

Package ‘artiFISHal’

November 14, 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	1
AcSmry	3
artiFISHal	5
dfromx	6
first	6
logit2	7
MeshPass	8
plotblank	9
prednode	9
recode	10
SampFish	11
SimFish	13
TuneSelec	16
ViewSelec	17
ViewZones	18
xfromz	19
zfromx	19

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

<code>SimPop</code>	A list with elements <code>LakeInfo</code> , <code>FishInfo</code> , <code>FishParam</code> , <code>FishPop</code> , typically output from <code>SimFish</code> . See <code>SimFish</code> for details on the list elements.
<code>AcMtSurv</code>	A list with elements <code>Targets</code> , <code>AcSummaryCell</code> , <code>AcSummaryColumn</code> , <code>MtCatch</code> , typically output from <code>SampFish</code> .
<code>AcExcl</code>	A numeric vector of length 2, depth of acoustic "dead" zones at the surface and at the bottom (in m), default of <code>c(0, 0)</code> represents 100% acoustic availability of fish.
<code>MtExcl</code>	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 <code>c(0, 0)</code> represents 100% midwater trawl availability of fish.
<code>PanelProps</code>	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 <code>c(0.4, 0.3, 0.2, 0.1)</code> . 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 <code>ViewZones</code> to visualize the mesh panel zones.
<code>SelecParam</code>	<p>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 <code>MtL50Small = -Inf</code> and any slope. For 100% selectivity of large fish, use <code>MtL50Large = Inf</code> and any slope. Column names and descriptions:</p> <ul style="list-style-type: none"> • <code>G</code> = character, a one-letter nickname for the group (e.g., fish species and lifestage) used in plotting • <code>Zone</code> = character, mesh panel zone, one of "mouth", "middle", "aft", or "cod" • <code>MtL50Small</code> = numeric, the length (in mm) at which small fish have a 50% probability of being captured by the trawl • <code>MtSlopeSmall</code> = numeric, the (inverse) slope at which small fish probability of capture increases with length, smaller values are steeper • <code>MtL50Large</code> = 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. *Canadian Journal of Fisheries and Aquatic Sciences* 70:1845-1857. <http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ>

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, BotDepMax=100,
  FishParam=fishp, TotNFish=50000)

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

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 <code>Targets</code> data frame output from <code>SampFish</code> . 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 <code>SimFish</code> as well as a few additional objects.
SurvParam	A named vector with the survey inputs supplied as arguments to <code>SampFish</code> .

Details

Acoustic intervals are identified by the easting (in m) of their midpoint. Acoustic layers are identified 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 ($0.5 * \text{AcAngle}$). 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. ¹ 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, BotDepMax=20,
FishParam=fishp, TotNFish=50000, Seed=667)

# survey the population
surv <- SampFish(SimPop=res, NumEvents=2, AcNum=5, AcInterval=3000, AcLayer=10, AcAngle=70)

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

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 vignette². 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) used **artiFISHal** to evaluate several different approaches for estimating the biomass of pelagic fish species in the Great Lakes.

¹[http://www.tandfonline.com/doi/abs/10.1577/1548-8675\(2000\)020<ofhorizontalacousticandpurse-seineestim](http://www.tandfonline.com/doi/abs/10.1577/1548-8675(2000)020<ofhorizontalacousticandpurse-seineestim)

²<https://github.com/JVAdams/artiFISHal/blob/master/Vignette.md>

U.S. Geological Survey (USGS) Computer Program **artiFISHal** version 2014-07. Written by Jean V. Adams, USGS - Great Lakes Science Center³, Ann Arbor, Michigan, USA. Written in programming 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 GitHub⁴, [_jvadams \(at\) usgs \(dot\) gov_](mailto:_jvadams@usgs.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. *Canadian Journal of Fisheries and Aquatic Sciences* 70:1845-1857. <http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ>

dfromx

Determine Distance to Shore from Easting

Description

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

Usage

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

Arguments

<code>x</code>	A numeric vector of the eastings to convert (in m).
<code>d2shr.we</code>	A numeric vector of length 2, distance (in the "x" direction) from west and east shores excluded from lake (in m).
<code>east_r</code>	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`.

³<http://www.glsc.usgs.gov/>

⁴<https://github.com/JVAdams/artiFISHal>

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 and 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, $x_{50a} = -\text{Inf}$ or $x_{50a} = \text{Inf}$.

References

This function is based on a modification of MATLAB⁵ code provided by Kresimir Williams, NOAA-AFSC⁶, at the Great Lakes Acoustic Users Group's Workshop on Trawl Performance, hosted by the Great Lakes Fishery Commission⁷, 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).

⁵<http://www.mathworks.com/products/matlab/>

⁶<http://www.afsc.noaa.gov>

⁷<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 MATLAB⁸ code provided by Kresimir Williams, NOAA-AFSC⁹, at the Great Lakes Acoustic Users Group's Workshop on Trawl Performance, hosted by the Great Lakes Fishery Commission¹⁰, 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	<i>Create a Blank Plot</i>
-----------	----------------------------

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))
```

⁸<http://www.mathworks.com/products/matlab/>

⁹<http://www.afsc.noaa.gov>

¹⁰<http://www.glfc.org/>

prednode	<i>Predict Node from a Fitted rpart Object</i>
----------	--

Description

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

Usage

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

Arguments

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

References

This function is a modification of an approach suggested in a post¹¹ to the R-help mailing list on 22 July 2008 by Brian D. Ripley¹², 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)
```

¹¹<http://tolstoy.newcastle.edu.au/R/e4/help/08/07/17702.html>

¹²<http://www.stats.ox.ac.uk/~ripley/>

recode	<i>Recode Values</i>
--------	----------------------

Description

Recode the values of a vector.

Usage

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

Arguments

<code>x</code>	A vector whose values will be recoded, can be character, numeric, or factor.
<code>old</code>	A vector of the unique values currently in the vector.
<code>new</code>	A vector of values which should replace the current ones.
<code>must.match</code>	A logical scalar indicating whether only those elements of the original vector with values in <code>old</code> 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	<i>Survey a Fish Population</i>
----------	---------------------------------

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

<code>SimPop</code>	A list with elements <code>LakeInfo</code> , <code>FishInfo</code> , <code>FishParam</code> , <code>FishPop</code> , typically output from <code>SimFish</code> .
<code>NumEvents</code>	An integer scalar, number of sampling events, i.e., number of times to repeat the survey.
<code>AcNum</code>	An integer scalar > 0 , number of equally-spaced, cross-lake, acoustic transects (oriented west-to-east).
<code>AcInterval</code>	A numeric scalar, length (distance) of acoustic interval (in m).
<code>AcLayer</code>	A numeric scalar, depth of acoustic layer (in m).
<code>AcAngle</code>	A numeric scalar, full beam angle width of down-looking acoustic transducer (in degrees).
<code>MtNum</code>	An integer scalar > 0 , target number of midwater trawl tows (oriented west-to-east along acoustic transects at random water depths).
<code>MtHt</code>	A numeric scalar, height of rectangular midwater trawl opening (in m).
<code>MtWd</code>	A numeric scalar, width of rectangular midwater trawl opening (in m).
<code>MtLen</code>	A numeric scalar, length (distance) of midwater trawl haul (in m).
<code>MtMinCat</code>	An integer scalar, the minimum catch (number of fish) per midwater trawl tow, default 2. Tows capturing fewer than <code>MtMinCat</code> fish will be tossed out.
<code>MtMulti</code>	An integer scalar, the initial number of midwater trawl tows is multiplied by this scalar in an attempt to achieve the target number of tows, <code>MtNum</code> , even after eliminating those tows that extend beyond the boundaries of the lake or those with fewer than <code>MtMinCat</code> , default 6.
<code>PlotsPdf</code>	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.
<code>Seed</code>	An integer scalar, starting seed for stochasticity incorporated in placement of acoustic transects and midwater trawl tows. Use <code>Seed</code> to ensure the survey is conducted in the same location with each call to <code>SampFish</code> . Otherwise, if set to NULL, the default, a random seed is used, resulting in a different tow location with each call to <code>SampFish</code> .

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 strengths (`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. *Canadian Journal of Fisheries and Aquatic Sciences* 70:1845-1857. <http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ>

Yule, DL. 2000. ¹³ *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, BotDepMax=200,
  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)
```

¹³[http://www.tandfonline.com/doi/abs/10.1577/1548-8675\(2000\)020ofhorizontalacousticandpurse-seineestim](http://www.tandfonline.com/doi/abs/10.1577/1548-8675(2000)020ofhorizontalacousticandpurse-seineestim)

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 $2 * \text{BotDepMax}$. 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 <code>BotDepMax</code> . View this figure ¹⁴ for a diagram of the artificial lake.
FishParam	<p>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:</p> <ul style="list-style-type: none"> • 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 $\text{wt} = \text{LWC1} * \text{len}^{\text{LWC2}}$, (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, $\text{ts} = \text{TSC1} + \text{TSC2} * \log_{10}(\text{len}/10)$, (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

¹⁴<https://raw.githubusercontent.com/JVAdams/artiFISHal/master/images/LakeFigures.JPG>

	<ul style="list-style-type: none"> • <code>N</code> = numeric, mean northing (m) • <code>NE</code> = numeric, error around northing, expressed as SD/mean • <code>WD</code> = numeric, mean water depth (m) • <code>WDE</code> = numeric, error around water depth, expressed as SD/mean • <code>D2B</code> = numeric, mean distance to bottom (m) • <code>D2BE</code> = numeric, error around distance to bottom, expressed as SD/mean
<code>TotNFish</code>	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 <code>TotNFish</code> , 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 <code>TotNFish</code> (see Details).
<code>TSRange</code>	A numeric vector of length 2, the range of target strengths to use for the fish (in db), default <code>c(-65, -20)</code> .
<code>PlotsPdf</code>	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.
<code>Seed</code>	An integer scalar, starting seed for stochasticity incorporated in fish population generation. Use <code>Seed</code> to ensure the same population is generated with each call to <code>SimFish</code> . Otherwise, if set to NULL, the default, a random seed is used, resulting in a different population with each call to <code>SimFish</code> .

Details

The artificial lake can be imagined as a rectangular subset of a "real" lake. The east and west boundaries of the artificial 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 diagram¹⁵.

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);

¹⁵<https://raw.githubusercontent.com/JVAdams/artiFISHal/master/images/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. *Canadian Journal of Fisheries and Aquatic Sciences* 70:1845-1857. <http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0072#.U1KYxPldXTQ>

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, BotDepMax=100,
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)
```


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, east, ints, slopes)
```

Arguments

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