Package 'artiFISHal'

November 12, 2014

Version 2014-07

Date 2014-07

Title A Pelagic Fish Community Simulator

Author Jean V. Adams [aut, cre]

Maintainer Jean V. Adams <jvadams@usgs.gov>

Depends R (>= 3.1.0)

Imports MASS, plotrix, rpanel, rpart

Description artiFISHal allows you to simulate and sample a population of fish.
Use it to create an artificial lake and populate it with known numbers of
fish (identified in species-size groups) to mimic pelagic fish communities.
Then, sample the fish population with virtual acoustic and midwater trawl surveys.

LazyData TRUE

License GPL

URL https://github.com/JVAdams/artiFISHal

R topics documented:

AcMtEst *Combine Acoustic and Midwater Trawl Survey Data*

Description

Combine survey data from acoustic transects and midwater trawl tows (created by SampFish). Apply availability to the acoustic data and catchability (availability and selectivity) to the midwater trawl catch.

Usage

```
AcMtEst(SimPop, AcMtSurv, AcExcl = c(0, 0), MtExcl = c(0, 0),
  PanelProps = c(0.4, 0.3, 0.2, 0.1), SelecParam = NULL, Seed = NULL)
```

Arguments

SimPop	A list with elements LakeInfo, FishInfo, FishParam, FishPop, typically output from SimFish. See SimFish for details on the list elements.
AcMtSurv	A list with elements Targets, AcSummaryCell, AcSummaryColumn, MtCatch, typically output from SampFish.
AcExcl	A numeric vector of length 2, depth of acoustic "dead" zones at the surface and at the bottom (in m), default of c(0, 0) represents 100% acoustic availability of fish.
MtExcl	A numeric vector of length 2, depth of zones unfishable with the midwater trawl at the surface and at the bottom (in m), default of c(0, 0) represents 100% midwater trawl availability of fish.
PanelProps	A numeric vector of length 4, size of the different mesh panel zones of the midwater trawl, mouth (outermost), middle, aft, and cod (inner), default c(0.4, 0.3, 0.2, 0.1). Sizes are expressed as proportions of the distance from the outer edge of the trawl to the trawl center in both the vertical and horizontal directions, and they should add up to 1. Use ViewZones to visualize the mesh panel zones.
SelecParam	A data frame with 6 columns in which each row provides the midwater trawl selectivity parameters for a given fish group and mesh panel zone. All columns must be completely filled in (no missing values). Selectivity is assumed to be 100% for any group-zone combination not represented as a row in the data frame. For 100% selectivity of small fish, use MtL50Small = -Inf and any slope. For 100% selectivity of large fish, use MtL50Large = Inf and any slope. Column names and descriptions: • G = character, a one-letter nickname for the group (e.g., fish species and lifestage) used in plotting • Zone = character, mesh panel zone, one of "mouth", "middle", "aft", or "cod" • MtL50Small = numeric, the length (in mm) at which small fish have a 50% probability of being captured by the trawl • MtSlopeSmall = numeric, the (inverse) slope at which small fish probability of capture increases with length, smaller values are steeper • MtL50Large = numeric, the length (in mm) at which large fish have a 50% probability of being captured by the trawl

- `MtSlopeLarge` = numeric, the (absolute value of the inverse) slope at which large fish probability of capture decreases with length, smaller values are steeper

`Seed` An integer scalar, starting seed for stochasticity incorporated in acoustic and midwater trawl catchability. Use `Seed` to ensure the same individual fish are included in the surveys with each call to `CatchComb`. Otherwise, if set to NULL, the default, a random seed is used, resulting in a different fish selection with each call to `CatchComb`.

Details

A classification tree is used to relate the catch composition of the midwater trawl to the location of the trawl in the lake (e.g., MTReast, ACnorth, MTRd2sh, MTRbdep). This tree is then used to assign a single midwater trawl catch to each acoustic cell (interval x layer), such that the estimated acoustic densities can be assigned to specific fish groups (species, life stages). See, for example, Yule et al. (2013).

Value

A data frame with estimated fish density (in number per ha) and biomass (in kg per ha) for each sampling event and group (species, lifestage).

References

Yule, DL, JV Adams, DM Warner, TR Hrabik, PM Kocovsky, BC Weidel, LG Rudstam, and PJ Sullivan. 2013. Evaluating analytical approaches for estimating pelagic fish biomass using simulated fish communities[1]. Canadian Journal of Fisheries and Aquatic Sciences 70:1845-1857.

See Also

`SimFish`, `SampFish`, `ViewZones`, `TuneSelec`.

Examples

```
# parameters for small (a) and large (A) alewife as input to the simulator
fishp <- data.frame(
G = c("a", "A", "A"),
Z = c(50, 140, 140), ZE = c(0.25, 0.2, 0.2),
LWC1 = 0.000014, LWC2 = 2.8638, LWCE = 0.18,
TSC1 = -64.2, TSC2 = 20.5, TSCE = c(0.02, 0.07, 0.07),
PropN = c(0.55, 0.25, 0.20),
E = c(NA, 900, 2800), EE = c(NA, 4.5, 0.3),
N = NA, NE = NA,
WD = c(5, 15, 15), WDE = c(0.5, 0.7, 0.7),
D2B = NA, D2BE = NA)

# simulate the fish population
res <- SimFish(LakeName="Clear Lake", LkWidth=3000, LkLength=2000, BotDepMin=20, BotDepMa
FishParam=fishp, TotNFish=50000)

# survey the population
surv <- SampFish(SimPop=res, NumEvents=2, AcNum=5, AcInterval=3000, AcLayer=10, AcAngle=7
```

[1] http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxP1dXTQ

```
selec <- data.frame(
G = c("A", "a", "A", "a", "A", "a"),
Zone = c("mouth", "mouth", "middle", "middle", "aft", "aft"),
MtL50Small = c(100, 100, 60, 60, 30, 30),
MtSlopeSmall = c(40, 40, 30, 30, 20, 20),
MtL50Large = c(180, 180, Inf, Inf, Inf, Inf),
MtSlopeLarge = c(20, 20, 100, 100, 100, 100))

AcMtEst(SimPop=res, AcMtSurv=surv, Seed=927)
AcMtEst(SimPop=res, AcMtSurv=surv, AcExcl=c(5, 10), MtExcl=c(2, 2), SelecParam=selec, See
```

`AcSmry` *Summarize Acoustic Survey Data*

Description

Summarize acoustic survey data by interval and layer.

Usage

```
AcSmry(AcTarg, LakeInfo, SurvParam)
```

Arguments

`AcTarg`	A data frame list with information on fish detected in an acoustics survey, specifically the `Targets` data frame output from `SampFish`. Each row represents a single target, columns describe the specific location of fish in the lake and their target strengths.
`LakeInfo`	A list with the lake inputs supplied as arguments to `SimFish` as well as a few additional objects.
`SurvParam`	A named vector with the survey inputs supplied as arguments to `SampFish`.

Details

Acoustic intervals are identified by the easting (in m) of their midpoint. Acoustic layers are indentified by the water depth (in m) of their midpoint.

A weighting variable, range weight (Yule 2000), is used to account for different volumes of water sampled in the acoustic survey as a function of the distance from the transducer (in m) and the transducer half angle (0.5 * `AcAngle`). The sum of the range weights is reported as `sum.rw` in the `AcCell` and `AcColumn` data frames.

Value

A list with 2 elements.

- `AcCell` is a data frame with information on the acoustic survey summarized by acoustic interval and layer.
- `AcColumn` is a data frame with information on the acoustic survey summarized by acoustic interval.

References

Yule, DL. 2000. .[2] North American Journal of Fisheries Management 20:759-775.

See Also

SampFish

Examples

```
# parameters for small (a) and large (A) alewife as input to the simulator
fishp <- data.frame(
G = c("a", "A", "A"),
Z = c(50, 140, 140), ZE = c(0.25, 0.2, 0.2),
LWC1 = 0.000014, LWC2 = 2.8638, LWCE = 0.18,
TSC1 = -64.2, TSC2 = 20.5, TSCE = c(0.02, 0.07, 0.07),
PropN = c(0.55, 0.25, 0.20),
E = c(NA, 900, 2800), EE = c(NA, 4.5, 0.3),
N = NA, NE = NA,
WD = c(5, 15, 15), WDE = c(0.5, 0.7, 0.7),
D2B = NA, D2BE = NA)

# simulate the fish population
res <- SimFish(LakeName="Clear Lake", LkWidth=3000, LkLength=2000, BotDepMin=20, BotDepMa
FishParam=fishp, TotNFish=50000, Seed=667)

# survey the population
surv <- SampFish(SimPop=res, NumEvents=2, AcNum=5, AcInterval=3000, AcLayer=10, AcAngle=7

AcSmry(AcTarg=surv$Targets, LakeInfo=res$LakeInfo, SurvParam=surv$SurvParam)
```

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artiFISHal *Pelagic Fish Community Simulator*

Description

artiFISHal is a pelagic fish community simulator, which can be used to create artificial lakes and populate them with known numbers of fish (identified in species-size groups) to mimic pelagic fish communities. **artiFISHal** can then be used to sample these fish with virtual acoustic and midwater trawl surveys.

Details

An example of how to use the functions in **artiFISHal** is given in this vignette[3]. Use SimFish to create an artificial lake and populate it with known numbers of fish (identified in species-size groups) to mimic pelagic fish communities. Use SampFish to sample the fish population with virtual acoustic and midwater trawl surveys.

Yule et al. (2013)[4] used **artiFISHal** to evaluate several different approaches for estimating the biomass of pelagic fish species in the Great Lakes.

U.S. Geological Survey (USGS) Computer Program **artiFISHal** version 2014-07. Written by Jean V. Adams, USGS - Great Lakes Science Center[5], Ann Arbor, Michigan, USA. Written in program-

[2] http://www.tandfonline.com/doi/abs/10.1577/1548-8675(2000)020ofhorizontalacousticandpurse-seineestima
[3] https://github.com/JVAdams/artiFISHal/blob/master/Vignette.md
[4] http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ
[5] http://www.glsc.usgs.gov/

ming language R (R Core Team, 2014, www.R-project.org), version 3.1.1 (2014-07-10). Run on a PC with Intel(R) Core(TM) I7-4600m CPU, 2.90 GHz processor, 16.0 GB RAM, and Microsoft Windows 7 Enterprise operating system 2009 Service Pack 1. Source code is available from Jean V. Adams on GitHub[6], _jvadams (at) usgs (dot) gov_.

Disclaimer: Although this program has been used by the USGS, no warranty, expressed or implied, is made by the USGS or the United States Government as to the accuracy and functioning of the program and related program material nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by the USGS in connection therewith.

References

Yule, DL, JV Adams, DM Warner, TR Hrabik, PM Kocovsky, BC Weidel, LG Rudstam, and PJ Sullivan. 2013. Evaluating analytical approaches for estimating pelagic fish biomass using simulated fish communities[7]. Canadian Journal of Fisheries and Aquatic Sciences 70:1845-1857.

`dfromx` *Determine Distance to Shore from Easting*

Description

Determine the distance to the lake shore from a given easting.

Usage

```
dfromx(x, d2shr.we, eastr)
```

Arguments

`x`	A numeric vector of the eastings to convert (in m).
`d2shr.we`	A numeric vector of length 2, distance (in the "x" direction) from west and east shores excluded from lake (in m).
`eastr`	A numeric vector of length 2, easting range (minimum and maximum) corresponding to the west and east shores of the lake (in m).

Details

An internal function called by `SimFish`.

Value

A numeric vector, same length as `x`, with distances to shore (west or east, whichever is closer) for each easting provided (in m).

See Also

`SimFish`, `zfromx`, `xfromz`.

[6] `https://github.com/JVAdams/artiFISHal`
[7] `http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ`

first *Identify the First Elements of Series of Repeated Values*

Description

Identify the first elements of series of repeated values.

Usage

```
first(x)
```

Arguments

x	A vector whose values will be explored for series of repeated values, can be character, numeric, or factor.

Value

An integer vector the same length as x, with a 1 for every element that is different than the one before it, and a 0 for every element that is the same as the one before it.

Examples

```
first(c(1, 2, 1, 2, 2, 1, 1, 3))
```

logit2 *Double Logistic Probability*

Description

Probability distribution function of double logistic curve, with ascending an descending limbs allowing for parabolic-shaped probabilities.

Usage

```
logit2(x, x50a, slopea, x50b, slopeb)
```

Arguments

x	A numeric vector.
x50a	A numeric scalar, the quantile at which small values of x have a 50% probability, the first "location" parameter.
slopea	A numeric scalar, the slope at which the probability for small values of x increases, the first "scale" parameter.
x50b	A numeric scalar, the quantile at which large values of x have a 50% probability, the second "location" parameter.
slopeb	A numeric scalar, the slope at which the probability for large values of x decreases, the second "scale" parameter.

Details

The double logistic function mimics the single logistic function if either of the location paramters are set to the extremes, `x50a = -Inf` or `x50a = Inf`.

References

This function is based on a modification of MATLAB[8] code provided by Kresimir Williams, NOAA-AFSC[9], at the Great Lakes Acoustic Users Group's Workshop on Trawl Performance, hosted by the Great Lakes Fishery Commission[10], 22-24 April 2014, in Ann Arbor, Michigan, USA.

Examples

```
x <- 1:400
y1 <- logit2(x=x, x50a=90, slopea=10, x50b=Inf, slopeb=-20)
plot(x, y1)

y2 <- logit2(x=x, x50a=-Inf, slopea=10, x50b=300, slopeb=-20)
plot(x, y2)

y3 <- logit2(x=x, x50a=90, slopea=10, x50b=300, slopeb=-20)
plot(x, y3)
```

MeshPass *Determine the Largest Fish that can Pass through a Net*

Description

Determine the largest height (or depth) of a fish that can pass through a single diamond-shaped mesh of a net.

Usage

```
MeshPass(BarMesh, H2WRatio, L2HRatio = NA, Plot = TRUE)
```

Arguments

`BarMesh`	A numeric scalar, the length of one side of a square mesh (in inches).
`H2WRatio`	A numeric scalar, the ratio of the height (vertex to vertex) of a single square mesh (oriented as a diamond) to its width (vertex to vertex).
`L2HRatio`	A numeric scalar, > 1, the ratio of the length of a fish to its height (or depth). If set to NA, the default, no length calculations will be done.
`Plot`	A logical scalar, indicating if a diagram (drawn to scale) of the mesh and the largest fish should be shown, default TRUE.

Details

The cross sectional shape of the fish (looking it right in the nose) is assumed to be a geometric shape similar to an ellipse, two vertically-oriented tangential circles of equal size (like a figure 8).

[8] `http://www.mathworks.com/products/matlab/`
[9] `http://www.afsc.noaa.gov`
[10] `http://www.glfc.org/`

Value

A named vector with 2 elements: fish height (in inches) and fish length (in mm).

References

This function is based on a modification of ellipse-based MATLAB[11] code provided by Kresimir Williams, NOAA-AFSC[12], at the Great Lakes Acoustic Users Group's Workshop on Trawl Performance, hosted by the Great Lakes Fishery Commission[13], 22-24 April 2014, in Ann Arbor, Michigan, USA.

Examples

```
MeshPass(BarMesh=2, H2WRatio=0.3)
MeshPass(BarMesh=2, H2WRatio=0.3, L2HRatio=4)
MeshPass(BarMesh=2, H2WRatio=1/0.3, L2HRatio=4)
```

---

plotblank *Create a Blank Plot*

Description

Create a blank plot (no symbols) on which to add other plotting features.

Usage

```
plotblank(x = 0:1, y = 0:1, xlab = "", ylab = "", las = 1, ...)
```

Arguments

x	A numeric vector, the x coordinates of points in the plot.
y	A numeric vector, the y coordinates of points in the plot.
xlab	A character scalar, title for the x axis, default "".
ylab	A character scalar, title for the y axis, default "".
las	A numeric scalar, style of axis labels, 0 = always parallel to the axis, 1 = always horizontal (default), 2 = always perpendicular to the axis, 3 = always vertical.
...	Additional arguments to the `plot` function.

See Also

`plot`, `title`, `par`

Examples

```
plotblank(xlim=c(1, 100))
```

[11] http://www.mathworks.com/products/matlab/
[12] http://www.afsc.noaa.gov
[13] http://www.glfc.org/

`prednode` *Predict Node from a Fitted rpart Object*

Description

Predict the node identification number from a fitted `rpart` object.

Usage

```
prednode(object, newdata)
```

Arguments

`object`	A fitted model object of class "rpart", the result of a call to the `rpart` function.
`newdata`	A data frame containing the values for which predictions will be made. The predictors referred to in the right side of `formula(object)` must be present by name in newdata.

References

This function is a modification of an approach suggested in a post[14] to the R-help mailing list on 22 July 2008 by Brian D. Ripley[15], Professor of Applied Statistics, University of Oxford, Oxford, UK.

See Also

`rpart`, `predict.rpart`

Examples

```
## Not run:

z.auto <- rpart(Mileage ~ Weight, car.test.frame)
prednode(z.auto, car.test.frame)

fit <- rpart(Kyphosis ~ Age + Number + Start, data = kyphosis)
prednode(fit, kyphosis)

## End(Not run)
```

[14] `http://tolstoy.newcastle.edu.au/R/e4/help/08/07/17702.html`
[15] `http://www.stats.ox.ac.uk/~ripley/`

recode — *Recode Values*

Description

Recode the values of a vector.

Usage

```
recode(x, old, new, must.match = TRUE)
```

Arguments

x	A vector whose values will be recoded, can be character, numeric, or factor.
old	A vector of the unique values currently in the vector.
new	A vector of values which should replace the current ones.
must.match	A logical scalar indicating whether only those elements of the original vector with values in old should be returned (TRUE), or all values should be returned (FALSE) though some may be unchanged, default TRUE.

Value

A vector the same length as x (unless must.match=TRUE), with old values replaced by new values.

Examples

```
recode(c(1,1,1,2,3,4,1,10,3), 1:3, 1001:1003)
recode(c(1,1,1,2,3,4,1,10,3), 1:3, 1001:1003, must.match=FALSE)
```

SampFish — *Survey a Fish Population*

Description

Sample a simulated population of pelagic fish (created with SimFish) with down-looking acoustics (cross-lake, west-to-east) and midwater trawls (west-to-east)

Usage

```
SampFish(SimPop, NumEvents = 1, AcNum, AcInterval, AcLayer, AcAngle, MtNum,
  MtHt, MtWd, MtLen, MtMinCat = 2, MtMulti = 6, PlotsPdf = NA,
  Seed = NULL)
```

Arguments

SimPop	A list with elements LakeInfo, FishInfo, FishParam, FishPop, typically output from SimFish.
NumEvents	An integer scalar, number of sampling events, i.e., number of times to repeat the survey.
AcNum	An integer scalar > 0, number of equally-spaced, cross-lake, acoustic transects (oriented west-to-east).
AcInterval	A numeric scalar, length (distance) of acoustic interval (in m).
AcLayer	A numeric scalar, depth of acoustic layer (in m).
AcAngle	A numeric scalar, full beam angle width of down-looking acoustic transducer (in degrees).
MtNum	An integer scalar > 0, target number of midwater trawl tows (oriented west-to-east along acoustic transects at random water depths).
MtHt	A numeric scalar, height of rectangular midwater trawl opening (in m).
MtWd	A numeric scalar, width of rectangular midwater trawl opening (in m).
MtLen	A numeric scalar, length (distance) of midwater trawl haul (in m).
MtMinCat	An integer scalar, the minimum catch (number of fish) per midwater trawl tow, default 2. Tows capturing fewer than MtMinCat fish will be tossed out.
MtMulti	An integer scalar, the initial number of midwater trawl tows is mulitplied by this scalar in an attempt to achieve the target number of tows, MtNum, even after eliminating those tows that extend beyond the boundaries of the lake or those with fewer than MtMinCat, default 6.
PlotsPdf	A character scalar, name of pdf file to store the diagnostic plots in. If NA, the default, plots are displayed on the screen instead. If FALSE, no plots are created.
Seed	An integer scalar, starting seed for stochasticity incorporated in placement of acoustic transects and midwater trawl tows. Use Seed to ensure the survey is conducted in the same location with each call to SampFish. Otherwise, if set to NULL, the default, a random seed is used, resulting in a different tow location with each call to SampFish.

Details

All sampling is assumed to be "perfect" with no issues of fish availability, acoustic dead zones, or trawl selectivity. So, the acoustic transects capture echoes from all fish that fall within the triangular prism defined by the randomly selected northing of the transect and the beam angle (AcAngle) of the transducer, which is assumed to be at the surface of the water. And, the midwater trawl tows capture all fish that fall within the rectangular prism defined by the randomly selected water depth of the tow, the trawl gape (MtHt and MtWd), and the tow length (MtLen).

Three diagnostic plots are produced, if PlotsPdf is not FALSE. The first is a top (bird's eye) view of the acoustic transects and midwater trawls in lake, drawn to scale. In this plot, acoustic transects are shown as solid blue lines and midwater trawl tows are shown as red rectangles. Second is a side view of each acoustic transect separately, showing the individual fish targets as blue circles (larger circles indicate larger fish) and midwater trawl tows as red rectangles with the number of fish captured written inside. The acoustic transect number and the number of targets in the transect are printed on the plot. Third is a length frequency histogram for fish captured in each midwater trawl tow. The midwater trawl tow number and the number of fish captured in the tow are printed on the plot.

Value

A list with 3 elements.

- `SurvParam` is a named vector with the survey inputs supplied as arguments to `SampFish`.
- `Targets` is a data frame with information on fish detected in the virtual acoustics survey. Each row represents a single target, columns describe the specific location of fish in the lake and their target strengths. Three columns are included that would not be available in a real acoustic survey: group (`G`) and size (`len` and `wt`).
- `MtCatch` is a data frame with information on the fish captured in the virtual midwater trawl survey. Each row represents a single fish, columns describe the specific location of the trawl and the group and size of the fish. Seven columns are included that would not be available in a real midwater trawl survey: the specific location of the fish (`f.east`, `f.north`, `f.d2sh`, `f.botdep`, `f.wdep`, `f.d2bot`) and their target strenghs (`ts`).

References

Yule, DL, JV Adams, DM Warner, TR Hrabik, PM Kocovsky, BC Weidel, LG Rudstam, and PJ Sullivan. 2013. Evaluating analytical approaches for estimating pelagic fish biomass using simulated fish communities[16]. Canadian Journal of Fisheries and Aquatic Sciences 70:1845-1857.

Yule, DL. 2000. .[17] North American Journal of Fisheries Management 20:759-775.

See Also

`SimFish`

Examples

```
# parameters for small (a) and large (A) alewife as input to the simulator
fishp <- data.frame(
G = c("a", "A", "A"),
Z = c(50, 140, 140), ZE = c(0.25, 0.2, 0.2),
LWC1 = 0.000014, LWC2 = 2.8638, LWCE = 0.18,
TSC1 = -64.2, TSC2 = 20.5, TSCE = c(0.02, 0.07, 0.07),
PropN = c(0.55, 0.25, 0.20),
E = c(NA, 900, 2800), EE = c(NA, 4.5, 0.3),
N = NA, NE = NA,
WD = c(5, 15, 15), WDE = c(0.5, 0.7, 0.7),
D2B = NA, D2BE = NA)

# simulate the fish population
res <- SimFish(LakeName="Clear Lake", LkWidth=3000, LkLength=2000, BotDepMin=20, BotDepMa
FishParam=fishp, TotNFish=50000, Seed=667)

# survey the population
surv <- SampFish(SimPop=res, NumEvents=2, AcNum=5, AcInterval=3000, AcLayer=10, AcAngle=7

# look at the results
surv$SurvParam
head(surv$Targets)
head(surv$MtCatch)
```

[16] http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ
[17] http://www.tandfonline.com/doi/abs/10.1577/1548-8675(2000)020ofhorizontalacousticandpurse-seineestima

SimFish *Simulate a Fish Population*

Description

Create a simulated population of pelagic fish in an artificial lake.

Usage

```
SimFish(LakeName, LkWidth, LkLength, BotDepMin, BotDepMax, BotDepVertex = 2 *
  BotDepMax, FishParam, TotNFish, TSRange = c(-65, -20), PlotsPdf = NA,
  Seed = NULL)
```

Arguments

LakeName	A character scalar, full name for artificial lake to be used in plot titles.
LkWidth	A numeric scalar, the width of the lake in the west-east direction (in m).
LkLength	A numeric scalar, the length of the lake in the south-north direction (in m).
BotDepMin	A numeric scalar, the minimum bottom depth of the lake, at both the west and east shorelines (in m).
BotDepMax	A numeric scalar, the maximum bottom depth of the lake (in m).
BotDepVertex	A numeric scalar, the vertical distance from the surface to the "vertex" of the lake bottom (in m), default 2*BotDepMax. The "vertex" of the lake bottom is the point at which the angled lake beds along the west and east shores would intersect, were they not cut off first by the specified BotDepMax. View this figure[18] for a diagram of the artificial lake.
FishParam	A data frame with 18 columns in which each row describes a sub-population of fish to be placed in the artificial lake. The first 11 columns must be completely filled in (no missing values). The last 8 columns may have some missing values. However, in each row, **either** water depth (WD and WDE) **or** distance to bottom (D2B and D2BE) **must** be filled in, but **not both**. Column names and descriptions:

- G = character, a one-letter nickname for the group (e.g., fish species and lifestage) used in plotting
- Z = numeric, mean length (in mm)
- ZE = numeric, error around mean length, expressed as SD/mean
- LWC1, LWC2 = numeric, length-weight regression coefficients, where wt = LWC1*len^LWC2, (wt in g, len in mm)
- LWCE = numeric, error around weight estimate, expressed as SD(estimate)/estimate
- TSC1, TSC2 = numeric, target strength and length relation coefficients, ts = TSC1 + TSC2*log10(len/10), (ts in db, len in mm)
- TSCE = numeric, error around target strength estimate, expressed as SD(estimate)/estimate
- PropN = numeric, approximate proportion of population that the row represents (automatically adjusted to ensure they sum to 1)
- E = numeric, mean easting (m)
- EE = numeric, error around easting, expressed as SD/mean

[18] https://raw.githubusercontent.com/JVAdams/artiFISHal/master/LakeFigures.JPG

- N = numeric, mean northing (m)
- NE = numeric, error around northing, expressed as SD/mean
- WD = numeric, mean water depth (m)
- WDE = numeric, error around water depth, expressed as SD/mean
- D2B = numeric, mean distance to bottom (m)
- D2BE = numeric, error around distance to bottom, expressed as SD/mean

TotNFish — A numeric scalar indicating the target number of fish to put in the lake. The actual number of fish in the population will likely be smaller than TotNFish, because the process used to populate the lake with fish ends up with some fish out of water (beyond the boundaries of the artificial lake), which are then removed from the population. Memory on your computer limits the size of TotNFish (see Details).

TSRange — A numeric vector of length 2, the range of target strengths to use for the fish (in db), default c(-65, -20).

PlotsPdf — A character scalar, name of pdf file to store the diagnostic plots in. If NA, the default, plots are displayed on the screen instead. If FALSE, no plots are created.

Seed — An integer scalar, starting seed for stochasticity incorporated in fish population generation. Use Seed to ensure the same population is generated with each call to SimFish. Otherwise, if set to NULL, the default, a random seed is used, resulting in a different population with each call to SimFish.

Details

The artificial lake can be imagined as a rectangular subset of a "real" lake. The east and west boundaries of the artifical lake do not reach the shoreline of the "real" lake, unless BotDepMin is set to zero. The north and south boundaries of the artificial lake do not ascend to a shoreline, instead the bottom depth remains constant in the south-north direction (i.e., for a given easting). The angle of the western lake bed is twice as steep as the angle of the eastern lake bed. View the top and side views of the artificial lake in this diagram[19].

You may wish to cap the total number of fish at 5 million if your computer has a memory of about 2 GB (2047 MB). This limit can be increased if you have more memory available in R. You can check the memory available with memory.limit.

The diagnostic plots produced, if PlotsPdf is not FALSE, include scatterplots of 1,000 fish randomly selected from the population, scatterplots of 250 fish randomly selected from each group, and histograms of the size and spatial distribution of all the fish in the lake.

Value

A list with 6 elements:

- Truth, a data frame with the total number and weight of each fish group in the population;
- LakeInfo, a list with the lake inputs supplied as arguments to SimFish as well as a few additional objects which are used by SampFish in surveying the population,
  - ints = a numeric vector of length 2, the intercepts of the angled lake beds along the west and east shores of the lake (in m)
  - slopes = a numeric vector of length 2, the slopes of the angled lake beds along the west and east shores of the lake (unitless)
  - d2shr.we = a numeric vector of length 2, distance (in the west-east direction) from west and east shores excluded from lake (in m);

[19] https://raw.githubusercontent.com/JVAdams/artiFISHal/master/LakeFigures.JPG

- FishInfo, a list with the fish inputs supplied as arguments to SimFish;
- FishParam, the data frame supplied as an argument to SimFish;
- FishPop, a data frame in which each row is a fish, and 10 columns describe the fish group (G), location (easting f.east, northing f.north, distance to shore f.d2sh, bottom depth f.botdep, water depth f.wdep, distance to bottom f.d2bot, all in m), and fish size (total length in mm len, weight in g wt, and target strength in db ts); and
- PropExcluded, a numeric vector showing the proportion of the requested number of fish, TotNFish, that were eliminated from the population based on their size (LengthWeight, TS) or location (Easting, Northing, WaterDepth, BottomDepth, D2Shore). If you end up with far fewer fish than requested, this can be useful in troubleshooting where the problem might lie.

References

Yule, DL, JV Adams, DM Warner, TR Hrabik, PM Kocovsky, BC Weidel, LG Rudstam, and PJ Sullivan. 2013. Evaluating analytical approaches for estimating pelagic fish biomass using simulated fish communities[20]. Canadian Journal of Fisheries and Aquatic Sciences 70:1845-1857.

See Also

SampFish

Examples

```
## Not run:

# parameters for small (a) and large (A) alewife as input to the simulator
fishp <- data.frame(
G = c("a", "A", "A"),
Z = c(50, 140, 140), ZE = c(0.25, 0.2, 0.2),
LWC1 = 0.000014, LWC2 = 2.8638, LWCE = 0.18,
TSC1 = -64.2, TSC2 = 20.5, TSCE = c(0.02, 0.07, 0.07),
PropN = c(0.55, 0.25, 0.20),
E = c(NA, 900, 2800), EE = c(NA, 4.5, 0.3),
N = NA, NE = NA,
WD = c(5, 15, 15), WDE = c(0.5, 0.7, 0.7),
D2B = NA, D2BE = NA)

# simulate the fish population
res <- SimFish(LakeName="Clear Lake", LkWidth=3000, LkLength=2000, BotDepMin=20, BotDepMa
FishParam=fishp, TotNFish=1000, Seed=667)

# look at the results
res$Truth
res$LakeInfo
res$FishInfo
head(res$FishParam)
head(res$Fish)
res$PropExcluded


## End(Not run)
```

[20] http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ

TuneSelec *Tune Midwater Trawl Selectivity*

Description

Interactive visualization of midwater trawl selectivity curve for aid in tuning selectivity parameters used in `AcMtEst`.

Usage

```
TuneSelec()
```

Details

Interactive sliders are provided for the four parameters of interest which are required for defining the midwater trawl selectivity of the mesh panel zones as a double logistic curve:

- `MtL50Small` the length (in mm) at which small fish have a 50% probability of being captured by the trawl
- `MtSlopeSmall` the slope at which small fish probability of capture increases with length
- `MtL50Large` the length (in mm) at which large fish have a 50% probability of being captured by the trawl
- `MtSlopeLarge` the (absolute value of the) slope at which large fish probability of capture decreases with length

Note that the sliders pop up in a separate R window, which may be hidden if you click on another window.

See Also

`AcMtEst`, `logit2`

Examples

```
## Not run:
TuneSelec()

## End(Not run)
```

ViewSelec *View Midwater Trawl Selectivity Curves*

Description

Visualization of midwater trawl selectivity curves based on parameters used in `AcMtEst`.

Usage

```
ViewSelec(SelecParam)
```

Arguments

`SelecParam` A data frame with 6 columns in which each row provides the midwater trawl selectivity parameters for a given fish group and mesh panel zone. All columns must be completely filled in (no missing values). Selectivity is assumed to be 100% for any group-zone combination not represented as a row in the data frame. For 100% selectivity of small fish, use MtL50Small = -Inf and any slope. For 100% selectivity of large fish, use MtL50Large = Inf and any slope. Column names and descriptions:

- `G` = character, a one-letter nickname for the group (e.g., fish species and lifestage) used in plotting
- `Zone` = character, mesh panel zone, one of "mouth", "middle", "aft", or "cod"
- `MtL50Small` = the length (in mm) at which small fish have a 50% probability of being captured by the trawl
- `MtSlopeSmall` = the (inverse) slope at which small fish probability of capture increases with length, smaller values are steeper
- `MtL50Large` = the length (in mm) at which large fish have a 50% probability of being captured by the trawl
- `MtSlopeLarge` = the (absolute value of the inverse) slope at which large fish probability of capture decreases with length, smaller values are steeper

See Also

`AcMtEst`, `logit2`

Examples

```
## Not run:

selec <- data.frame(
G = c("A", "a", "A", "a", "A", "a"),
Zone = c("mouth", "mouth", "middle", "middle", "aft", "aft"),
MtL50Small = c(100, 90, 60, 50, 30, 2),
MtSlopeSmall = c(40, 40, 30, 30, 20, 20),
MtL50Large = c(180, 180, Inf, Inf, Inf, Inf),
MtSlopeLarge = c(20, 20, 100, 100, 100, 100))
ViewSelec(selec)

## End(Not run)
```

`ViewZones` *Visualize the Mesh Panel Zones of a Midwater Trawl*

Description

Draw a diagram displaying the sizes of the mesh panel zones of a midwater trawl.

Usage

```
ViewZones(PanelProps = c(0.4, 0.3, 0.2, 0.1))
```

Arguments

PanelProps	A numeric vector of length 4, size of the different mesh panel zones of the midwater trawl, mouth (outermost), middle, aft, and cod (inner), default c(0.4, 0.3, 0.2, 0.1). Sizes are expressed as proportions of the distance from the outer edge of the trawl to the trawl center in both the vertical and horizontal directions, and they should add up to 1.

Details

A diagram is produced giving a view of the midwater trawl mesh panel zones (drawn to scale) from the perspective a fish located directly in the center of the oncoming trawl path.

See Also

AcMtEst

Examples

```
## Not run:
ViewZones()
ViewZones(c(0.4, 0.4, 0.1, 0.1))

## End(Not run)
```

---

xfromz *Determine Easting from Bottom Depth*

Description

Determine the easting from a given distance to lake bottom, incorporating random assignment to west or east shore if not specified.

Usage

```
xfromz(z, maxz, ints, slopes, shore = "random")
```

Arguments

z	A numeric vector of the distances to lake bottom to convert (in m).
maxz	A numeric scalar, the maximum bottom depth of the lake (in m).
ints	A numeric vector of length 2, the intercepts of the angled lake beds along the west and east shores of the lake (in m).
slopes	A numeric vector of length 2, the slopes of the angled lake beds along the west and east shores of the lake (unitless).
shore	A numeric or character scalar, indicating if the shore should be west (0), east (1) or randomly assigned ("random", default).

Details

An internal function called by SimFish.

Value

A numeric vector, same length as x, with distances to bottom for each easting provided (in m).

See Also

SimFish, dfromx, zfromx. The assignment to shore is necessary because the artificial lake will have two eastings for each bottom depth (except for the depth at the vertex).

---

zfromx *Determine Bottom Depth from Easting*

Description

Determine the distance to the bottom from a given easting.

Usage

```
zfromx(x, maxz, eastr, ints, slopes)
```

Arguments

x	A numeric vector of the eastings to convert (in m).
maxz	A numeric scalar, the maximum bottom depth of the lake (in m).
eastr	A numeric vector of length 2, easting range (minimum and maximum) corresponding to the west and east shores of the lake (in m).
ints	A numeric vector of length 2, the intercepts of the angled lake beds along the west and east shores of the lake (in m).
slopes	A numeric vector of length 2, the slopes of the angled lake beds along the west and east shores of the lake (unitless).

Details

An internal function called by SimFish.

Value

A numeric vector, same length as x, with distances to bottom for each easting provided (in m).

See Also

SimFish, dfromx, xfromz.