March 29, 2017

This is the SAS code that accompanies Devlin et al. 2016. L&O methods. Much of it will be irrelevant for the purpose of modeling Mountain Lakes.

\*Sept 11 2015 Updating files to accommodate shallow water PMAx. These data are LOESS fits to the

PMAX calculated by YV and published int the 2014 FS paper.;\*February 14 2015. Model test manuscript is pretty much done but there are some inconsistencies between shawn's computations. Also

the digital elevation maps give really wierd sediment distributions. I am quickly rerunning Shawns inputs using a bathymetry in

which each basin's layeres are divided into equal 0.1 m increments. crude but obvious. I am putting this into the optimum model.

Step 0: Creating a new file called BIO 1 that has PMAX values from 3 highest values;

**data** oldbio;

set mtest.bio;

drop Kat\_div mean\_pmax geo\_pmax pmax\_z max\_pmax mean\_noon\_par mean\_Ik shallow\_pmax TOD PAR\_noon\_2 var26;

**run**;

**Proc** **sort**;

by Lake\_ID DOY z;

**run**;

**proc** **sort** data = mtest.sp;

by Lake\_ID DOY;

**run**;

**data** oldbio1;

merge oldbio mtest.sp;

by Lake\_ID DOY;

**run**;

**proc** **sort** data=oldbio1;

by Lake\_ID SP zmean zmax DR gamma mean\_kd Ik\_lit z ;

**run**;

**proc** **means** data = oldbio1;

by Lake\_ID SP zmean zmax DR gamma z mean\_kd Ik\_lit z ;

var Ik\_z Kd1 LOD LOD1;

output out =oldbio2 (drop = \_type\_ \_freq\_) mean=;

**run**;

**data** oldbio3;

set oldbio2;

light\_z\_fract=exp(-kd1\*z);

**run**;

**data** bionew;

set mtest.bio\_up;

pmax\_z =GPPR\_z;

PAR\_Noon\_2=two\_wk\_mean\_Par;

drop DOY two\_wk\_mean\_par GPPR\_z;

**run**;

**PRoc** **sort**;

by Lake\_ID SP z;

**run**;

**data** bionew1;

merge oldbio3 bionew;

by Lake\_ID SP z;

**run**;

\*data crystPI;

\*set wi\_Pam.piavgcr;

\*if lake\_ID = 'US\_CRYST' and Depth NE 8 and depth NE 6;

\*Lit\_Pcnt= 100\*exp(-depth\*0.31);

\*run;

**Data** bionew2;

set bionew1;

if lake\_ID = 'US\_TROUT' then Ik\_z = (light\_z\_fract\***100**)\***4.24**+**20.79**;

if lake\_ID = 'US\_SPARK' then Ik\_z = (light\_z\_fract\***100**)\***2.59**+**107.02**;

\*if lake\_ID = 'US\_CRYST' then Ik\_z = (light\_z\_fract\*100)\*4.03 - 2.25;

**run**;

**proc** **sort** data=bionew2;

by lake\_ID SP z;

**run**;

**Proc** **means** data=bionew2;

by lake\_ID SP;

var Ik\_z;

output out = ikz (drop= \_type\_ \_freq\_) mean = mean\_Ik;

**run**;

**data** bionew3;

merge bionew2 ikz;

by Lake\_ID SP;

**run**;

**data** shallow1;

set mtest.pmax\_SatO2;

if z=**0.5** or z=**1**;

shallow\_pmax=GPPR;

keep LAKE\_ID SP shallow\_pmax;

**run**;

**data** shallow2;

set mtest.pmax\_SatO2;

if z=**2** and Lake\_ID ='US\_CRYST';

shallow\_pmax=GPPR;

keep LAKE\_ID SP shallow\_pmax;

**run**;

**Proc** **append**

base=shallow1 data=shallow2;

**run**;

**proc** **sort** data=shallow1;

by Lake\_ID SP;

**run**;

**data** bionew4;

merge bionew3 shallow1;

by Lake\_ID SP;

**run**;

**proc** **sort** data= mtest.pmax\_sato2;

by lake\_ID sp;

**run**;

**proc** **means** data= mtest.pmax\_sato2;

by lake\_ID sp;

var GPPR ln\_Gppr;

output out = avgpmax (drop =\_type\_ \_freq\_) mean= ;

**run**;

**data** avgpmax;

set avgpmax;

mean\_pmax=gppr;

geo\_pmax=exp(ln\_Gppr);

drop gppr ln\_Gppr;

**run**;

**data** mtest.bio2;

merge bionew4 avgpmax;

by lake\_ID SP;

if light\_z\_fract GE **0.01**;

**run**;

\*\*\*\*\*\*\*step 1. Figuring out littoral zone extent. UPdated September 11 2015;

**proc** **sort** data=mtest.bio2;

by lake\_id SP z ;

**run**;

**data** kd;

set mtest.bio2;

keep lake\_id SP z kd1 ;

**run**;

**proc** **sort** data=kd;

by lake\_ID z;

**run**;

**proc** **sort** data= mtest.morph; \*here we need to make a morph file with the three different morphometry models and the

two different kd's so that we can compare models with different littoral zone depths. Create models with relative rather

than absolute areas to make it easier.

\*optimal model: areaz = bath;

\*peterson model: areaz= YVm2;

\*carpenter model: areaz = Carpm2;

by lake\_id z;

**run**;

**data** morph1;

merge mtest.morph kd;

by lake\_ID z;

if SP=**.** then delete;

**run**;

\* not needed data morph2;\* this file takes the z 1 percent for sample days in order to figure out cummulative area using all

3 models;

\*set morph1;

\*z1p=4.6/kd1;

\*if z< = z1p;

\*run;

**proc** **sort** data=morph1;

by lake\_ID SP z;

**run**;

**proc** **means** data = morph1;\*calculate total littoral surface area using kd from the day of sampling

;

by lake\_ID SP;

var digit bath yvm2 carpm2;

output out=Area1p (drop = \_type\_ \_freq\_) sum=la\_digit La\_bath La\_yvm2 LA\_carpm2;

**run**;

**data** morph3;\*merge surface area by depth with data on total littoral surface area. This converts area

at each depth interval to a fraction of the total littoral area;

merge morph1 area1p;

by lake\_ID SP;

F\_digit= digit/la\_digit;

F\_Bath=bath/LA\_bath;

F\_yvm2=yvm2/La\_Yvm2;

F\_carp = Carpm2/LA\_carpm2;

keep Lake\_ID SP z Kd1 F\_digit F\_bath F\_Yvm2 F\_carp;

**run**;

**proc** **sort** data=morph3;\*this file will be used for the optimal model and all basic comparisons;

by lake\_ID SP z;

**run**;

\*\*\*\*check accuracy of morph3. All F values should add up to 1;

**proc** **means** data= morph3;

by Lake\_ID SP;

var F\_digit F\_bath F\_Yvm2 F\_carp;

output out = check\_m3 sum=;

**run**;\*code checks out;

**Data** peri1;

set mtest.bio2;\*we need to use an updated version of mtestbio in order to eliminate the

stron effect of missing data at 0.5m;

keep Lake\_ID SP z pmax\_z mean\_pmax shallow\_pmax geo\_pmax mean\_noon\_par ik\_z mean\_ik LOD1;

**run**;

**proc** **sort** data =peri1;

by Lake\_id SP z;

**run**;

**data** peri;

merge morph3 peri1;

by lake\_id SP z;

**run**;

\*\*\*

\*\*\*

\*\*

\*

\* calculate morphology using seasonal mean kds;

**proc** **sort** data=mtest.bio2;

by lake\_id SP;

**run**;

**data** kdm;

set mtest.bio2;

keep lake\_id SP mean\_Kd par\_noon\_2 LOD1;

**run**;

**proc** **sort** data=kdm;

by lake\_ID sp;

**run**;

**proc** **means** data=kdm;

by lake\_ID SP;

var mean\_kd par\_noon\_2 LOD1;

output out = kdmm (drop = \_Type\_ \_freq\_) mean =;

**run**;

**data** kdmm1;

set kdmm;

if SP=**1**;

**run**;

**data** kdmm2;

set kdmm;

if SP=**2**;

**run**;

**data** kdmm3;

set kdmm;

if SP=**3**;

**run**;

**data** kdmm4;

set kdmm;

if SP=**4**;

**run**;

**data** kdmm5;

set kdmm;

if SP=**5**;

**run**;

**data** kdmm6;

set kdmm;

if SP=**6**;

**run**;

**data** kdmm7;

set kdmm;

if SP=**7**;

**run**;

**proc** **sort** data= mtest.morph; \*here we need to make a morph file with the three different morphometry models and the

two different kd's so that we can compare models with different littoral zone depths. Create models with relative rather

than absolute areas to make it easier.

\*optimal model: areaz = bath;

\*peterson model: areaz= YVm2;

\*carpenter model: areaz = Carpm2;

by lake\_id z;

**run**;

**data** morphs1;

merge mtest.morph kdmm1;

by lake\_ID ;

**run**;

**data** morphs2;

merge mtest.morph kdmm2;

by lake\_ID ;

**run**;

**proc** **append** base=morphs1 data=morphs2;

**run**;

**data** morphs3;

merge mtest.morph kdmm3;

by lake\_ID ;

**run**;

**proc** **append** base=morphs1 data=morphs3;

**run**;

**data** morphs4;

merge mtest.morph kdmm4;

by lake\_ID ;

**run**;

**proc** **append** base=morphs1 data=morphs4;

**run**;

**data** morphs5;

merge mtest.morph kdmm5;

by lake\_ID ;

if Lake\_Id = 'US\_SPARK';

**run**;

**proc** **append** base=morphs1 data=morphs5;

**run**;

**data** morphs6;

merge mtest.morph kdmm6;

by lake\_ID ;

if Lake\_Id = 'US\_SPARK';

**run**;

**proc** **append** base=morphs1 data=morphs6;

**run**;

**data** morphs7;

merge mtest.morph kdmm7;

by lake\_ID ;

if Lake\_Id = 'US\_SPARK';

**run**;

**proc** **append** base=morphs1 data=morphs7;

**run**;

**data** morph4;

set morphs1;

z1p=**4.6**/mean\_KD;

if z LE z1p;

**run**;

**proc** **sort** data=morph4;

by lake\_ID SP z;

**run**;

**proc** **means** data = morph4;

by lake\_ID SP;

var digit bath ;

output out=Area1pA (drop = \_type\_ \_freq\_) sum=la\_digit La\_bath ;

**run**;

**data** morph5; \*Create a file with the total littoral area (standardized ) and compute

fractional area at depth;

merge morph4 area1pA;

by lake\_ID SP;

F\_digit= digit/la\_digit;

F\_Bath=bath/LA\_bath;

keep Lake\_ID SP z Mean\_KD PAR\_Noon\_2 LOD1 F\_digit F\_bath ;

**run**;

**proc** **sort** data=morph5;

by lake\_ID SP z;

**run**;

\*\*\*\*check accuracy of morph5. All F values should add up to 1;

**proc** **means** data= morph5;

by Lake\_ID SP;

var F\_digit F\_bath ;

output out = check\_m5 sum=;

**run**;\*code checks out;

**Data** peri2;

set mtest.bio2;

keep Lake\_ID SP z pmax\_z ;

**run**;

**proc** **sort** data =peri2;

by Lake\_id SP z;

**run**;

**data** peri3;

merge morph5 peri2;

by lake\_id SP z;

if mean\_Kd = **.** then delete;

if Pmax\_z = **.** then pmax\_z =**.5**;

**run**;

**data** peri4;

set peri3;

light\_z=**100**\*exp(-mean\_Kd\*z);

if lake\_ID = 'US\_TROUT' then Ik\_z = (light\_z)\***4.24**+**20.79**;

if lake\_ID = 'US\_SPARK' then Ik\_z = (light\_z)\***2.59**+**107.02**;

else ik\_z=light\_z\***3.3**+ **68**;

**run**;

\*15 February 2015 Code works;

\*model comparison 0 - optimal model;

**data** BPOpt; \*This calculates ppr on the days that we measured it using the optimal model;

set peri;

ik=ik\_z;

BPMax=pmax\_z;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

Opt\_Bppr=BPPRz\*areaz;

keep lake\_ID z SP opt\_Bppr;

**run**;

**proc** **sort** data=bpopt;

by lake\_ID SP z;

**run**;

\*model comparison 0.5 - fract of LBP below max sampling depth;

**data** BPgt8; \*This calculates ppr on the days that we measured it using the optimal model

but resticting analysis to > 8 m;

set peri;

if z GT **8**;

ik=ik\_z;

BPMax=pmax\_z;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

GT8\_Bppr=BPPRz\*areaz;

keep lake\_ID z SP gt8\_Bppr;

**run**;

**proc** **sort** data=bpgt8;

by lake\_ID SP z;

**run**;

**proc** **means** data=bpgt8;

by lake\_ID SP;

var gt8\_Bppr;

output out=lbp\_gt8 (drop=\_type\_ \_freq\_ )sum=;

**run**;

\*model comparison 1 - shallow pmax;

**data** BPSh; \*This calculates ppr on the days that we measured it using pmax from the shallowest depth;

set peri;

\*zlit=4.6/kd1;

\*if z LE zlit; \*this limits our measurments to depth of 1 percent light;

ik=ik\_z;

BPMax=shallow\_pmax;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

Shw\_Bppr=BPPRz\*areaz;

keep lake\_ID z SP Shw\_Bppr;

**run**;

**proc** **sort** data=bpSh;

by lake\_ID SP z;

**run**;

\*model comparison 2 - average Pmax;

**data** BPAvg; \*This calculates ppr on the days that we measured it using the unweighted average Pmax across depths;

set peri;

\*zlit=4.6/kd1;

\*if z LE zlit; \*this limits our measurments to depth of 1 percent light;

ik=ik\_z;

BPMax=mean\_pmax;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

Pavg\_Bppr=BPPRz\*areaz;

keep lake\_ID z SP Pavg\_Bppr;

**run**;

**proc** **sort** data=BPavg;

by lake\_ID SP z;

**run**;

\*model comparison 3 - geomean pmax;

**data** BPGeo; \*This calculates ppr on the days that we measured it using the geometric mean pmax;

set peri;

\*zlit=4.6/kd1;

\*if z LE zlit; \*this limits our measurments to depth of 1 percent light;

ik=ik\_z;

BPMax=geo\_pmax;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

GeoM\_Bppr=BPPRz\*areaz;

keep lake\_ID z SP GeoM\_Bppr;

**run**;

**proc** **sort** data=bpGeo;

by lake\_ID SP z;

**run**;

\*model comparison 4 - Ik\_avg;

**data** BP\_Ika; \*This calculates ppr on the days that we measured it using a value of Ik averaged across all depths;

set peri;

\*zlit=4.6/kd1;

\*if z LE zlit; \*this limits our measurments to depth of 1 percent light;

ik=mean\_ik;

BPMax=pmax\_z;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

PPR\_Ika=BPPRz\*areaz;

keep lake\_ID z SP PPR\_Ika;

**run**;

**proc** **sort** data=bp\_Ika;

by lake\_ID SP z;

**run**;

\*model comparison 5 - Constant Ik;

**data** BP\_ikC; \*This calculates ppr on the days that we measured it using a constant value of Ik from the literature;

set peri;

\*zlit=4.6/kd1;

\*if z LE zlit; \*this limits our measurments to depth of 1 percent light;

ik=**300**;

BPMax=pmax\_z;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

PPR\_ikC=BPPRz\*areaz;

keep lake\_ID z SP PPR\_Ikc;

**run**;

**proc** **sort** data=BP\_Ikc;

by lake\_ID SP z;

**run**;

**data** comp;

merge BPOpt bpSh BPavg BPgeo BP\_Ika BP\_Ikc ;

by lake\_ID SP z;

**run**;

**proc** **means** data=comp;

by lake\_ID SP;

var opt\_Bppr Shw\_bppr Pavg\_bppr geoM\_bppr PPR\_Ika PPR\_Ikc;

output out=comp1 (drop= \_Type\_ \_Freq\_) sum=;

**run**;

\*model comparison 6 - light;

**data** BP\_KDa; \*This calculates ppr on the days that we measured it using a seasonal mean kd and a 2 week mean noon time PAR;

set peri4;

ik=ik\_z;

BPMax=pmax\_z;

kd=mean\_kd;

areaz=F\_Bath;

noon=par\_noon\_2;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

PPR\_Kda=BPPRz\*areaz;

keep lake\_ID z SP PPR\_Kda;

**run**;

**proc** **sort** data=BP\_Kda;

by lake\_ID SP z;

**run**;

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\* February 20 2015;

\*Below this is problematic. Already created comp files above and calculated effect sizes. Still haven't

analyzed morophological effects;

**proc** **means** data =BP\_kda;

by lake\_ID SP;

var PPR\_kda;

output out=comp2 (drop =\_type\_ \_Freq\_) sum=;

**run**;

**data** ppr\_all;

merge comp1 comp2;

by Lake\_ID SP;

**run**;

\*\*\*\*;

**data** ppr\_all;

set Ppr\_all;

ES\_shw=(Shw\_Bppr-Opt\_Bppr)/Opt\_bPPR\***100**;

ES\_Pavg=(Pavg\_Bppr-Opt\_Bppr)/Opt\_bPPR\***100**;

ES\_GeoM=(Geom\_Bppr-Opt\_Bppr)/Opt\_bPPR\***100**;

ES\_Ika=(PPR\_Ika-Opt\_Bppr)/Opt\_bPPR\***100**;

ES\_Ikc=(PPR\_Ikc-Opt\_Bppr)/Opt\_bPPR\***100**;

ES\_kda=(PPR\_Kda-opt\_bppr)/Opt\_Bppr\***100**;

**run**;

**Proc** **means** data=PPr\_all;

by lake\_ID;

var ES\_shw ES\_Pavg ES\_GeoM ES\_ika ES\_Ikc ES\_Kda;

output out = mtest.PPr\_lake2 (drop = \_Type\_ \_Freq\_) mean=;

**run**;

**Proc** **means** data=mtest.ppr\_lake2;

Var ES\_shw ES\_Pavg ES\_GeoM ES\_ika ES\_Ikc ES\_Kda;

output out = mtest.fig2\_2 (drop = \_Type\_ \_Freq\_) mean= stderr= SE\_shw SE\_Pavg SE\_GeoM

SE\_ika SE\_ikc SE\_kda;

**run**;

**data** mtest.fig2\_2;

set mtest.fig2\_2;

LPavg=ES\_Pavg-**1.96**\*SE\_Pavg;

UPavg=ES\_Pavg+**1.96**\*SE\_Pavg;

LPSh=ES\_Shw -**1.96**\*SE\_Shw;

UPSh=ES\_Shw +**1.96**\*SE\_Shw;

LPgeo=ES\_Geom-**1.96**\*SE\_GeoM;

UPgeo=ES\_GeoM+**1.96**\*SE\_GeoM;

LIKa=ES\_ika-**1.96**\*SE\_ika;

UIKa=ES\_ika+**1.96**\*SE\_ika;

LIKc=ES\_ikc -**1.96**\*SE\_ikc;

UIKc=ES\_ikc +**1.96**\*SE\_ikc;

LKda=ES\_kda - **1.96**\*SE\_Ika;

UKda=ES\_kda + **1.96**\*SE\_Ika;

**run**;

\*25 February 2015 ;

\*model comparison 7 - different morphometries;

**data** BP\_morph; \*This calculates ppr on the days that we measured it using the optimal model;

set peri;

\*zlit=4.6/kd1;

\*if z LE zlit; \*this limits our measurments to depth of 1 percent light;

ik=ik\_z;

BPMax=pmax\_z;

kd=kd1;

areaz=F\_Bath;

noon=mean\_noon\_par;

time=**0.25**;

BpprzT=**0**;

do until (time > LOD1);\*uses actual length of day for day of ppr;

light = noon\*sin(constant('pi')\*Time/LOD1);

BPPRZT = BpprZT+(BPmax\*TANH(light\*exp(-Kd\*Z)/Ik)); \*calculates benthic ppr at time t assuming an Ik of 300;

time=time+**0.25**;\*increments time by 15 minutes;

end;

BPPRZ=BPPRZT/**4**;\*calculates daily benthic PPR times the area at depth. divided by 4 to account for 15 min.time;

Opt\_Bppr=BPPRz\*areaz;

Digit\_Bppr=BPPRz\*F\_digit;

Carp\_BPPR=BPPRZ\*F\_carp;

YV\_Bppr=BPPRZ\*F\_Yvm2;

keep lake\_ID z SP opt\_Bppr Digit\_bppr Carp\_BPPR YV\_BPPR;

**run**;

**Proc** **sort**;

by lake\_ID SP;

**run**;

**PRoc** **means** data=bp\_morph;

by Lake\_ID SP;

var Opt\_BPPR Digit\_BPPR Carp\_BPPR YV\_Bppr;

output out = BP\_morph1 (drop = \_type\_ \_Freq\_) sum=;

**run**;

**data** BP\_morph1;

set BP\_morph1;

ES\_digit=(Digit\_Bppr-Opt\_Bppr)/Opt\_bPPR\***100**;

ES\_carp=(Carp\_Bppr-Opt\_Bppr)/Opt\_bPPR\***100**;

ES\_YV=(YV\_Bppr-Opt\_Bppr)/Opt\_bPPR\***100**;

**run**;

**proc** **sort**;

by Lake\_ID;

**run**;

**proc** **means** data=BP\_morph1;

by Lake\_ID;

var ES\_Digit ES\_Carp ES\_YV;

output out= mtest.fig5\_2 (drop = \_TYPE\_ \_Freq\_) mean= Stderr = SE\_Digit SE\_Carp SE\_YV;

**run**;

**data** mtest.fig5\_2;

set mtest.fig5\_2;

LPdigit=ES\_digit -**1.96**\*SE\_DIGIT;

UPdigit=ES\_digit+**1.96**\*SE\_digit;

LPcarp=ES\_Carp -**1.96**\*SE\_Carp;

UPcarp=ES\_Carp+**1.96**\*SE\_Carp;

LPYV=ES\_YV -**1.96**\*SE\_YV;

UPYV=ES\_YV+**1.96**\*SE\_YV;

**run**;

**proc** **means** data=comp1;

by lake\_ID;

var opt\_bppr;

output out=mtest.Fig2R1 (drop = \_type\_ \_freq\_) mean = stderr=SE\_LBP;

**run**;

**proc** **means** data=mtest.bio2;

by lake\_ID SP;

var z;

output out = maxdepth (drop=\_type\_ \_freq\_) max=zmax;

**run**;

**data** below8;

set morph3;

if z>**8**;

**run**;

**proc** **means** data=below8;

by lake\_ID SP;

var f\_bath;

output out = f\_below (drop = \_type\_ \_freq\_) sum=;

**run**;

**data** comp2;

merge comp1 lbp\_gt8;

by Lake\_ID sp;

F\_below=gt8\_BPPR/opt\_BPPR;

**run**;