Appendix e. Minitab macros for hydroacoustic data processing

Appendix E1.–Minitab macro “tranbath” to reduce depth data.

This Minitab macro “tranbath” (abbreviated from TRANsect BATHymetry) for Minitab reduces the amount of bathymetry data by selecting every 20th record from all the records in the bathymetry file. It always selects the first and last records for the selected transect so that the overall transect length is not truncated. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *tranbath.mac*. Use of the macro is outlined in Appendix D.

Input columns

lat - latitude for the bathymetry data (decimal degrees)

lon - longitude for the bathymetry data (decimal degrees)

z - depth for the bathymetry data (negative meters)

Output columns

rlat - latitude from the bathymetry data (decimal degrees)

rlon - longitude from the bathymetry data (decimal degrees)

rz - depth from the bathymetry data (negative meters)

*MACRO*

*tranbath lat lon z rlat rlon rz*

*mcolumns lat lon rlat rlon idx z rz*

*mconstant n k j i*

*let n = count(lat) # counts the number of records*

*let j = round(n/20) # determines the whole number of n/20, an index*

*let i = 0 # initializes index*

*set idx # creates an index column where 1-20 is repeated*

*j(1:20/1)1 # j times*

*end.*

*let idx(n) = 1 # assigns index of '1' to last record*

-continued-

Appendix E1.–Page 2 of 2.

*Do k = 1:n # selects each record from the input columns with*

*# an index of '1' and saves it in the output*

*let i = i + 1*

*let rlat(i) = lat(k)*

*let rlon(i) = lon(k)*

*let rz(i) = z(k)*

*endif*

*Enddo*

*ENDMACRO*

Appendix E2.–Minitab macro “gridtrden” to calculate transect length and fish density for grid stations.

This Minitab macro “gridtrden” (abbreviated from GRID TRansect DENsity) for Minitab computes transect fish density (fish/km2) and length (km) at the surface from the reduced bathymetry distance from point 'i' to point 'i+1' using Great Circle distance formula. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *gridtrden.mac*. Use of the macro is outlined in Appendix D.

Input columns

rlat = reduced bathymetry latitude

rlon = reduced bathymetry longitude

fz = individual fish depths for transect (m)

Output columns

trl = transect length (km)

tfd = transect fish density (fish/km2)

*MACRO*

*gridtrden rlat rlon fz trl tfd*

*Mcolumn rlat rlon fz tfd hd vd trl clat clon rtl*

*Mconstant tl n k m*

*let n = count(rlat)*

*let m = n-1*

*let clat = radians(rlat) # convert degrees to radians*

*let clon = radians(rlon)*

*DO k = 1:m*

*let rtl(k) = acos(sin(clat(k))\*sin(clat(k+1)) + cos(clat(k))\*cos(clat(k+1))\*cos(clon(k)-clon(k+1)))\*3441.04\*1.852*

*ENDDO*

*let trl = sum(rtl) # sum distances*

*Let tl = trl(1)*

-continued-

Appendix E2.–Page 2 of 2.

*Let tfd =sum(1/(-fz\*0.108316)/tl)\*1000 # calculate transect fish density (fish/km2)*

*ENDMACRO*

Appendix E3.–Minitab macro “gridstamd” to calculate mean density, SE, and CV.

This Minitab macro “gridstamd” (abbreviated from GRID STAtion Mean Density) computes the mean density of fish for a station from transect lengths and density estimates from the “gridtrden” macro along with standard error and coefficient of variation. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *gridstamd.mac*. Use of the macro is outlined in Appendix D.

Input columns

trl = transect length (km)

tfd = transect fish density (fish/km2)

Output columns – station mean density, SE, and CV

md = station mean density estimate (fish/km2)

sed = station standard error of wmd (fish/km2)

cv = station coefficient of variation (expressed as a percent)

*MACRO*

*gridstamd trl tfd md sed cv*

*Mcolumn trl tfd md sed w cv*

*Mconstant nt*

*Let nt = count(trl) # nt = number of transects*

*Let md = mean(tfd)*

*Let sed = stdev(tfd)/sqrt(nt)*

*Let cv = 100\*sed/md*

*ENDMACRO*

Appendix E4.–Minitab macro “startran1” to calculate transect length and endpoints.

This Minitab macro “startran1” (abbreviated from STAR TRANsect step 1) uses transect location data (blat, blon) to calculate transect length and transect end points. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *startran1.mac*. Use of the macro is outlined in Appendix D.

*MACRO*

*startran1 blat blon elat elon trl*

*Mcolumn blat blon elat elon trl relat relon rclat rclon rlat rlon td*

*Mconstant bn k m*

*Let bn = count (blat)*

*Let elat(1) = blat(1) # identify end point latitudes*

*Let elat(2) = blat(bn)*

*Let elon(1) = blon(1) # identify end point longitudes*

*Let elon(2) = blon(bn)*

*# calculate transect length (kilometers) from blat and blon using great circle formula*

*# this version calculates distance between successive points and sums them for a total transect length*

*Let rlat = radians(blat) # convert degrees to radians*

*Let rlon = radians(blon)*

*Let m = bn-1*

*DO k = 1:m*

*Let td(k) = (acos(sin(rlat(k))\*sin(rlat(k+1)) + cos(rlat(k))\*cos(rlat(k+1))\*cos(rlon(k)-rlon(k-1)))\*3441.04)\*1.852*

*ENDDO*

*Let trl = sum(td)*

*ENDMACRO*

Appendix E5.–Minitab macro “starsum1” to calculate the geographic center of the transect endpoints.

This Minitab macro “starsum1” (abbreviated from STAR SUMmary step 1) uses endpoints from all transects to calculate the mean latitude and longitude, and the maximum distance to center. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *starsum1.mac*. Use of the macro is outlined in Appendix D.

*MACRO*

*starsum1 elat elon mlat mlon md2c*

*Mcolumn elat elon mlat mlon d2c md2c relat relon rclat rclon*

*Mconstant clat clon*

*Let mlat = mean(elat) # calculate star center*

*Let mlon = mean(elon)*

*Let clat = mlat(1) # constants*

*Let clon = mlon(1)*

*Let relat = radians(elat) # convert degrees to radians*

*Let relon = radians(elon)*

*Let rclat = radians(clat)*

*Let rclon = radians(clon)*

*# calculate distance to center (kilometers) from endpoints using great circle formula*

*Let d2c = (acos(sin(relat)\*sin(rclat) + cos(relat)\*cos(rclat)\*cos(relon-rclon))\*3441.04)\*1.852*

*Let md2c = max(d2c)*

*ENDMACRO*

Appendix E6.–Minitab macro “startran2” to calculate the adjusted mean fish density.

The Minitab macro “startran2” (abbreviated from STAR TRANsect step 2) will calculate the transect length, the mean location of the star, each fish's distance from the center of the star (for applying a density correction factor), and the adjusted fish density based on the fish locations. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *startran2.mac*. Use of the macro is outlined in Appendix D.

*MACRO*

*startran2 flat flon fz mlat mlon md2c trl dens*

*Mcolumn flat flon fz mlat mlon dens d2c dlat dlon &*

*rflat rflon rclat rclon pd2c md2c zad dad trl fzk*

*Mconstant clat clon mxd tlen*

*Let clat = mlat(1) # constants*

*Let clon = mlon(1)*

*Let mxd = md2c(1)*

*Let tlen = trl(1)*

*Let fzk = fz/1000*

*Let rflat = radians(flat) # convert degrees to radians*

*Let rflon = radians(flon)*

*Let rclat = radians(clat)*

*Let rclon = radians(clon)*

*# calculate distance (kilometers) to center from flat and flon using great circle formula*

*Let d2c = (acos(sin(rflat)\*sin(rclat) + cos(rflat)\*cos(rclat)\*cos(rflon-rclon))\*3441.04)\*1.852*

-continued-

Appendix E6.–Page 2 of 2.

*Let pd2c = d2c/mxd # convert d2c to proportional distance using max dtc*

*Let dad = 0.004791+2.2601097\*pd2c # adjust for pd2c using G2 - fixed center simulation*

*Let zad = -dad/(fzk\*0.108316) # adjust for fish depth*

*Let dens = sum(zad)/tlen # transect fish density (fish/m^2)?????????km^2*

*ENDMACRO*

Appendix E7.–Minitab macro “starsum2” to calculate the overall mean fish density from all transects.

The Minitab macro “starsum2” (abbreviated from STAR SUMmary step 2) computes the mean density estimate, standard error, and coefficient of variation of fish for a station using the transect density estimates. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *starsum2.mac*. Use of the macro is outlined in Appendix D.

Input columns

tfd = transect fish density (fish/km2)

Output columns

md = station mean density estimate (fish/km2)

sed = station standard error of wmd (fish/km2)

cv = station coefficient of variation expressed as a percent

*MACRO*

*starsum2 tfd md sed cv*

*Mcolumn tfd md sed w cv*

*Mconstant nt*

*Let nt = count(tfd) # nt = number of transects*

*Let md = mean(tfd)*

*Let sed = stdev(tfd)/sqrt(nt)*

*Let cv = 100\*sed/md*

*ENDMACRO*

Appendix E8.–Minitab macro “gridarea” to calculate the grid station area.

This Minitab macro calculates the station area for grid station surveys. The data entry format is the same as that used by the star station area macro (Appendix E9). Output is in km2. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *gridarea.mac*. Use of the macro is outlined in Appendix D.

Input columns

tr = transect number

blat = transect begin latitude

blon = transect begin longitude

elat = transect end latitude

elon = transect end longitude

Output columns

aq = area of quadrilaterals formed by transect begin/end points

tsa = total station area (sum of ta)

*MACRO*

*gridarea tr blat blon elat elon aq tsa*

*mcolumn tr blat blon elat elon trl s1 s2 d1 d2 aq tsa rblat rblon relat relon*

*mconstant n i m*

*let n = count(tr)*

*let rblat = radians(blat) # convert degrees latitude and longitude to radians for trig functions*

*let rblon = radians(blon)*

*let relat = radians(elat)*

*let relon = radians(elon)*

*let trl = acos(sin(rblat)\*sin(relat) + cos(rblat)\*cos(relat)\*cos(rblon-relon))\*3441.04\*1.852 # transect lengths*

*let m = n-1*

*Do i = 1:m*

*# lengths of 'sides' between transect begin/end points #*

-continued-

Appendix E8.–Page 2 of 2.

*let s1(i) = acos(sin(rblat(i))\*sin(relat(i+1)) + cos(rblat(i))\*cos(relat(i+1))\*cos(rblon(i)-relon(i+1)))\*3441.04\*1.852*

*let s2(i) = acos(sin(relat(i))\*sin(rblat(i+1)) + cos(relat(i))\*cos(rblat(i+1))\*cos(relon(i)-rblon(i+1)))\*3441.04\*1.852*

*# length of diagonals for each quatrilateral formed by adjacent transect begin/end points #*

*let d1(i) = acos(sin(rblat(i))\*sin(rblat(i+1)) + cos(rblat(i))\*cos(rblat(i+1))\*cos(rblon(i)-rblon(i+1)))\*3441.04\*1.852*

*let d2(i) = acos(sin(relat(i))\*sin(relat(i+1)) + cos(relat(i))\*cos(relat(i+1))\*cos(relon(i)-relon(i+1)))\*3441.04\*1.852*

*#formula for area of a convex quadrilateral: Area = (1/4)\*sqrt[ 4\*p^2\*q^2 - (a^2 + c^2 - b^2 - d^2) ] #*

*let aq(i) = 0.25\*sqrt( 4\*(d1(i)\*\*2)\*(d2(i)\*\*2) - ( (s1(i)\*\*2) + (s2(i)\*\*2) - (trl(i)\*\*2) -(trl(i+1)\*\*2))\*\*2 )*

*Enddo*

*let tsa = sum(aq)*

*ENDMACRO*

Appendix E9.–Minitab macro “stararea” to calculate the star station area.

This Minitab macro calculates the station area for star station surveys. The data entry format is the same as that used by the grid station area macro (Appendix E8). Output is in km2. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *stararea.mac*. Use of the macro is outlined in Appendix D.

Input columns

tr = transect number

blat = transect begin latitude

blon = transect begin longitude

elat = transect end latitude

elon = transect end longitude

Output columns

aq = area of quadrilaterals formed by transect begin/end points

tsa = total station area (sum of ta)

*MACRO*

*stararea tr blat blon elat elon ta tsa*

*Mcolumn tr blat blon elat elon vlat vlon cp pd rlat rlon mlat mlon y x ps ss tx ty th ta tsa*

*Mconstant n i a b c m k clat clon j p q cx cy*

*let n = count(tr)*

*let p = 0*

*IF mod(n,2) = 0 # detects if transect number is odd or even and adjusts for even values*

*let n = n+1 # pretends there are an odd (n+1) number of transects*

*let p = 1*

*ENDIF*

*let a = 0*

*let b = 0*

*let c = 0*

*Do i = 1:n # loop to rearrange transect begin/end data into perimeter order*

*let b = i+a # a, b, and c are counters*

*let c = i+a*

-continued-

Appendix E9.–Page 2 of 3.

*IF b > n*

*let c = c-n*

*ENDIF*

*let vlat(b) = blat(c)*

*let vlon(b) = blon(c)*

*IF b = n*

*let c = c-n*

*ENDIF*

*let vlat(b+1) = elat(c+1)*

*let vlon(b+1) = elon(c+1)*

*let a = a+1*

*Enddo*

*IF p = 1 # deletes empty cells for even number of transects*

*Delete n:n vlat*

*Delete n:n vlon*

*let q = count(vlat)*

*Delete q:q vlat*

*Delete q:q vlon*

*ENDIF*

*let rlat = radians(vlat) # convert degrees latitude and longitude to radians*

*let rlon = radians(vlon)*

*let mlat = radians(round(min(vlat),3)-0.001) # set origin for metric coordinates (meters)*

*let mlon = radians(round(min(vlon),3)-0.001)*

*let m = count(vlat)*

*Do k = 1:m # convert degrees lat/lon to metric coordinates (kilometers)*

*let y(k) = acos(sin(rlat(k))\*sin(mlat) + cos(rlat(k))\*cos(mlat)\*cos(mlon-mlon))\*3441.04\*1.852 # latitude conversion to km*

*let x(k) = acos(sin(mlat)\*sin(mlat) + cos(mlat)\*cos(mlat)\*cos(mlon-rlon(k)))\*3441.04\*1.852 # longitude conversion to km*

-continued-

Appendix E9.–Page 3 of 3.

*Enddo*

*let cx = mean(x) # calculate star center*

*let cy = mean(y)*

*let cp(1) = cx*

*let cp(2) = cy*

*let m = count(y) # append first transect point to close perimeter*

*let y(m+1) = y(1)*

*let x(m+1) = x(1)*

*Do j = 1:m # calculate values needed to get triangle areas*

*let pd(j) = sqrt( (x(j) - x(j+1))\*\*2 + (y(j) - y(j+1))\*\*2 ) # perimeter line segment length (km)*

*let ps(j) = (y(j) - y(j+1))/(x(j) - x(j+1)) #slope of perimeter line segment*

*let ss(j) = -1/ps(j) # slope of triangle height - perpendicular to ps(j)*

*let tx(j) = (-ps(j)\*x(j) + y(j) + ss(j)\*cx - cy) / (ss(j) - ps(j)) # triangle height x coordinate on perimeter line segment (km)*

*let ty(j) = ps(j)\*tx(j) - ps(j)\*x(j) + y(j) # triangle height y coordinate on perimeter line segment (km)*

*let th(j) = sqrt( (cx - tx(j))\*\*2 + (cy - ty(j))\*\*2 ) # triangle height (km)*

*let ta(j) = 0.5\*pd(j)\*th(j) # triangle area (km^2)*

*Enddo*

*let tsa = sum(ta) # sum of triangle areas (km^2)*

*ENDMACRO*

Appendix E10.–Minitab macro “rockfish” to calculate SE from pooled variance.

This Minitab macro calculates the SE for the population estimates using pooled variances of the survey data, total rockfish population and its standard error for a station, total population for an area with a pooled SE, and black rockfish estimates. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *rockfish.mac*. Use of the macro is outlined in Appendix D.

Input columns

ntran = number of transects in station

starea = area of station in km2

den = estimated density for station

SEd = standard error of station density estimate

pbrf = proportion of black rockfish from video/jigging

trf = total number of rockfish counted in video = sample size for proportion

*MACRO*

*rockfish ntran starea den SEd pbrf trf pop SEp pCV tpop pSEp pCVp brfp SEbrf CVbrf tbrf SEtbrf CVtbrf*

*Mcolumn ntran starea den SEd pbrf trf pop varp SEp tpop pSEp brfp Vprop Vbrf SEbrf tbrf SEtbrf pCV pCVp CVbrf CVtbrf*

*Mconstant*

*# station population estimate = pop*

*Let pop = starea\*den*

*# station population variance = varp*

*Let varp = (starea\*\*2)\*(SEd\*\*2)*

*# station population SE = SEp*

*Let SEp = sqrt(varp)*

*# station population CV = pCV*

*Let pCV = SEp/pop*

*# area total population estimate = tpop*

*Let tpop = sum(pop)*

-continued-

Appendix E10.–Page 2 of 2.

*# standard error for total population estimate = pSEp*

*Let pSEp = sqrt(sum(varp))*

*# area population CV = pCVp*

*Let pCVp = pSEp/tpop*

*# station black rockfish population estimate = brfp*

*Let brfp = pbrf\*pop*

*# station black rockfish proportion variance= Vprop*

*Let Vprop =(pbrf\*(1-pbrf))/trf*

*# station black rock fish population variance = Vbrf*

*Let Vbrf = (pop\*\*2)\*Vprop + (pbrf\*\*2)\*varp + Vprop\*varp*

*# station black rockfish population standard error = SEbrf*

*Let SEbrf = sqrt(Vbrf)*

*# station black rockfish population CV = CVbrf*

*Let CVbrf = SEbrf/brfp*

*# area total black rockfish population estimate = tbrf*

*Let tbrf = sum(brfp)*

*# standard error for total brf pop estimate = SEtbrf*

*Let SEtbrf = sqrt(sum(SEbrf\*\*2))*

*# area black rockfish population CV = CVtbrf*

*Let CVtbrf = SEtbrf/tbrf*

*ENDMACRO*

Appendix E11.–Minitab macro “popall” to calculate district summary data.

This Minitab macro generates district summary data from the pooled data. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *popall.mac*. Use of the macro is outlined in Appendix D.

*MACRO*

*PopAll Trans Area tpop pSEp tbrf SEtbrf c21 c22 c23 c24 c25 c26 c28 c29 c30*

*Mcolumn Trans Area tpop pSEp tbrf SEtbrf c21 c22 c23 c24 c25 c26 c28 c29 c30*

*Mconstant tp*

*let tp = tpop(1)*

*Let c21 = COUNT(Trans)*

*Let c22 = SUM(Area)*

*Let c23 = tpop/c22*

*Let c24 = pSEp/c22*

*Let c25 = c24/c23*

*Let c26 = tpop*

*Let c29 = tbrf*

*Let c28 = c29/tp*

*Let c30 = SEtbrf*

*ENDMACRO*

Appendix E12.–Minitab macro “popindex” to generate district summary data from the index stations pooled data.

This Minitab macro generates district summary data from the index stations pooled data. Note: the descriptions to the right of hashtag symbols (#) are for narrative reference only and are ignored by Minitab when running the macro. The italicized text below should be pasted into a simple text document, and the document placed in the default Minitab macros folder with the file name *popindex.mac*. Use of the macro is outlined in Appendix D.

*MACRO*

*PopIndex Trans Area tbrf SEtbrf c21 c22 c23 c24 c25*

*Mcolumn Trans Area tbrf SEtbrf c21 c22 c23 c24 c25*

*Let c21 = COUNT(Trans)*

*Let c22 = SUM(Area)*

*Let c23 = tbrf/c22*

*Let c24 = SEtbrf/c22*

*Let c25 = c24/c23*

*ENDMACRO*