Package ‘ecorest’

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Title Conducts Analyses Informing Ecosystem Restoration Decisions

Version 2.0.0

Description Three sets of data and functions for informing ecosystem restoration decisions, particularly in the context of the U.S. Army Corps of Engineers. First, model parameters are compiled as a data set and associated metadata for over 300 habitat suitability models developed by the U.S. Fish and Wildlife Service (USFWS 1980, <https://www.fws.gov/policy-library/870fw1>). Second, functions for conducting habitat suitability analyses both for the models described above as well as generic user-specified model parameterizations. Third, a suite of decision support tools for conducting cost-effectiveness and incremental cost analyses (Robinson et al. 1995, IWR Report 95-R-1, U.S. Army Corps of Engineers).

Depends R (>= 3.5.0)

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Encoding UTF-8

LazyData true

Imports viridis, stats, graphics, grDevices

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Contents

`annualizer` *Time-averaged restoration project outcomes*

Description

`annualizer` computes time-averaged quantities based on linear interpolation.

Usage

```
annualizer(timevec, benefits)
```

Arguments

`timevec`	numeric vector of time intervals.
`benefits`	numeric vector of values to be interpolated.

Value

A time-averaged value over the specified time horizon.

References

Robinson R., Hansen W., and Orth K. 1995. Evaluation of environmental investments procedures manual interim: Cost effectiveness and incremental cost analyses. IWR Report 95-R-1. Institute for Water Resources, U.S. Army Corps of Engineers, Alexandria, Virginia.

Examples

```
#Constant value through time
annualizer(c(0,50), c(100,100))
annualizer(seq(0,50), rep(100,51))

#Simple time series
annualizer(seq(0,50), seq(0,50))

#User-specified time intervals
demo.timevec <- c(0,2,20,50)
demo.ben <- c(0,100,90,80)
annualizer(demo.timevec, demo.ben)
```

BBfinder *Identifies "best buy" actions*

Description

`BBfinder` this analysis examines the slope of the cost-effectiveness frontier to isolate how unit cost (cost/benefit) increases with increasing environmental benefit. Restoration actions with the lowest slope of unit cost are considered "best buys".

Usage

```
BBfinder(benefit, cost, CE)
```

Arguments

`benefit`	a vector of restoration benefits. Typically, these are time-averaged ecological outcomes (e.g., average annual habitat units). Often project benefits are best presented as the "lift" associated with a restoration action (i.e., the benefits of an alternative minus the benefits of a "no action" plan).
`cost`	a vector of restoration costs. Typically, these are monetary costs associated with a given restoration action such as project first cost or annualized economic cost. Notably, these functions are agnostic to units, so costs could also be non-monetary such as lost political capital or social costs of each alternative.
`CE`	numeric vector of 0's and 1's indicating whether a plan is cost-effective (1) or non-cost-effective (0). Can be derived from ecorest::CEfinder.

Value

A list with summaries of all restoration actions as well as best buy plans only.

References

Robinson R., Hansen W., and Orth K. 1995. Evaluation of environmental investments procedures manual interim: Cost effectiveness and incremental cost analyses. IWR Report 95-R-1. Institute for Water Resources, U.S. Army Corps of Engineers, Alexandria, Virginia

Examples

```
#Identify cost-effective actions based on random vectors of benefits and costs
benefit <- runif(50,min=0,max=10)
cost <- runif(50, min=0,max=1000)
CE <- CEfinder(benefit, cost)
BBfinder(benefit, cost, CE)

#Identify cost-effective actions based on a small number of user-specified benefits and costs
restben <- c(0, 10, 5, 20, 20)
restcost <- c(0, 100, 100, 200, 150)
restCE <- CEfinder(restben, restcost)
BBfinder(restben, restcost, restCE)
```

`CEfinder` *Finds cost-effective frontier*

Description

`CEfinder` returns cost-effectiveness analysis for a particular set of alternatives.

Usage

```
CEfinder(benefit, cost)
```

Arguments

`benefit`	a vector of restoration benefits. Typically, these are time-averaged ecological outcomes (e.g., average annual habitat units). Often project benefits are best presented as the "lift" associated with a restoration action (i.e., the benefits of an alternative minus the benefits of a "no action" plan).
`cost`	a vector of restoration costs. Typically, these are monetary costs associated with a given restoration action such as project first cost or annualized economic cost. Notably, these functions are agnostic to units, so costs could also be non-monetary such as lost political capital or social costs of each alternative.

Value

A numeric vector identifying each plan as cost-effective (1) or non-cost-effective (0). The cost-effective actions comprise the Pareto frontier of non-dominated alternatives at a given level of cost or benefit.

References

Robinson R., Hansen W., and Orth K. 1995. Evaluation of environmental investments procedures manual interim: Cost effectiveness and incremental cost analyses. IWR Report 95-R-1. Institute for Water Resources, U.S. Army Corps of Engineers, Alexandria, Virginia

Examples

```
#Identify cost-effective actions based on random vectors of benefits and costs
CEfinder(runif(50,min=0,max=10), runif(50, min=0,max=1000))

#Identify cost-effective actions based on a small number of user-specified benefits and costs
restben <- c(0, 10, 5, 20, 20)
restcost <- c(0, 100, 100, 200, 150)
CEfinder(restben, restcost)
```

`CEICAplotter` *Plots cost-effectiveness and incremental cost analysis*

Description

`CEICAplotter` Plots Cost-effective Incremental Cost Analysis (CEICA) in *.jpeg format.

Usage

```
CEICAplotter(altnames, benefit, cost, CE, BB, figure.name)
```

Arguments

`altnames`	vector of numerics or characters as unique restoration action identifiers.
`benefit`	a vector of restoration benefits. Typically, these are time-averaged ecological outcomes (e.g., average annual habitat units). Often project benefits are best presented as the "lift" associated with a restoration action (i.e., the benefits of an alternative minus the benefits of a "no action" plan).
`cost`	a vector of restoration costs. Typically, these are monetary costs associated with a given restoration action such as project first cost or annualized economic cost. Notably, these functions are agnostic to units, so costs could also be non-monetary such as lost political capital or social costs of each alternative.
`CE`	numeric vector of 0's and 1's indicating whether a plan is cost-effective (1) or non-cost-effective (0). Can be derived from ecorest::CEfinder.
`BB`	numeric vector of 0's and 1's indicating whether a plan is a best buy (1) or not (0). Can be derived from ecorest::BBfinder.
`figure.name`	output figure file name structured as "filename.jpeg".

Value

A multi-panel *.jpeg figure summarizing cost-effectiveness and incremental cost analyses.

References

Robinson R., Hansen W., and Orth K. 1995. Evaluation of environmental investments procedures manual interim: Cost effectiveness and incremental cost analyses. IWR Report 95-R-1. Institute for Water Resources, U.S. Army Corps of Engineers, Alexandria, Virginia

Examples

```
#Identify cost-effective actions based on random vectors of benefits and costs
altnames<- paste("Alt",seq(1,50), sep="")
benefit <- runif(50,min=0,max=10)
cost <- runif(50, min=0,max=1000)
CE <- CEfinder(benefit, cost)
BB <- BBfinder(benefit, cost, CE)[[1]][,4]
CEICAplotter(altnames, benefit, cost, CE, BB, tempfile("CEICAexample",fileext=".jpeg"))
```

HSIarimean — *Computes Habitat Suitability Index with Arithmetic Mean*

Description

HSIarimean uses arithmetic mean to combine suitability indices into an overarching habitat suitability index.

Usage

```
HSIarimean(x)
```

Arguments

x	a vector of suitability indices.

Value

A value of habitat quality from 0 to 1 ignoring NA values.

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Determine patch quality based on a vector of four suitability indices.
HSIarimean(c(0.25, 0.25, 0.25, 0.25))

#Determine patch quality based on a vector of suitability indices with an NA.
HSIarimean(c(0.25, 0.25, NA, 0.25))

#Demonstrate error message associated with out of range outcomes.
```

```
HSIarimean(c(0.25, 0.25, 10.00, 0.25))
```

`HSIeqtn` *Computes Habitat Suitability Index based on Model-Specified Equation*

Description

`HSIeqtn` computes a habitat suitability index based on equations specified in U.S. Fish and Wildlife Service habitat suitability models contained within ecorest via HSImodels and HSImetadata. Habitat suitability indices represent an overall assessment of habitat quality from combining individual suitability indices for multiple independent variables. The function computes an overall habitat suitability index.

Usage

```
HSIeqtn(HSImodelname, SIV, HSImetadata, exclude = NULL)
```

Arguments

`HSImodelname`	a character string in quotations that must match an existing model name in HSImetadata.
`SIV`	a vector of suitability index values used in the model specified in HSImodelname.
`HSImetadata`	a data frame of HSI model metadata within the ecorest package.
`exclude`	a list of character strings specifying components to be excluded from calculations.

Value

A numeric of the habitat suitability index ranging from 0 to 1.

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Compute patch quality for the Barred Owl model (no components)
#Allen A.W. 1982. Habitat Suitability Index Models: Barred owl. FWS/OBS 82/10.143.
#U.S. Fish and Wildlife Service. https://pubs.er.usgs.gov/publication/fwsobs82_10_143.
#Suitability indices relate to density of large trees, mean diameter of overstory trees,
#and percent canopy cover of overstory.
#Example suitability vectors
HSIeqtn("barredowl", c(1,1,1), HSImetadata) #c(1,1,1) should result in 1.00
HSIeqtn("barredowl", c(0.5,1,1), HSImetadata) #c(0.5,1,1) should result in 0.707
HSIeqtn("barredowl", c(0,1,1), HSImetadata) #c(0,1,1) should result in 0.00
HSIeqtn("barredowl", c(0,NA,1), HSImetadata) #c(0,NA,1) should return error message
HSIeqtn("barredowl", c(NA,1,1,1), HSImetadata) #c(NA,1,1,1) should return error message

#Compute patch quality for the Juvenile Alewife model (two components)
#Pardue, G.B. 1983. Habitat Suitability index models: alewife and blueback herring.
#U.S. Dept. Int. Fish Wildl. Serv. FWS/OBS-82/10.58. 22pp.
#Suitability indices relate to zooplankton density, salinity, and water temperature
#Example suitability vectors are c(1,1,1), c(0.5,1,1), and c(0,1,1)
HSIeqtn("alewifeJuv", c(1,1,1), HSImetadata) #c(1,1,1) should result in 1.00
HSIeqtn("alewifeJuv", c(0.5,1,1), HSImetadata) #c(0.5,1,1) should result in 0.50
HSIeqtn("alewifeJuv", c(0,1,1), HSImetadata) #c(0,1,1) should result in 0.00
HSIeqtn("alewifeJuv", c(1,NA,1), HSImetadata) #c(1,NA,1) returns error message
HSIeqtn("alewifeJuv", c(1,1,1,NA), HSImetadata) #c(1,1,1,NA) returns error message

#Compute patch quality for Cutthroat trout model for lacustrine habitats (7 components)
#with spawning and lacustrine habitat and with only lacustrine habitat (i.e.,
#embryo component is excluded).
#Hickman, T., and R.F. Raleigh. 1982. Habitat suitability index models:
#Cutthroat trout. U.S.D.I. Fish and Wildlife Service. FWS/OBS-82/10.5. 38 pp.
#Suitability indices relate to temperature during the warmest period of the year,
#maximum temperature during embryo development, minimum dissolved oxygen during
#the late growing season, average velocity over spawning areas, average size
#of substrate in spawning areas, annual maximal or minimal pH, and percent fines
#in the spawning area.
#Example suitability vectors are c(1,1,1,1,1,1,1), c(0.5,1,0.5,0,1,1,1) and c(1,NA,0.5,NA,NA,0.5,NA)
#c(1,1,1,1,1,1,1) should result in 1
HSIeqtn("cutthroatLacGenLtoe15C", c(1,1,1,1,1,1,1), HSImetadata)
#c(0.5,1,0.5,0,1,1,1) should result in 0
HSIeqtn("cutthroatLacGenLtoe15C", c(0.5,1,0.5,0,1,1,1), HSImetadata)
#c(1,NA,0.5,NA,NA,0.5,NA) should result in 0.63
HSIeqtn("cutthroatLacGenLtoe15C", c(1,NA,0.5,NA,NA,0.5,NA), HSImetadata, exclude=c("CE"))
```

`HSIgeomean` *Habitat Suitability Index with Geometric Mean*

Description

HSIgeomen uses geometric mean to combine suitability indices into an overarching habitat suitability index.

Usage

```
HSIgeomean(x)
```

Arguments

`x`	a vector of suitability indices

Value

A value of habitat quality from 0 to 1 ignoring NA values.

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Determine patch quality based on a vector of four suitability indices.
HSIgeomean(c(0.25, 0.25, 0.25, 0.25))

#Determine patch quality based on a vector of suitability indices with an NA.
HSIgeomean(c(0.25, 0.25, NA, 0.25))

#Determine patch quality based on a vector of suitability indices with a zero-value.
HSIgeomean(c(0.25, 0.25, 0.0, 0.25))

#Demonstrate error message associated with out of range outcomes.
HSIgeomean(c(2, 2, NA, 3))
```

`HSImetadata` *Habitat suitability index (HSI) model metadata*

Description

Metadata for 351 U.S. Fish and Wildlife Service Habitat suitability index (HSI) models

Usage

```
HSImetadata
```

Format

A data frame with 351 rows and 85 variables:

model Model name

submodel Model specifications

species Scientific nomenclature of modeled taxa

geography Geographic range of organism

ecosystem Type of habitat

documentation Citation of original model

note Conditions under which model may be applied

website Link to individual model source

SIV1 Suitability index values for each organism specific condition

SIV1B Suitability index values for each organism specific condition

SIV2 Suitability index values for each organism specific condition

SIV2B Suitability index values for each organism specific condition

SIV3 Suitability index values for each organism specific condition

SIV3B Suitability index values for each organism specific condition

SIV4 Suitability index values for each organism specific condition

SIV4B Suitability index values for each organism specific condition

SIV5 Suitability index values for each organism specific condition

SIV5B Suitability index values for each organism specific condition

SIV6 Suitability index values for each organism specific condition

SIV6B Suitability index values for each organism specific condition

SIV7 Suitability index values for each organism specific condition

SIV7B Suitability index values for each organism specific condition

SIV8 Suitability index values for each organism specific condition

SIV8B Suitability index values for each organism specific condition

SIV9 Suitability index values for each organism specific condition

SIV10 Suitability index values for each organism specific condition

SIV11 Suitability index values for each organism specific condition

SIV12 Suitability index values for each organism specific condition

SIV13 Suitability index values for each organism specific condition

SIV14 Suitability index values for each organism specific condition

SIV15 Suitability index values for each organism specific condition

SIV15B Suitability index values for each organism specific condition

SIV16 Suitability index values for each organism specific condition

SIV16B Suitability index values for each organism specific condition

SIV17 Suitability index values for each organism specific condition

SIV18 Suitability index values for each organism specific condition
SIV19 Suitability index values for each organism specific condition
SIV20 Suitability index values for each organism specific condition
SIV21 Suitability index values for each organism specific condition
SIV22 Suitability index values for each organism specific condition
CF Food component equation
CRF Food/reproduction component equation
CRN Roosting-nesting component equation
CC Cover component equation
CCRO Cover roosting component equation
CCRF Cover-reproduction-food component equation
CCF Cover-food component equation
CCSF Cover-food shrub component equation
CCHF Cover-food herbaceous component equation
CWF Winter food component
CSF Summer food component
CFF Fall food component
CW Water component
CCB Cover breeding component
CB Brood component
CN Nest component
CNBC Nest-brood cover component
CCN Cover nesting component
CP Pair habitat component
CWQ Water quality component
CR Reproduction component
CCR Cover reproduction component
CD Disturbance component
COT Other component
CL Larval component
CEL Embryo and larval component
CE Embryo component
CJ Juvenile component
CFr Fry component
CS Spawning component
CA Adult component
CI Island component

CIN Interspersion component

CNI Non-island component

CWFC Winter cover food component

CFBS Summer food brood component

CFSWF Fall spring winter food component

CSPF Spring food component

CWC Winter cover component

CCFS Fall to spring cover component

CSS Substrate-suspended solids component

CT Topography component

CTe Temperature component

CJA Juvenile adult component

Eqtn HSI overarching model equation in R syntax

Source

https://pubs.usgs.gov/

`HSImin` *Habitat Suitability Index with Minimum*

Description

`HSImin` uses the minimum of given suitability indices to calculate an overarching habitat suitability index.

Usage

```
HSImin(x)
```

Arguments

`x`	a vector of suitability indices

Value

A value of habitat quality from 0 to 1 ignoring NA values.

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Determine patch quality based on a vector of four suitability indices.
HSImin(c(0.1, 0.25, 0.25, 0.25))

#Determine patch quality based on a vector of suitability indices with an NA.
HSImin(c(0.1, 0.25, NA, 0.25))

#Demonstrate error message associated with out of range outcomes.
HSImin(c(2, 4, NA, 3))
```

HSImodels *Habitat suitability index (HSI) models*

Description

This list of data frames contains 351 U.S. Fish and Wildlife Service Habitat suitability index (HSI) models. Please note that some of the original HSI documents provide little reference data for constructing suitability curves; hence, some suitability curves are estimated using the authors' best judgement. Users should always cross-reference results with the original documentation.

Usage

```
HSImodels
```

Format

An object of class `list` of length 351.

Details

@format A list with 351 data frames each containing an HSI model with multiple independent variables and associated habitat suitability indices (a 0 to 1 value). Data represent break points in curves with linear extrapolation between. Categorical input variables are coded as letters.

variable1 independent variable for assessing habitat suitability

SIV1 suitability index value relative to variable1

... additional variables and suitability indices

Source

https://pubs.usgs.gov/

HSIplotter — *Plots habitat suitability index curves*

Description

`HSIplotter` plots all suitability curves.

Usage

```
HSIplotter(SI, figure.name)
```

Arguments

`SI`	matrix of suitability curves ordered as parameter breakpoints and associated suitability indices for each parameter with appropriate column names.
`figure.name`	output figure file name structured as "filename.jpeg".

Value

A multi-panel *.jpeg figure showing all suitability curves.

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Build and define a matrix of the Barred Owl suitability curves
#Allen A.W. 1982. Habitat Suitability Index Models: Barred owl. FWS/OBS 82/10.143.
#U.S. Fish and Wildlife Service. https://pubs.er.usgs.gov/publication/fwsobs82_10_143.
var1 <- cbind(c(0,2,4,NA), c(0.1,1,1,NA)) #Number of trees > 51cm diameter per 0.4 ha plot
var2 <- cbind(c(0,5,20,NA), c(0,0,1,NA)) #Mean diameter of overstory trees
var3 <- cbind(c(0,20,60,100), c(0,0,1,1)) #Percent canopy cover of overstory trees
barredowl <- cbind(var1, var2, var3)
colnames(barredowl)<- c("tree.num", "tree.num.SIV",
  "avg.dbh.in", "avg.dbh.SIV", "can.cov", "can.cov.SIV")

#Create suitability curve summary plot
HSIplotter(barredowl, tempfile("BarredOwl",fileext=".jpeg"))
```

HSIwarimean *Habitat Suitability Index with a Weighted Arithmetic Mean*

Description

HSIwarimean uses a weighted arithmetic mean to combine suitability indices into an overarching habitat suitability index.

Usage

```
HSIwarimean(x, w)
```

Arguments

x	is a vector of suitability indices.
w	is a vector of weights (0 to 1 values that must sum to one).

Value

A value of habitat quality from 0 to 1 ignoring NA values.

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Determine patch quality based on a vector of four, equal-weight suitability indices.
HSIwarimean(c(1, 0, 0, 0), c(0.25, 0.25, 0.25, 0.25))

#Determine patch quality based on a vector of four, unequal-weight suitability indices.
HSIwarimean(c(1, 0, 0, 0), c(1, 0, 0, 0))

#Determine patch quality based on a vector of four, unequal-weight suitability indices.
HSIwarimean(c(1, 0, 0, 0), c(0, 1, 0, 0))

#Demonstrate error for mismataching inputs.
HSIwarimean(c(1, 0, 0, 0), c(0, 0, 0))

#Demonstrate error for incorrect weighting.
HSIwarimean(c(1, 0, 0, 0), c(1, 1, 0, 0))

#Demonstrate error for out of range output.
```

```
HSIwarimean(c(1, 1, 1, 10), c(0.2, 0.3, 0.3, 0.2))
```

HUcalc *Computes Habitat Quality, Quantity, and Units*

Description

HUcalc computes habitat units given a set of suitability indices, a habitat suitability index equation, and habitat quantity.

Usage

```
HUcalc(SI.out, habitat.quantity, HSIfunc, ...)
```

Arguments

SI.out	is a vector of application-specific suitability indices, which can be produced from SIcalc.
habitat.quantity	is a numeric of habitat size associated with these suitability indices (i.e., length, area, or volume).
HSIfunc	is a function for combination of the suitability indices.
...	optional arguments to HSIfunc.

Value

A vector of habitat quality, habitat quantity, and index units (quantity times quality).

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Summarize habitat outcomes based on a vector of two suitability indices
#using multiple combination equations.
HUcalc(c(0.1,1), 100, HSIarimean)
HUcalc(c(0.1,1), 100, HSIgeomean)
HUcalc(c(0.1,1), 100, HSImin)
HUcalc(c(0.1,1), 100, HSIwarimean, c(1,0))
HUcalc(c(0.1,1), 100, HSIwarimean, c(0,1))
```

```
#HSIfunc can also represent functions outside of the ecorest package
HUcalc(c(0.1,1), 100, mean)
HUcalc(c(0.1,1), 100, max)
```

SIcalc *Computes Suitability Indices*

Description

SIcalc computes suitability indices given a set of suitability curves and project-specific inputs. Suitability indices may be computed based on either linear interpolation (for continuous variables) or a lookup method (for categorical variables).

Usage

```
SIcalc(SI, input.proj)
```

Arguments

SI	matrix of suitability curves ordered as parameter breakpoints and associated suitability indices for each parameter. Note that users should enter NA for excluded variables in HSImodels.
input.proj	numeric or categorical vector of application-specific input parameters associated with the suitability curve data from SI.

Value

A vector of the suitability index values that match given user inputs. Values are returned as equal to the extreme of a range if inputs are outside of model range.

References

US Fish and Wildlife Service. (1980). Habitat as a basis for environmental assessment. Ecological Services Manual, 101.

US Fish and Wildlife Service. (1980). Habitat Evaluation Procedures (HEP). Ecological Services Manual, 102.

US Fish and Wildlife Service. (1981). Standards for the Development of Habitat Suitability Index Models. Ecological Services Manual, 103.

Examples

```
#Build and define a matrix of the Barred Owl suitability curves
#Allen A.W. 1982. Habitat Suitability Index Models: Barred owl. FWS/OBS 82/10.143.
#U.S. Fish and Wildlife Service. https://pubs.er.usgs.gov/publication/fwsobs82_10_143.
var1 <- cbind(c(0,2,4,NA), c(0.1,1,1,NA)) #Number of trees > 51cm diameter per 0.4 ha plot
var2 <- cbind(c(0,5,20,NA), c(0,0,1,NA)) #Mean diameter of overstory trees
var3 <- cbind(c(0,20,60,100), c(0,0,1,1)) #Percent canopy cover of overstory trees
barredowl <- cbind(var1, var2, var3)
colnames(barredowl)<- c("tree.num", "tree.num.SIV",
  "avg.dbh.in", "avg.dbh.SIV", "can.cov", "can.cov.SIV")

#Set user input variables that should return (1, 0, 0)
input.demo1 <- c(2, 5, 20)
SIcalc(barredowl, input.demo1)

#Set user input variables that should return (1, 1, 1)
input.demo2 <- c(4, 20, 60)
SIcalc(barredowl, input.demo2)

#Set user input variables that should return (1, 1, 0.5)
input.demo3 <- c(4, 20, 40)
SIcalc(barredowl, input.demo3)

#Set user input variables that should return (0.1, 0.5, 0.5)
input.demo4 <- c(0, 12.5, 40)
SIcalc(barredowl, input.demo4)

#Set user input variables that should return (1, 1, 1)
input.demo5 <- c(4, 40, 60)
SIcalc(barredowl, input.demo5)

#Set user input variables that should return (1, NA, 1)
input.demo6 <- c(4, NA, 60)
SIcalc(barredowl, input.demo6)

#Suitability curves may also be drawn from HSImodels (data within ecorest)
#Import Barred Owl suitability curves with HSImodels$barredowl
#The input examples are repeated from above

#Set user input variables that should return (1, 0, 0)
SIcalc(HSImodels$barredowl, input.demo1)

#Set user input variables that should return (1, 1, 1)
SIcalc(HSImodels$barredowl, input.demo2)

#Set user input variables that should return (1, 1, 0.5)
SIcalc(HSImodels$barredowl, input.demo3)

#Set user input variables that should return (0.1, 0.5, 0.5)
SIcalc(HSImodels$barredowl, input.demo4)

#Set user input variables that should return (1, 1, 1)
```

```
SIcalc(HSImodels$barredowl, input.demo5)

#Set user input variables that should return (1, NA, 1)
SIcalc(HSImodels$barredowl, input.demo6)
```

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