Chapter 3 Results

# **Occupancy Modeling**

## Longnose Dace:

lnd.results.p

AICc DeltaAICc weight Deviance

p(~1)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m) 8 232.1214 0.0000000 4.468482e-01 215.01375

p(~pctcbbl)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m) 9 232.8778 0.7564065 3.061318e-01 213.48250

p(~mFlow)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m) 9 234.2962 2.1747765 1.506306e-01 214.90087

p(~pctcbbl + mFlow)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m) 10 235.1891 3.0676477 9.638930e-02 213.470

p(~1)Psi(~1) 2 274.3253 42.2038430 3.059934e-10 14.31515

p(~pctcbbl)Psi(~1) 3 275.1556 43.0341955 2.020241e-10 268.97786

p(~mFlow)Psi(~1) 3 276.3634 44.2420055 1.104411e-10 270.18567

p(~pctcbbl + mFlow)Psi(~1) 4 277.2700 45.1485752 7.018940e-11 268.97151

> summary(lnd.results.p$p.Dot.Psi.global)#top model

Output summary for Occupancy model

Name : p(~1)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m)

Npar : 8

-2lnL: 215.0137

AICc : 232.1214

Beta

estimate se lcl ucl

p:(Intercept) 0.7886324 0.2370637 0.3239876 1.2532771

Psi:(Intercept) -13.7424040 3.4036133 -20.4134860 -7.0713218

Psi:Area\_km2 0.0815432 0.0430690 -0.0028721 0.1659586

Psi:pctcbbl 0.0262324 0.0126095 0.0015178 0.0509471

Psi:elev\_m -0.0155926 0.0067008 -0.0287261 -0.0024590

Psi:avgT 0.9264744 0.2170951 0.5009680 1.3519809

Psi:med\_len 0.0016041 0.0022830 -0.0028705 0.0060787

Psi:BRT\_100m -0.0606896 0.0355451 -0.1303581 0.0089789

Real Parameter p

1 2 3

0.6875376 0.6875376 0.6875376

Real Parameter Psi

1

0.1194406

> lnd.results.p$p.Dot.Psi.global$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.6875376 0.0509283 0.5802958 0.7778666

Psi g1 a0 t1 0.1194406 0.0394681 0.0610394 0.2205914

> summary(lnd.results.p$p.cobble.Psi.global)#2nd model

Output summary for Occupancy model

Name : p(~pctcbbl)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m)

Npar : 9

-2lnL: 213.4825

AICc : 232.8778

Beta

estimate se lcl ucl

p:(Intercept) 1.5576146 0.6915590 0.2021589 2.9130703

p:pctcbbl -0.0120534 0.0099921 -0.0316378 0.0075311

Psi:(Intercept) -13.8394640 3.4188226 -20.5403560 -7.1385713

Psi:Area\_km2 0.0838281 0.0443854 -0.0031673 0.1708235

Psi:pctcbbl 0.0275105 0.0128240 0.0023754 0.0526456

Psi:elev\_m -0.0155999 0.0066934 -0.0287189 -0.0024808

Psi:avgT 0.9269554 0.2166546 0.5023124 1.3515984

Psi:med\_len 0.0016313 0.0022835 -0.0028444 0.0061069

Psi:BRT\_100m -0.0612748 0.0359630 -0.1317624 0.0092127

Real Parameter p

1 2 3

0.7028076 0.7028076 0.7028076

Real Parameter Psi

1

0.1193774

> lnd.results.p$p.cobble.Psi.global$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.7028076 0.0520978 0.5918997 0.7940614

Psi g1 a0 t1 0.1193774 0.0394964 0.0609555 0.2206368

> summary(lnd.results.p$p.flow.Psi.global)#3rd model

Output summary for Occupancy model

Name : p(~mFlow)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m)

Npar : 9

-2lnL: 214.9009

AICc : 234.2962

Beta

estimate se lcl ucl

p:(Intercept) 1.0405909 0.7878773 -0.5036487 2.5848305

p:mFlow -0.9550091 2.8440446 -6.5293366 4.6193183

Psi:(Intercept) -13.7652080 3.4061153 -20.4411950 -7.0892223

Psi:Area\_km2 0.0812543 0.0429947 -0.0030154 0.1655239

Psi:pctcbbl 0.0261453 0.0125945 0.0014600 0.0508305

Psi:elev\_m -0.0155597 0.0066998 -0.0286913 -0.0024280

Psi:avgT 0.9274844 0.2175057 0.5011731 1.3537957

Psi:med\_len 0.0016339 0.0022932 -0.0028608 0.0061287

Psi:BRT\_100m -0.0606076 0.0355418 -0.1302696 0.0090543

Real Parameter p

1 2 3

0.6918858 0.6918858 0.6918858

Real Parameter Psi

1

0.1193551

> lnd.results.p$p.flow.Psi.global$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.6918858 0.0522079 0.5815025 0.7839705

Psi g1 a0 t1 0.1193551 0.0394418 0.0609948 0.2204458

> summary(lnd.results.p$p.flow.Psi.global) # 4th model

Output summary for Occupancy model

Name : p(~mFlow)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m)

Npar : 9

-2lnL: 214.9009

AICc : 234.2962

Beta

estimate se lcl ucl

p:(Intercept) 1.0405909 0.7878773 -0.5036487 2.5848305

p:mFlow -0.9550091 2.8440446 -6.5293366 4.6193183

Psi:(Intercept) -13.7652080 3.4061153 -20.4411950 -7.0892223

Psi:Area\_km2 0.0812543 0.0429947 -0.0030154 0.1655239

Psi:pctcbbl 0.0261453 0.0125945 0.0014600 0.0508305

Psi:elev\_m -0.0155597 0.0066998 -0.0286913 -0.0024280

Psi:avgT 0.9274844 0.2175057 0.5011731 1.3537957

Psi:med\_len 0.0016339 0.0022932 -0.0028608 0.0061287

Psi:BRT\_100m -0.0606076 0.0355418 -0.1302696 0.0090543

Real Parameter p

1 2 3

0.6918858 0.6918858 0.6918858

Real Parameter Psi

1

0.1193551

> lnd.results.p$p.flow.Psi.global$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.6918858 0.0522079 0.5815025 0.7839705

Psi g1 a0 t1 0.1193551 0.0394418 0.0609948 0.2204458

##Examine model list and look at model comparisons

> lnd.results.psi

model npar AICc DeltaAICc weight Deviance

p(~1)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT) 6 231.2474 0.0000000 6.075545e-01 218.61099

p(~1)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT + med\_len + BRT\_100m) 8 232.1214 0.8740887 3.924455e-01 215.01375

p(~1)Psi(~med\_len + BRT\_100m) 4 266.9726 35.7252538 1.061561e-08 258.67410

p(~1)Psi(~1) 2 274.3253 43.0779317 2.687393e-10 14.31515

summary(lnd.results.psi$p.Dot.Psi.habitat) #top model

Output summary for Occupancy model

Name : p(~1)Psi(~Area\_km2 + pctcbbl + elev\_m + avgT)

Npar : 6

-2lnL: 218.611

AICc : 231.2474

Beta

estimate se lcl ucl

p:(Intercept) 0.7823878 0.2384095 3.151051e-01 1.2496705

Psi:(Intercept) -15.4437790 3.3193149 -2.194964e+01 -8.9379221

Psi:Area\_km2 0.0683042 0.0388057 -7.755000e-03 0.1443634

Psi:pctcbbl 0.0225937 0.0112367 5.697491e-04 0.0446176

Psi:elev\_m -0.0141943 0.0064995 -2.693320e-02 -0.0014553

Psi:avgT 1.0182769 0.2143316 5.981871e-01 1.4383668

Real Parameter p

1 2 3

0.6861945 0.6861945 0.6861945

Real Parameter Psi

1

0.1259741

> lnd.results.psi$p.Dot.Psi.habitat$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.6861945 0.0513371 0.5781309 0.7772428

Psi g1 a0 t1 0.1259741 0.0395827 0.0665051 0.2257596

## Southern Redbelly Dace:

|  |  |
| --- | --- |
| |  | | --- | | srd.results.p  model npar AICc DeltaAICc weight Deviance  2 p(~1)Psi(~avgT + avdep + pctfines + med\_len + BRT\_100m) 7 253.1339 0.0000000 6.135489e-01 238.27893  4 p(~mFlow)Psi(~avgT + avdep + pctfines + med\_len + BRT\_100m) 8 254.0584 0.9245105 3.864509e-01 236.95071  1 p(~1)Psi(~1) 2 284.5240 31.3900635 9.366634e-08 16.67921  3 p(~mFlow)Psi(~1) 3 285.3329 32.1990159 6.250601e-08 279.15513  > #Two models <2 DeltaAICc  > summary(srd.results.p$p.Dot.Psi.global) #top model  Output summary for Occupancy model  Name : p(~1)Psi(~avgT + avdep + pctfines + med\_len + BRT\_100m)  Npar : 7  -2lnL: 238.2789  AICc : 253.1339  Beta  estimate se lcl ucl  p:(Intercept) 1.624430e-01 0.2400490 -0.3080530 0.6329390  Psi:(Intercept) -9.842362e+00 2.8293307 -15.3878500 -4.2968737  Psi:avgT 4.886556e-01 0.1622782 0.1705904 0.8067208  Psi:avdep 6.524987e+00 2.9944520 0.6558614 12.3941140  Psi:pctfines -7.635700e-03 0.0114258 -0.0300303 0.0147589  Psi:med\_len -8.677439e-05 0.0025719 -0.0051277 0.0049541  Psi:BRT\_100m -2.214255e-01 0.1346690 -0.4853767 0.0425256  Real Parameter p  1 2 3  0.5405217 0.5405217 0.5405217  Real Parameter Psi  1  0.0918079  > srd.results.p$p.Dot.Psi.global$results$real  estimate se lcl ucl fixed note  p g1 a0 t1 0.5405217 0.0596181 0.4235900 0.6531556  Psi g1 a0 t1 0.0918079 0.0638426 0.0220421 0.3119528  > summary(srd.results.p$p.flow.Psi.global) #2nd model  Output summary for Occupancy model  Name : p(~mFlow)Psi(~avgT + avdep + pctfines + med\_len + BRT\_100m)  Npar : 8  -2lnL: 236.9507  AICc : 254.0584  Beta  estimate se lcl ucl  p:(Intercept) -0.415953700 0.5560697 -1.5058503 0.6739428  p:mFlow 2.302377800 2.0069447 -1.6312339 6.2359895  Psi:(Intercept) -9.923993400 2.8838260 -15.5762930 -4.2716943  Psi:avgT 0.495378200 0.1663385 0.1693546 0.8214018  Psi:avdep 6.469377900 3.0698073 0.4525556 12.4862000  Psi:pctfines -0.007259100 0.0115693 -0.0299349 0.0154167  Psi:med\_len -0.000239252 0.0025410 -0.0052195 0.0047410  Psi:BRT\_100m -0.218558600 0.1325039 -0.4782662 0.0411490  Real Parameter p  1 2 3  0.5355637 0.5355637 0.5355637  Real Parameter Psi  1  0.0937626  > srd.results.p$p.flow.Psi.global$results$real  estimate se lcl ucl fixed note  p g1 a0 t1 0.5355637 0.0600660 0.4180419 0.6492645  Psi g1 a0 t1 0.0937626 0.0643118 0.0229326 0.3132267  srd.results.psi  model npar AICc DeltaAICc weight Deviance  2 p(~1)Psi(~avgT + avdep + pctfines + med\_len + BRT\_100m) 7 253.1339 0.000000 9.671871e-01 238.27893  3 p(~1)Psi(~avgT + avdep + pctfines) 5 260.0342 6.900296 3.069943e-02 249.58306  4 p(~1)Psi(~med\_len + BRT\_100m) 4 265.3861 12.252246 2.113339e-03 257.08763  1 p(~1)Psi(~1) 2 284.5240 31.390063 1.476539e-07 16.67921  summary(srd.results.psi$p.Dot.Psi.habitat) #2nd model (delta AIC = 6.9)  Output summary for Occupancy model  Name : p(~1)Psi(~avgT + avdep + pctfines)  Npar : 5  -2lnL: 249.5831  AICc : 260.0342  Beta  estimate se lcl ucl  p:(Intercept) 0.1603681 0.2401971 -0.3104182 0.6311544  Psi:(Intercept) -12.8754690 2.7519673 -18.2693250 -7.4816128  Psi:avgT 0.6363484 0.1574323 0.3277812 0.9449157  Psi:avdep 5.2690352 2.7106926 -0.0439225 10.5819930  Psi:pctfines 0.0062654 0.0103134 -0.0139489 0.0264797  Real Parameter p  1 2 3  0.5400063 0.5400063 0.5400063  Real Parameter Psi  1  0.1962996  > srd.results.psi$p.Dot.Psi.habitat$results$real  estimate se lcl ucl fixed note  p g1 a0 t1 0.5400063 0.0596648 0.4230127 0.6527512  Psi g1 a0 t1 0.1962996 0.0438787 0.1240408 0.2964084 | |

## Cottus:

cott.results.p

model npar AICc DeltaAICc weight Deviance

p(~mFlow)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m) 9 143.9335 0.000000 6.720419e-01 124.538190

p(~pctcbbl + mFlow)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m) 10 146.2448 2.311281 2.115963e-01 124.526070

p(~1)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m) 8 148.3359 4.402373 7.437605e-02 131.228220

p(~pctcbbl)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m) 9 149.4796 5.546070 4.198388e-02 130.084260

p(~mFlow)Psi(~1) 3 170.2823 26.348799 1.275931e-06 164.104560

p(~pctcbbl + mFlow)Psi(~1) 4 172.2666 28.333109 4.730859e-07 163.968140

p(~1)Psi(~1) 2 175.5223 31.588716 9.289530e-08 1.972209

p(~pctcbbl)Psi(~1) 3 176.5365 32.603009 5.594263e-08 170.358770

summary(cott.results.p$p.flow.Psi.global) #top model

Output summary for Occupancy model

Name : p(~mFlow)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m)

Npar : 9

-2lnL: 124.5382

AICc : 143.9335

Beta

estimate se lcl ucl

p:(Intercept) 3.1366427 0.8127890 1.5435761 4.7297092

p:mFlow -7.3736621 3.0282673 -13.3090660 -1.4382581

Psi:(Intercept) -1.3831533 2.8490446 -6.9672807 4.2009741

Psi:avgT -0.2150982 0.1589346 -0.5266101 0.0964137

Psi:mFlow -6.7035645 4.1191305 -14.7770600 1.3699313

Psi:HAiFLS\_for 0.0394516 0.0140849 0.0118453 0.0670579

Psi:boulder 1.3140131 0.5945395 0.1487157 2.4793105

Psi:med\_len 0.0098018 0.0040482 0.0018673 0.0177363

Psi:BRT\_100m 0.0463681 0.0204019 0.0063804 0.0863558

Real Parameter p

1 2 3

0.793825 0.793825 0.793825

Real Parameter Psi

1

0.0339142

> cott.results.p$p.flow.Psi.global$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.7938250 0.0619249 0.6471543 0.8899001

Psi g1 a0 t1 0.0339142 0.0230668 0.0087552 0.1224398

> #only one model <2 DeltaAICc

> summary(cott.results.p$p.full.Psi.global) #2nd model

Output summary for Occupancy model

Name : p(~pctcbbl + mFlow)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m)

Npar : 10

-2lnL: 124.5261

AICc : 146.2448

Beta

estimate se lcl ucl

p:(Intercept) 3.3033125 1.7298786 -0.0872498 6.6938747

p:pctcbbl -0.0027664 0.0251357 -0.0520323 0.0464995

p:mFlow -7.2374559 3.2600048 -13.6270660 -0.8478463

Psi:(Intercept) -1.3781579 2.8488978 -6.9619977 4.2056819

Psi:avgT -0.2153120 0.1589589 -0.5268715 0.0962476

Psi:mFlow -6.7157126 4.1181795 -14.7873450 1.3559194

Psi:HAiFLS\_for 0.0394368 0.0140847 0.0118307 0.0670428

Psi:boulder 1.3153372 0.5948391 0.1494526 2.4812218

Psi:med\_len 0.0098020 0.0040466 0.0018707 0.0177334

Psi:BRT\_100m 0.0463532 0.0203708 0.0064265 0.0862799

Real Parameter p

1 2 3

0.8002559 0.8002559 0.8002559

Real Parameter Psi

1

0.0338767

> cott.results.p$p.full.Psi.global$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.8002559 0.0839876 0.5885703 0.9181694

Psi g1 a0 t1 0.0338767 0.0230427 0.0087450 0.1223203

cott.results.psi

model npar AICc DeltaAICc weight Deviance

p(~mFlow)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m) 9 143.9335 0.00000 0.9963713400 124.5382

p(~mFlow)Psi(~avgT + mFlow + HAiFLS\_for + boulder) 7 155.2992 11.36565 0.0033915720 140.4442

p(~mFlow)Psi(~med\_len + BRT\_100m) 5 160.6364 16.70291 0.0002351964 150.1853

p(~mFlow)Psi(~1) 3 170.2823 26.34880 0.0000018917 164.1046

summary(cott.results.psi$p.flow.Psi.global) #top model

Output summary for Occupancy model

Name : p(~mFlow)Psi(~avgT + mFlow + HAiFLS\_for + boulder + med\_len + BRT\_100m)

Npar : 9

-2lnL: 124.5382

AICc : 143.9335

Beta

estimate se lcl ucl

p:(Intercept) 3.1366427 0.8127892 1.5435759 4.7297095

p:mFlow -7.3736621 3.0282677 -13.3090670 -1.4382572

Psi:(Intercept) -1.3831524 2.8490485 -6.9672875 4.2009827

Psi:avgT -0.2150982 0.1589348 -0.5266104 0.0964140

Psi:mFlow -6.7035678 4.1191326 -14.7770680 1.3699322

Psi:HAiFLS\_for 0.0394516 0.0140849 0.0118452 0.0670579

Psi:boulder 1.3140128 0.5945395 0.1487153 2.4793104

Psi:med\_len 0.0098018 0.0040482 0.0018673 0.0177363

Psi:BRT\_100m 0.0463681 0.0204019 0.0063804 0.0863558

Real Parameter p

1 2 3

0.793825 0.793825 0.793825

Real Parameter Psi

1

0.0339142

> cott.results.psi$p.flow.Psi.global$results$real

estimate se lcl ucl fixed note

p g1 a0 t1 0.7938250 0.0619248 0.6471543 0.8899001

Psi g1 a0 t1 0.0339142 0.0230668 0.0087552 0.1224398

# **CPUE comparisons and modeling:**

## Comparisons of CPUE b/w sites with and without Brown Trout:

#############################################################################

>

> # Mann Whitney U / Wilcox Sign Rank Test

>

> #-----

> #LND

> #-----

> #full dataset

> #two sided

> wilcox.test(a, b, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: a and b

W = 2307.5, p-value = 0.5831

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-5.583791e-06 2.437085e-05

sample estimates:

difference in location

-4.314327e-05

#-----

> #SRD

> #-----

> #full dataset

> #two sided

> wilcox.test(a3, b3, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: a3 and b3

W = 2823.5, p-value = 0.01801

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-4.732444e-05 3.729619e-06

sample estimates:

difference in location

7.413037e-05

> #greater without

> wilcox.test(a3, b3, mu=0, alt="g", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: a3 and b3

W = 2823.5, p-value = 0.009007

alternative hypothesis: true location shift is greater than 0

95 percent confidence interval:

9.185121e-06 Inf

sample estimates:

difference in location

7.413037e-05

#-----

> #Cottus

> #-----

> #full dataset

> #two sided

> wilcox.test(aa, bb, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: aa and bb

W = 1894, p-value = 0.0004144

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-3.932663e-05 -3.271496e-05

sample estimates:

difference in location

-2.911935e-06

> #greater than

> wilcox.test(aa, bb, mu=0, alt="g", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: aa and bb

W = 1894, p-value = 0.9998

alternative hypothesis: true location shift is greater than 0

95 percent confidence interval:

-8.490874e-06 Inf

sample estimates:

difference in location

-2.911935e-06

>

> #less than without BRT

> wilcox.test(aa, bb, mu=0, alt="l", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: aa and bb

W = 1894, p-value = 0.0002072

alternative hypothesis: true location shift is less than 0

95 percent confidence interval:

-Inf -2.270222e-05

sample estimates:

difference in location

-2.911935e-06

# CPUE Modeling Results:

## Longnose Dace:

summary(lnd.full.mod)

Top Model

Call:

zeroinfl(formula = LND\_ab ~ avwid + pctcbbl + pctSlope + med\_len + BRT\_100m |

1, data = newdata, offset = log(SegLen), dist = "negbin")

Pearson residuals:

Min 1Q Median 3Q Max

-0.2997 -0.2938 -0.2850 -0.2518 7.9494

Count model coefficients (negbin with log link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -7.723982 1.112132 -6.945 3.78e-12 \*\*\*

avwid 0.746383 0.318024 2.347 0.01893 \*

pctcbbl 0.018577 0.015538 1.196 0.23187

pctSlope -0.078077 0.040156 -1.944 0.05185 .

med\_len 0.002687 0.004186 0.642 0.52095

BRT\_100m -0.080822 0.029557 -2.734 0.00625 \*\*

Log(theta) -2.409503 0.212184 -11.356 < 2e-16 \*\*\*

Zero-inflation model coefficients (binomial with logit link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -8.764 49.718 -0.176 0.86

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Theta = 0.0899

Number of iterations in BFGS optimization: 35

Log-likelihood: -188.5 on 8 Df

parms

Est pLL pUL bcaLL bcaUL

count\_(Intercept) -7.724745099 -11.920635170 -6.05191148 -10.163062277 -5.237282810

count\_avwid 0.746678327 0.282935008 1.59415250 -0.015348765 1.246427234

count\_pctcbbl 0.018571577 -0.019220362 0.05674030 -0.016666208 0.059186993

count\_pctSlope -0.078073066 -0.223670599 -0.02195588 -0.172019982 -0.004146306

count\_med\_len 0.002687595 -0.004198554 0.01380220 -0.004896472 0.012599329

count\_BRT\_100m -0.080829722 -0.491908865 -0.03061826 -0.363098536 0.002675183

zero\_(Intercept) -10.455361106 -12.780162788 -8.49216526 -12.451733221 -1.511582566

expparms

Est pLL pUL bcaLL bcaUL

count\_(Intercept) 4.417594e-04 6.651720e-06 0.0023533593 3.856898e-05 0.005314678

count\_avwid 2.109980e+00 1.327019e+00 4.9241540896 9.847684e-01 3.477895028

count\_pctcbbl 1.018745e+00 9.809632e-01 1.0583809105 9.834719e-01 1.060973617

count\_pctSlope 9.248968e-01 7.995785e-01 0.9782833985 8.419623e-01 0.995862278

count\_med\_len 1.002691e+00 9.958102e-01 1.0138978878 9.951155e-01 1.012679035

count\_BRT\_100m 9.223507e-01 6.114581e-01 0.9698457312 6.955179e-01 1.002678765

zero\_(Intercept) 2.879349e-05 2.816086e-06 0.0002050709 3.910938e-06 0.220560650

> summary(lnd.env.mod)

Call:

zeroinfl(formula = LND\_ab ~ avwid + pctcbbl + pctSlope | 1, data = newdata,

offset = log(SegLen), dist = "negbin")

Pearson residuals:

Min 1Q Median 3Q Max

-0.2831 -0.2798 -0.2728 -0.2466 9.4851

Count model coefficients (negbin with log link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -7.35352 1.10184 -6.674 2.49e-11 \*\*\*

avwid 0.57710 0.27589 2.092 0.0365 \*

pctcbbl 0.02070 0.01136 1.823 0.0684 .

pctSlope -0.06575 0.04298 -1.530 0.1261

Log(theta) -2.52316 0.20901 -12.072 < 2e-16 \*\*\*

Zero-inflation model coefficients (binomial with logit link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -9.749 117.426 -0.083 0.934

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Theta = 0.0802

Number of iterations in BFGS optimization: 59

Log-likelihood: -191.4 on 6 Df

## Sculpins:

summary(cott.full.mod)

Call:

zeroinfl(formula = Cottus\_ab ~ avgT + HAiFLS\_for + mFlow + med\_len + BRT\_100m | 1, data = newdata, offset = log(SegLen),

dist = "negbin")

Pearson residuals:

Min 1Q Median 3Q Max

-0.26738 -0.26138 -0.16368 -0.03422 7.18254

Count model coefficients (negbin with log link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -1.561031 7.997958 -0.195 0.84525

avgT -0.468800 0.494991 -0.947 0.34359

HAiFLS\_for 0.085882 0.022072 3.891 9.98e-05 \*\*\*

mFlow -13.060838 4.605503 -2.836 0.00457 \*\*

med\_len 0.018635 0.008924 2.088 0.03679 \*

BRT\_100m 0.060184 0.038877 1.548 0.12161

Log(theta) -2.631455 0.306384 -8.589 < 2e-16 \*\*\*

Zero-inflation model coefficients (binomial with logit link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -5.133 21.834 -0.235 0.814

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Theta = 0.072

Number of iterations in BFGS optimization: 35

Log-likelihood: -137.7 on 8 Df

parms.cott

Est pLL pUL bcaLL bcaUL

count\_(Intercept) -1.37079969 -18.599959872 20.10494943 -24.932464825 16.09526724

count\_avgT -0.48094282 -1.841879564 0.45429781 -1.582112118 0.79643030

count\_HAiFLS\_for 0.08575467 0.017181258 0.18369239 0.014231349 0.17511631

count\_mFlow -13.13191973 -43.471900078 -1.94945204 -37.402163857 0.30753202

count\_med\_len 0.01871544 0.003314916 0.04717862 0.005964522 0.05533996

count\_BRT\_100m 0.05963046 -0.086391434 0.19017092 -0.116836387 0.16215207

zero\_(Intercept) -7.84949182 -9.868391857 1.06293769 -36.186105357 -0.32487371

>

> ## compare with normal based approximation

> confint(cott.full.mod)

2.5 % 97.5 %

count\_(Intercept) -17.236741306 14.11467835

count\_avgT -1.438965462 0.50136547

count\_HAiFLS\_for 0.042621445 0.12914180

count\_mFlow -22.087458463 -4.03421849

count\_med\_len 0.001143765 0.03612535

count\_BRT\_100m -0.016013353 0.13638057

zero\_(Intercept) -47.925543842 37.66032368

>

> expparms.cott

Est pLL pUL bcaLL bcaUL

count\_(Intercept) 2.539038e-01 8.358731e-09 5.388706e+08 1.485827e-11 9.774302e+06

count\_avgT 6.182003e-01 1.585193e-01 1.575067e+00 2.055405e-01 2.217611e+00

count\_HAiFLS\_for 1.089539e+00 1.017330e+00 1.201646e+00 1.014333e+00 1.191385e+00

count\_mFlow 1.980978e-06 1.319585e-19 1.423525e-01 5.707509e-17 1.360064e+00

count\_med\_len 1.018892e+00 1.003320e+00 1.048309e+00 1.005982e+00 1.056900e+00

count\_BRT\_100m 1.061444e+00 9.172351e-01 1.209456e+00 8.897308e-01 1.176039e+00

zero\_(Intercept) 3.899501e-04 5.178598e-05 2.894865e+00 1.925636e-16 7.226186e-01

## Southern Redbelly Dace:

summary(srd.full.mod)

Call:

zeroinfl(formula = SRD\_ab ~ avgT + pctfines + avdep + med\_len + BRT\_100m | 1, data = newdata, offset = log(SegLen), dist = "negbin")

Pearson residuals:

Min 1Q Median 3Q Max

-0.41959 -0.38742 -0.26031 -0.01657 5.17630

Count model coefficients (negbin with log link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -17.701774 3.536560 -5.005 5.58e-07 \*\*\*

avgT 0.800421 0.201010 3.982 6.83e-05 \*\*\*

pctfines -0.017629 0.016229 -1.086 0.2774

avdep 3.676087 3.587173 1.025 0.3055

med\_len -0.005156 0.002801 -1.840 0.0657 .

BRT\_100m -0.308615 0.154732 -1.995 0.0461 \*

Log(theta) -1.732043 0.226972 -7.631 2.33e-14 \*\*\*

Zero-inflation model coefficients (binomial with logit link):

Estimate Std. Error z value Pr(>|z|)

(Intercept) -9.172 84.719 -0.108 0.914

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Theta = 0.1769

Number of iterations in BFGS optimization: 52

Log-likelihood: -156.1 on 8 Df

parms.srd

Est pLL pUL bcaLL bcaUL

count\_(Intercept) -17.673130196 -25.47295965 -12.696204847 -24.74999399 -12.280395712

count\_avgT 0.798958590 0.46041137 1.254449123 0.48374627 1.298964358

count\_pctfines -0.017652109 -0.04661022 0.016123798 -0.05002931 0.012149007

count\_avdep 3.660855848 -3.16020161 12.730293586 -4.97316765 10.726395604

count\_med\_len -0.005149499 -0.01035594 0.005014264 -0.01340516 0.001056494

count\_BRT\_100m -0.308938657 -1.24201809 -0.146149946 -0.96471711 -0.096949985

zero\_(Intercept) -9.536313720 -10.78007414 -0.601502818 -13.76755024 -9.198393041

>

> ## compare with normal based approximation

> confint(srd.full.mod)

2.5 % 97.5 %

count\_(Intercept) -24.63330520 -1.077024e+01

count\_avgT 0.40644813 1.194394e+00

count\_pctfines -0.04943650 1.417865e-02

count\_avdep -3.35464189 1.070682e+01

count\_med\_len -0.01064645 3.347399e-04

count\_BRT\_100m -0.61188526 -5.345241e-03

zero\_(Intercept) -175.21754651 1.568734e+02

expparms.srd

Est pLL pUL bcaLL bcaUL

count\_(Intercept) 2.111821e-08 8.654375e-12 3.062728e-06 1.783258e-11 4.641859e-06

count\_avgT 2.223224e+00 1.584726e+00 3.505907e+00 1.622140e+00 3.665499e+00

count\_pctfines 9.825028e-01 9.544594e-01 1.016254e+00 9.512015e-01 1.012223e+00

count\_avdep 3.889462e+01 4.241721e-02 3.378288e+05 6.921189e-03 4.554224e+04

count\_med\_len 9.948637e-01 9.896975e-01 1.005027e+00 9.866843e-01 1.001057e+00

count\_BRT\_100m 7.342258e-01 2.888008e-01 8.640281e-01 3.810910e-01 9.076014e-01

zero\_(Intercept) 7.218244e-05 2.081007e-05 5.479913e-01 1.049129e-06 1.012019e-04

# **Size Comparisons:**

#-----

> #LND

> #-----

> ## compare across BRT status

> #size class 1

> wilcox.test(lnd.comp$bin1\_LND ~ lnd.comp$BRT, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: lnd.comp$bin1\_LND by lnd.comp$BRT

W = 152.5, p-value = 0.3945

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-6.422167e-05 1.999979e+00

sample estimates:

difference in location

4.42754e-06

> # p-value = 0.3945

>

> #size class 2

> wilcox.test(lnd.comp$bin2\_LND ~ lnd.comp$BRT, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: lnd.comp$bin2\_LND by lnd.comp$BRT

W = 121, p-value = 0.6726

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-8.999991 2.999968

sample estimates:

difference in location

-0.5205225

> # p-value = 0.6726

>

> #size class 3

> wilcox.test(lnd.comp$bin3\_LND ~ lnd.comp$BRT, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: lnd.comp$bin3\_LND by lnd.comp$BRT

W = 145.5, p-value = 0.6321

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-1.476669e-05 1.000009e+00

sample estimates:

difference in location

2.463477e-05

> # p-value = 0.6321

#-----

> #SRD

> #-----

> #-----tests

> #size class 1

> wilcox.test(aa1, bb1, mu=0, alt="g", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: aa1 and bb1

W = 165, p-value = 0.06527

alternative hypothesis: true location shift is greater than 0

95 percent confidence interval:

-1.014168e-05 Inf

sample estimates:

difference in location

0.999963

> #size class 2

> wilcox.test(aa2, bb2, mu=0, alt="g", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: aa2 and bb2

W = 137, p-value = 0.3443

alternative hypothesis: true location shift is greater than 0

95 percent confidence interval:

-1.000027 Inf

sample estimates:

difference in location

2.122537e-05

> #size class 3

> wilcox.test(aa3, bb3, mu=0, alt="g", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: aa3 and bb3

W = 126.5, p-value = 0.5

alternative hypothesis: true location shift is greater than 0

95 percent confidence interval:

-3.328354e-05 Inf

sample estimates:

difference in location

1.120899e-05

#-----

> #Cottus

> #-----

> ## compare across BRT status

> #size class 1

> wilcox.test(cott.comp$bin1\_Cottus ~ cott.comp$BRT, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: cott.comp$bin1\_Cottus by cott.comp$BRT

W = 15, p-value = 0.7411

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-71.00002 14.00000

sample estimates:

difference in location

-3.798836e-05

> # p-value = 0.7411

>

> #size class 2

> wilcox.test(cott.comp$bin2\_Cottus ~ cott.comp$BRT, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: cott.comp$bin2\_Cottus by cott.comp$BRT

W = 22, p-value = 0.6579

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-97 106

sample estimates:

difference in location

2.999973

> # p-value = 0.6579

>

> #size class 3

> wilcox.test(cott.comp$bin3\_Cottus ~ cott.comp$BRT, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: cott.comp$bin3\_Cottus by cott.comp$BRT

W = 21, p-value = 0.7484

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-15.00006 4.00000

sample estimates:

difference in location

1.000024

> # p-value = 0.7484

>

> #size class 4

> wilcox.test(cott.comp$bin4\_Cottus ~ cott.comp$BRT, mu=0, alt="two.sided", conf.int=T, conf.level=0.95, paired=F,

+ exact=F)

Wilcoxon rank sum test with continuity correction

data: cott.comp$bin4\_Cottus by cott.comp$BRT

W = 15, p-value = 0.611

alternative hypothesis: true location shift is not equal to 0

95 percent confidence interval:

-0.999929 0.000000

sample estimates:

difference in location