | 40.9 (96.5) |
| [8] | 6 | 0 | 232 | A | 18.8 (0–85.3) | 0(0)d |
| [9] | 0 | 32 | 1274 | M | 7.5 (0–30.3) | 0(0)d |
| [10] | 138 | 41 | 3737 | S | 11.2 (0–99.6) | 24.9 (0–100) |
| [11] | 6 | 33 | 850 | M | 48.9 (0–100) | 59.1 (0–100) |
| [12] | 0 | 92 | 1840e | P | 0(0)d | 33.2 (0–100) |

Data from studies included in the meta-analysis of introgression between westslope cutthroat trout and rainbow trout (RT). These include the published source, number of sample sites inside and outside the historical range of rainbow trout, number of genotyped fish, marker type, and the means (ranges) for each dependent variable.

*a*1. Boyer MC, Muhlfeld CC, Allendorf FW. Rainbow trout (*Oncorhynchus mykiss*) invasion and the spread of hybridization with native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*). Can J Fish Aquat Sci. 2008; 65: 658–669.

2. Campbell M, Cegelski C. Native species investigations. Grant # F-73-R-25, July 1, 2002 to June 30, 2003. Idaho Department of Fish and Game Report 03-49. 2003. 46 p.

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6. Corsi MP. Management and life history consequences of hybridization between westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) and rainbow trout (*Oncorhynchus mykiss*). Ph.D. dissertation, University of Montana, Missoula. 2011.

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9. Loxterman JL, Keeley ER, Njoroge ZM. Evaluating the influence of stocking history and barriers to movement on the spatial extent of hybridization between westslope cutthroat trout and rainbow trout. Can J Fish Aquat Sci. 2014; 71: 1050–1058.

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11. Paragamian VL, Walters J, Maiolie M, Handley K, Campbell M, Kozfkay C, et al. Kootenai River fisheries investigations: salmonid studies. Annual progress report May 1, 2007–April 30, 2008. Idaho Department of Fish and Game Report 08-21. 2008. 52 p.

12. Weigel DE, Peterson JT, Spruell P. Introgressive hybridization between native cutthroat trout and introduced rainbow trout. Ecol Appl. 2003; 13: 38–50.

bA, allozymes; M, microsatellites or other co-dominant markers; P, paired interspersed nuclear elements; S, single nucleotide polymorphisms.

cPRTA, percentage of rainbow trout alleles at a site; PFRT, percentage of fish with rainbow trout alleles at a site.

dAuthors did not report this variable, but for sites where PRTA or PFRT was zero, the other variable was set to zero.

eEstimated based on sample sizes in [12].

**Table B. Candidate variables.**

|  |  |  |
| --- | --- | --- |
| Variable | Rationale | Citationsa |
| *Abiotic* | | |
| T: mean August temperature (°C) | Declining temperature (or its surrogate, increasing elevation) is related to decreases in rainbow trout presence and introgression. Rainbow trout have metabolic rates, growth efficiencies, oxygen consumption rates, and life histories that are better adapted to warmer, more productive habitats. | [7,11,17,18,21,23,34,40,61,86,94,95,101–105] |
| S: slope (%) | Increasing slope may lead to greater bioenergetic costs for upstream migrating rainbow trout. Many salmonid species show reductions in habitat occupancy with greater slope. | [23,40,59,101,106–108] |
| MAF: mean annual flow (m3/s) | Larger, more productive streams are associated with rainbow trout, and smaller, less productive streams are associated with cutthroat trout. | [23,61,96,101,104,106,107,109,110] |
| CFM: center of flow mass, the date when 50% of the mean annual flow has been discharged | High snowmelt-driven flows in late spring and early summer are associated with declines in rainbow trout recruitment. | [85,111–114] |
| W95: number of winter days with flows among the top 5% for the year | High winter flows are positively related to rainbow trout presence and negatively related to cutthroat trout presence. | [23,59] |
| E, N: easting and northing (m) | Geographic location can serve as a surrogate for climatic and geological covariates not otherwise represented. | [51] |
| *Biotic* | | |
| DT13: Distance (m) to mean August temperature > 13 °C | Warmer streams may favor rainbow trout. Occurrence of rainbow trout peaked at this temperature in this region. | [6,7,8,11,29,35,36,95,115–117] |
| DF3: Distance (m) to mean annual flow > 2.83 m3/s | Larger streams may favor rainbow trout. This threshold exceeds those habitats generally suitable for cutthroat trout spawning. | See previous |
| DS: Shortest distance (m) to rainbow trout | The shortest distance among: 1) the two previous variables, 2) habitat known to support a naturally reproducing population of rainbow trout, or 3) habitat stocked with rainbow trout within 10 years of the time of genetic sampling. Proximity to any of these four habitats is a surrogate for proximity to rainbow trout propagules. | See previous |
| RTrange: historical range of rainbow trout (yes/no) | Occupancy over evolutionary time enabled rainbow trout to colonize a larger portion of a watershed, for hybrid zones to stabilize at their highest longitudinal point, and for levels of introgression to achieve a quasi-equilibrium. In some cases, being in the range of rainbow trout equates to exposure to the more fecund, anadromous form, steelhead, which may increase propagule pressure from rainbow trout. | [18,74,80] |
| YCTI: Yellowstone cutthroat trout introgression (yes/no) | Populations of westslope cutthroat trout may form hybrid swarms after contact with Yellowstone cutthroat trout. Three-way hybrids with rainbow trout can be common in these hybrid swarms, suggesting that hybridization between the cutthroat trout subspecies may form a genetic bridge to introgression with rainbow trout. | [18,118–121] |

Candidate variables considered in the logistic models, the rationale for their inclusion and expected effect, and supporting citations.

aReference numbering continues from the online text.

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**Table C. Covariate correlation matrix.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | T | S | CFM | W95 | MAF | DF3 | DT13 | DS | N | E | PRTA |
| S | -0.27 |  |  |  |  |  |  |  |  |  |  |
| CFM | -0.32 | 0.00 |  |  |  |  |  |  |  |  |  |
| W95 | 0.33 | -0.03 | -0.84 |  |  |  |  |  |  |  |  |
| MAF | 0.34 | -0.40 | 0.20 | -0.23 |  |  |  |  |  |  |  |
| DF3 | -0.33 | -0.05 | 0.08 | -0.07 | -0.29 |  |  |  |  |  |  |
| DT13 | -0.60 | -0.03 | 0.33 | -0.30 | -0.04 | 0.27 |  |  |  |  |  |
| DS | -0.60 | -0.01 | 0.24 | -0.20 | -0.28 | 0.65 | 0.55 |  |  |  |  |
| N | 0.12 | 0.04 | -0.13 | -0.03 | 0.10 | -0.13 | -0.10 | -0.20 |  |  |  |
| E | -0.29 | -0.19 | 0.09 | 0.06 | -0.14 | 0.20 | 0.27 | 0.25 | -0.38 |  |  |
| PRTA | 0.50 | -0.18 | -0.10 | 0.05 | 0.29 | -0.20 | -0.34 | -0.35 | 0.11 | -0.13 |  |
| PFRT | 0.55 | -0.24 | -0.12 | 0.13 | 0.33 | -0.24 | -0.33 | -0.42 | 0.03 | -0.08 | 0.89 |

Correlations among environmental covariates and introgression estimates at the 558 stream sites in the dataset.

**Table D. Model selection results for 10% PRTA.**

|  |  |  |
| --- | --- | --- |
| Rank | Model | AIC |
| 1 | T + RTrange + DS + DT13 + MAF + E | 433.13 |
| 2 | T + RTrange + DS + DT13 + MAF + E + YCTI | 433.51 |
| 3 | T + RTrange + DS + DT13 + MAF + E + W95 | 434.27 |
| 4 | T + RTrange + DS + DT13 + MAF + E + S | 434.32 |
| 5 | T + RTrange + DS + DT13 + MAF + E + S + YCTI | 434.61 |
| 6 | T + RTrange + DS + DT13 + MAF + E + W95 + YCTI | 435.06 |
| 7 | T + RTrange + DS + DT13 + MAF + E + DF3 | 435.11 |
| 8 | T + RTrange + DS + DT13 + MAF + E + S + W95 | 435.28 |
| 9 | T + RTrange + DS + DT13 + MAF + E + DF3 + YCTI | 435.34 |
| 10 | T + RTrange + DS + DT13 + MAF + E + S + W95 + YCTI | 436.02 |
| 11 | T + RTrange + DS + DT13 + MAF + E + DF3 + W95 | 436.21 |
| 12 | T + RTrange + DS + DT13 + MAF + E + DF3 + S | 436.28 |
| 13 | T + RTrange + DS + DT13 + MAF + E + DF3 + S + YCTI | 436.38 |
| 14 | T + RTrange + DS + DT13 + E + S + W95 | 436.54 |
| 15 | T + RTrange + DS + DT13 + MAF + E + DF3 + W95 + YCTI | 436.85 |
| 16 | RTrange + DS + DT13 + MAF + E + S | 436.97 |
| 17 | RTrange + DS + DT13 + MAF + E + S + YCTI | 437.08 |
| 18 | T + RTrange + DS + DT13 + MAF + E + DF3 + S + W95 | 437.18 |
| 19 | T + RTrange + DS + DT13 + E + S + W95 + YCTI | 437.61 |
| 20 | T + RTrange + DS + DT13 + MAF + E + DF3 + S + W95 + YCTI | 437.73 |
|  | T | 484.96 |
|  | DS | 495.27 |
|  | DT13 | 499.36 |
|  | MAF | 557.78 |
|  | RTrange | 579.24 |
|  | E | 589.13 |

Model selection results for logistic regression equations relating environmental covariates to whether sites exceeded 10% rainbow trout alleles (PRTA). The 20 top models are ranked from most to least plausible, along with single-variable models for each of the covariates in the consensus model. Underlined variables had coefficients that were not significantly different from zero. The top-ranked model is the consensus model.

**Table E. Descriptive covariate statistics.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Mean | Median | SD | Minimum | Maximum |
| T (°C) | 11.73 | 11.50 | 2.67 | 3.91 | 27.36 |
| S (%) | 0.037 | 0.030 | 0.029 | 0 | 0.100 |
| CFM (day) | 193 | 212 | 64 | 0 | 280 |
| W95 (days) | 1.24 | 0.40 | 1.79 | 0 | 18.45 |
| MAF (m3/s) | 0.641 | 0.221 | 1.016 | 0.028 | 5.653 |
| DF3 (m) | 19374 | 11559 | 31126 | 0 | 200000 |
| DT13 (m) | 13211 | 5898 | 24690 | 0 | 200000 |
| DS (m) | 5785 | 2876 | 13667 | 0 | 200000 |
| N (m) | 1841862 | 1851978 | 140886 | 1516682 | 2098463 |
| E (m) | 1535116 | 1539858 | 142958 | 1234229 | 1862914 |

Descriptive statistics for model covariates throughout the 55,234-km stream network in the study area.