## Running a BH3 analysis

A BH3 analysis is initiated by invoking the main procedure, bh3\_procedure or the equivalent function bh3\_entry, which call another 20 functions and procedures that the user does not need to concern themselves with unless they want to separately run individual parts of the analysis. The geographical, temporal and habitat scope as well as other details of the analysis are controlled by 26 parameters on the main procedure, whose values are passed into the functions called. The user invokes bh3\_procedure by issuing the

CALL public.bh3\_procedure(…);

command with the desired set of arguments in a pgAdmin query window or on the PostgreSQL command line using the syntax

psql –h 127.0.0.1 –p 5432 –U postgres –d bh3 –c “CALL public.bh3\_procedure(…);”

where –h is the IP address of the PostgreSQL server host (defaults to 127.0.0.1 / localhost); -p the port number the server is listening on (defaults to 5432); -U is the user name; -d is the database name (which will usually be bh3); and –c is the SQL command to be executed, enclosed in double quotes.

All but six of these parameters have default values, as they are relatively unlikely to change. Values must be provided for the six parameters that have no default values; the other 20 are optional and may be skipped. However, if a value is to be provided for any optional parameter values must also be provided for all optional parameters preceding it in the parameter list. This is because the PL/PGSQL language matches arguments to parameters by position in the list and does not support named arguments.

The six required parameters control (1) the area of interest (boundary\_filter [, boundary\_filter\_negate]); (2) the habitats to be included or excluded (habitat\_types\_filter [, habitat\_types\_filter\_negate]); (3) the temporal scope (start\_year [, end\_year]); the sources of (4) species sensitivity (species\_sensitivity\_source\_table) and (5) pressure information (pressure\_schema); and (6) the schema in which the output tables are to be created (output\_schema).

### (1) Area of interest. Parameters: boundary\_filter, boundary\_filter\_negate.

The area of interest is defined by one or more polygons taken from the table static.unofficial\_country\_waters\_simplified\_wgs84. The polygons are identified by the boundary\_filter parameter. This is an array of integers, each of which is the primary key value (column gid) of the corresponding record in the table static.unofficial\_country\_waters\_simplified\_wgs84. A PostgreSQL array is declared by the ARRAY keyword followed by a coma separated list of elements in square brackets, for example as ARRAY[4, 5]::integer[]. The additional, optional element at the end is a PostgreSQL type cast which expressly declares the array as an array of integers. The array ARRAY[4, 5]::integer[] as the first argument (boundary\_filter) means that the topological union of the polygons identified by gid 4 and 5 in the table static.unofficial\_country\_waters\_simplified\_wgs84 defines the boundary of the area of interest, that is Scotland territorial and offshore waters.

Sometimes it may be more convenient to exclude one or a few polygons rather than specifying a long list of polygons to be included. This is supported by the optional Boolean parameter boundary\_filter\_negate. If this is true (default is false) the boundary\_filter list of gid values will be interpreted as an exclusion list. The ARRAY[4, 5]::integer[] example with boundary\_filter\_negate set to true would translate into an area of interest defined by the topological union of all but Scotland territorial and offshore waters.

### (2) Habitats to be included or excluded. Parameters: habitat\_types\_filter, habitat\_types\_filter\_negate.

The second parameter, habitat\_types\_filter, is a list of EUNIS L3 habitat codes to be included in or excluded from the analysis. This is another array, this time of text strings. It is declared in the same way as the integer boundary array, i.e. by the ARRAY keyword followed by a comma separated element list in square brackets, for example: ARRAY['A5.1','A5.2','A5.3','A5.4','A5.5','A5.6','A5.7','A5.1+5.4']::character varying[]. Array elements are strings that must be enclosed in single quotes. The cast at the end (]::character varying[]) is optional. This array will be used to filter the habitat map and species sensitivity samples. Only habitat polygons (table static.uk\_habitat\_map\_wgs84) whose eunis\_l3 value matches one of the listed codes and Marine Recorder sample records related to a eunis\_correlation\_table record whose eunis\_code\_2007 value matches one the listed values will be included. The uk\_habitat\_map\_wgs84. eunis\_l3 match is exact as these codes are EUNIS L3. Since the eunis\_correlation\_table .eunis\_code\_2007 column contains all EUNIS levels, the elements of the habitat\_types\_filter argument are pattern matched using a “begins with” pattern that will include EUNIS L3 and up.

Like the boundary\_filter array, the habitat\_types\_filter array can be turned into an exclusion list by setting the optional habitat\_types\_filter\_negate parameter to true. This means that all but the listed EUNIS L3 habitats will be included. This is probably more useful here than for the boundary\_filter argument because the lists may be expected to be longer and comparisons with a shorter array will perform better than with a longer array.

### (3) Temporal scope. Parameters: start\_year, end\_year.

Two parameters, one required and one optional, define the temporal scope of the analysis. The required parameter start\_year sets the start, the optional parameter end\_year the end of the time span of interest. Date arguments are specified as integer years, for example 2010::integer (the cast is optional). If this date was the start\_year argument and no end\_year argument was specified end\_year would default to the current year and the analysis would include only Marine Recorder samples (table marinerec.sample) with sample\_date ranging between 1 January 2010 and the 31 December of the current year; and only pressure records whose year column values range between 2010 and the current year.

### (4) Source of species sensitivity data. Parameters: species\_sensitivity\_source\_table.

The fourth argument specifies the lookup table in the lut schema from which species sensitivity scores are obtained. The sensitivity\_source enum defines the options, with each enum value corresponding to a query drawing on one or more lookup tables in the lut schema: 'broadscale\_habitats'::sensitivity\_source to all rows from lut.sensitivity\_broadscale\_habitats::sensitivity\_source; 'eco\_groups'::sensitivity\_source to all rows from lut.sensitivity\_eco\_groups; 'rock'::sensitivity\_source to all rows from lut.sensitivity\_rock; 'rock\_eco\_groups'::sensitivity\_source to a full join of sensitivity\_eco\_groups and sensitivity\_rock selecting for species listed in both tables the surface sensitivity with the higher confidence or, if confidence is equal in both tables, the higher sensitivity value; and ‘eco\_groups\_rock’::sensitivity\_source to all rows from lut.sensitivity\_eco\_groups\_rock. The species\_sensitivity\_source\_table parameter is of the enum type; so to use lut. sensitivity\_rock\_eco\_groups as the sensitivity data source the species\_sensitivity\_source\_table argument must be 'rock\_eco\_groups'::sensitivity\_source, i.e. the enum value as a string cast to the sensitivity\_source enum type.

To make lookup table with slightly different structures compatible with one another, the bh3\_sensitivity function pulls the sensitivity data in a standardized form: eunis\_l3\_name, characterising\_species, sensitivity\_ab\_su\_num, sensitivity\_ab\_ss\_num, confidence\_ab\_su\_num, confidence\_ab\_ss\_num. Not all of these columns need to present in all of the sensitivity source tables; however, eunis\_l3\_code and some columns containing numeric sensitivity and confidence score will be required. If additional sensitivity source tables are added corresponding values must be added to the sensitivity\_source enum and the bh3\_sensitivity function must be modified to cover the new tables. If the new sources do not distinguish between surface and sub-surface sensitivities another version of the bh3\_sensitivity function may be required and the bh3\_species\_sensitivity\_clipped may need to be re-written to call different sensitivity functions for different types of sensitivity data.

### (5) Source of pressure information. Parameters: pressure\_schema.

Pressure data are taken from multiple tables that share the same structure and reside in the same schema. Currently the only schema available in the bh3 database is ices\_abrasion; it contains the OSPAR intensity totals for 2009–2016. The schema name is specified as a string in single quotes with an optional cast to the name type, e.g. ‘ices\_abrasion’::name. The analysis will include all tables in the specified schema that have the columns “c\_square”, “year”, sar\_surface\_column (parameter defaulting to ‘sar\_surface’), sar\_subsurface\_column (parameter defaulting to ‘sar\_subsurface’). The first two column names are hard coded; the other two are parameters of bh3\_procedure whose values may be modified if other pressure schemas with different pressure data are to be used in future. Pressure data will be filtered by geographic area and timespan of interest.

### (6) Output schema. Parameters: output\_schema, output\_owner.

The last required parameter is the name of the output schema, as a string optional cast to the name type, e.g. ‘northern\_ireland’::name. All output tables will be generated in this schema. If it doesn’t already exist it will be created. If it does exist it will be dropped, along with all its contents, and re-created. If the optional output\_owner argument is present, the new schema will be owned by the specified role.

## Adding data to the bh3 database

### Adding a new area of interest boundary

Boundaries are taken from the table static.unofficial\_country\_waters\_simplified\_wgs84. Any additional boundary must be added to that table, assuring that it has a valid geometry. The primary key column, gid, which identifies the boundary in filter conditions, is automatically populated.

To add geometries in QGIS, add the static.unofficial\_country\_waters\_simplified\_wgs84 table and the source file or table to a QGIS map project. Given the size of the bh3 database, the fastest and most likely the only reasonable way to add one of its tables to a QGIS project is the Database Manager plugin, which is a standard part of the QGIS distribution and found in the Database menu. The Data Source Manager dialogue may take forever to inventory the spatial tables in the bh3 database, freezing QGIS to the point where it can only be closed using Task Manager.

Start editing the layer based on the static.unofficial\_country\_waters\_simplified\_wgs84 table by right clicking on it and clicking Toggle Editing. Select the geometry or geometries to be added on the source layer, copy them to the clipboard (Edit > Copy features), select the boundary layer being edited and paste the features into it (Edit > Paste Features). Finish the edit session by right clicking the boundary layer and clicking Toggle Editing again.

To add a larger number of boundary geometries, import them into a new table using Database Manager, then insert the geometries into the static.unofficial\_country\_waters\_simplified\_wgs84 table and drop the table created by Database Manager. Unfortunately, Database Manager cannot append rows to an existing table. Assuming the imported table is called static.import\_table and has a text column called “name” and a geometry column named “geom”, the insert statement will look like this:

INSERT INTO static.unofficial\_country\_waters\_simplified\_wgs84

(

the\_geom

,adminarea

)

SELECT geom

,name

FROM static.import\_table;

The gid column will be auto populated from a sequence. The other columns are optional; technically even the adminarea column is, but it will be helpful to identify the record to human users. SQL statement templates may be created easily in pgAdmin by right clicking on the table name in the database tree and invoking one of the commands in the context menu’s Scripts sub-menu.

## Updating the habitat map

The table static.uk\_habitat\_map\_wgs84 holds the habitat map. This is hardcoded. The table has no dependents in the database. Data can be inserted or removed and the entire table may be replaced without constraints. To replace the table with a new version, rename the existing static.uk\_habitat\_map\_wgs84 table or drop it if it is no longer required; then import the new table into the database as static.uk\_habitat\_map\_wgs84. This can be done using the QGIS Database Manager plugin which can import from any QGIS vector layer into a PostgreSQL/PostGIS database. Thus, any vector data format that QGIS can read may be imported, including all ESRI major formats (shape file, file geodatabase, personal geodatabase). The new data should be topologically cleaned either before or after import, or both. It is exceedingly important to add a spatial index (preferably clustered) to the new table. The commands to do this can be copied from the SQL definition of the existing static.uk\_habitat\_map\_wgs84 table; select the table in the database tree and click the SQL tab at the top of the window to view the table’s SQL definition.

## Adding sensitivity and pressure information

Items (4), “Source of species sensitivity data,” and (5), “Source of pressure information,” of the previous section offer some information on the requirements on additional sensitivity and pressure data.

Pressure data come in one table per year. Adding additional years amounts to importing new tables (presumably from OSPAR shape files, using the QGIS Database Manager plugin) into the ices\_abrasion schema. As long as the new tables are in the pressure schema specified by the pressure\_schema argument and have the correct structure (see item (5) of previous section) they will be included in future runs of bh3\_procedure.

## BH3 procedures

### Procedure public.bh3\_index

Purpose

Indexes one or more columns of a table and re-computes its statistics.

Approach

Creates index(es) with name(s) composed of table and column names if they do not already exist.

Calls analyze to re-compute table statistics.

Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Default value** |
| schema\_name | name | Schema name of table to be indexed. |  |
| table\_name | name | Table name of table to be indexed. |  |
| column\_names\_types | character varying[][] | Two dimensional array of columns to be indexed. Each column is represented by an array of length two. The first element is the column name; the second is the index type. Valid types are, where ''s'' for spatial (GIST) and ''u'' for unique (BTREE). Any other value will be interpreted as requesting a non-unique BTREE index. |  |

Calls

No nested calls

### Procedure public.bh3\_drop\_spatial\_table

Purpose

Drops a spatial table and its PostGIS metadata.

Approach

Calls the DropGeometryTable function to drop a spatial table along with its PostGIS metadata.

Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Default value** |
| spatial\_tables | name[] | Array of arrays of length two (table schema and table name of table to be dropped). |  |

Calls

No nested calls.

### Procedure public.bh3\_drop\_temp\_table

Purpose

Drops a temporary table if it exists.

Approach

Looks up the temporary table’s schema in database metadata and drop it using a qualified name.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| table\_name | name | Name of temporary table to be dropped. |  |

Calls

No nested calls.

### Procedure public.bh3\_procedure

Purpose

Main entry point that starts a BH3 run.

This is called by the QGIS user interface and may be executed directly in pgAdmin or on the PostgreSQL command line.

Approach

Creates the output schema and an error\_log table in it if they do not already exist.

Then calls the bh3\_get\_pressure\_csquares\_size, bh3\_habitat\_boundary\_clip, bh3\_habitat\_grid, bh3\_sensitivity\_layer\_prep,

bh3\_sensitivity\_map and bh3\_disturbance\_map functions, inserting any error rows returned into the error\_log table.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_filter | integer | gid of AOI polygon in boundary\_table to be included (or excluded if boundary\_filter\_negate is true). |  |
| habitat\_types\_filter | character varying[] | Array of eunis\_l3 codes of habitats in habitat\_table to be included (or excluded if habitat\_types\_filter\_negate is true). |  |
| start\_year | integer | Earliest year for Marine Recorder species samples to be included. |  |
| species\_sensitivity\_source\_table | sensitivity\_source | Source table for habitat sensitivity scores (enum value one of { ‘broadscale\_habitats’, ‘eco\_groups’, ‘rock’, ‘rock\_eco\_groups’, ‘eco\_groups\_rock’ }). |  |
| pressure\_schema | name | Schema in which pressure source tables are located (all tables in this schema that have the required columns will be used). |  |
| output\_schema | name | Schema in which output tables will be created (will be created if it does not already exist; tables in it will be overwritten). |  |
| boundary\_schema | name | Schema of table containing AOI boundary polygons. | “static” |
| boundary\_table | name | Name of table containing AOI boundary polygons. | “unofficial\_country\_waters\_simplified\_wgs84” |
| habitat\_schema | name | Habitat table schema. | “static” |
| habitat\_table | name | Habitat table name. | “uk\_habitat\_map\_wgs84” |
| habitat\_sensitivity\_lookup\_schema | name | Schema of habitat sensitivity lookup table. | “lut” |
| habitat\_sensitivity\_lookup\_table | name | Name of habitat sensitivity lookup table. | “sensitivity\_broadscale\_habitats” |
| habitat\_sensitivity\_table | name | Name of habitat sensitivity output table. | “habitat\_sensitivity” |
| habitat\_sensitivity\_grid\_table | name | Name of gridded habitat sensitivity output table. | “habitat\_sensitivity\_grid” |
| species\_sensitivity\_max\_table | name | Table name of species sensitivity maximum map. | “species\_sensitivity\_max” |
| species\_sensitivity\_mode\_table | name | Table name of species sensitivity mode map. | “species\_sensitivity\_mode” |
| sensitivity\_map\_table | name | Table name of output sensitivity map. | “sensitivity\_map” |
| pressure\_map\_table | name | Table name of pressure map, created in output\_schema. | “pressure\_map” |
| disturbance\_map\_table | name | Table name of output disturbance map. | “disturbance\_map” |
| sar\_surface\_column | name | SAR surface column name in pressure source tables. | “sar\_surface” |
| sar\_subsurface\_column | name | SAR sub-surface column name in pressure source tables. | “sar\_subsurface” |
| end\_year | integer | Latest year for Marine Recorder species samples and pressure data to be included. | Current date and time |
| boundary\_filter\_negate | boolean | If true condition built with boundary\_filter is to be negated, i.e. AOI is all but the polygon identified by boundary\_filter. | False |
| habitat\_types\_filter\_negate | boolean | If true condition built with habitat\_types\_filter is to be negated, i.e. EUNIS L3 codes in habitat\_types\_filter will be excluded. | False |
| remove\_overlaps | boolean | If true overlaps will be removed from habitat\_sensitivity\_table (significantly increases processing time). | False |
| output\_srid | integer | SRID of output tables (reprojecting greatly affects performance). | 4326 |

Calls

bh3\_get\_pressure\_csquares\_size

bh3\_boundary\_subdivide

bh3\_habitat\_boundary\_clip

bh3\_habitat\_grid

bh3\_sensitivity\_layer\_prep

bh3\_sensitivity\_map

bh3\_disturbance\_map.

### Procedure public.bh3\_repair\_geometries

Purpose

Repairs the geometries in the specified column of a table and converts them to multi geometries.

Approach

Uses a zero buffer to repair geometries. Geometries that are part of a collection are repaired individually.

Repaired geometries are converted to their corresponding multi types.

Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Default value** |
| schema\_name | name | Schema name of geometry table. |  |
| table\_name | name | Table name of geometry table. |  |
| geom\_column | name | Geometry column name. | “the\_geom” |

Calls

No nested calls

## BH3 functions

### Function public.bh3\_entry

Purpose

Main entry point that starts a BH3 run.

This is called by the QGIS user interface and may be executed directly in pgAdmin or on the PostgreSQL command line.

Approach

Creates the output schema and an error\_log table in it if they do not already exist.

Then calls the bh3\_get\_pressure\_csquares\_size, bh3\_habitat\_boundary\_clip, bh3\_habitat\_grid, bh3\_sensitivity\_layer\_prep,

bh3\_sensitivity\_map and bh3\_disturbance\_map functions, inserting any error rows returned into the error\_log table.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_filter | integer | gid of AOI polygon in boundary\_table to be included (or excluded if boundary\_filter\_negate is true). |  |
| habitat\_types\_filter | character varying[] | Array of eunis\_l3 codes of habitats in habitat\_table to be included (or excluded if habitat\_types\_filter\_negate is true). |  |
| start\_year | integer | Earliest year for Marine Recorder species samples to be included. |  |
| species\_sensitivity\_source\_table | sensitivity\_source | Source table for habitat sensitivity scores (enum value one of { ‘broadscale\_habitats’, ‘eco\_groups’, ‘rock’, ‘rock\_eco\_groups’, ‘eco\_groups\_rock’ }). |  |
| pressure\_schema | name | Schema in which pressure source tables are located (all tables in this schema that have the required columns will be used). |  |
| output\_schema | name | Schema in which output tables will be created (will be created if it does not already exist; tables in it will be overwritten). |  |
| boundary\_schema | name | Schema of table containing AOI boundary polygons. | “static” |
| boundary\_table | name | Name of table containing AOI boundary polygons. | “unofficial\_country\_waters\_simplified\_wgs84” |
| habitat\_schema | name | Habitat table schema. | “static” |
| habitat\_table | name | Habitat table name. | “uk\_habitat\_map\_wgs84” |
| habitat\_sensitivity\_lookup\_schema | name | Schema of habitat sensitivity lookup table. | “lut” |
| habitat\_sensitivity\_lookup\_table | name | Name of habitat sensitivity lookup table. | “sensitivity\_broadscale\_habitats” |
| habitat\_sensitivity\_table | name | Name of habitat sensitivity output table. | “habitat\_sensitivity” |
| habitat\_sensitivity\_grid\_table | name | Name of gridded habitat sensitivity output table. | “habitat\_sensitivity\_grid” |
| species\_sensitivity\_max\_table | name | Table name of species sensitivity maximum map. | “species\_sensitivity\_max” |
| species\_sensitivity\_mode\_table | name | Table name of species sensitivity mode map. | “species\_sensitivity\_mode” |
| sensitivity\_map\_table | name | Table name of output sensitivity map. | “sensitivity\_map” |
| pressure\_map\_table | name | Table name of pressure map, created in output\_schema. | “pressure\_map” |
| disturbance\_map\_table | name | Table name of output disturbance map. | “disturbance\_map” |
| sar\_surface\_column | name | SAR surface column name in pressure source tables. | “sar\_surface” |
| sar\_subsurface\_column | name | SAR sub-surface column name in pressure source tables. | “sar\_subsurface” |
| end\_year | integer | Latest year for Marine Recorder species samples and pressure data to be included. | Current date and time |
| boundary\_filter\_negate | boolean | If true condition built with boundary\_filter is to be negated, i.e. AOI is all but the polygon identified by boundary\_filter. | False |
| habitat\_types\_filter\_negate | boolean | If true condition built with habitat\_types\_filter is to be negated, i.e. EUNIS L3 codes in habitat\_types\_filter will be excluded. | False |
| remove\_overlaps | boolean | If true overlaps will be removed from habitat\_sensitivity\_table (significantly increases processing time). | False |
| output\_srid | integer | SRID of output tables (reprojecting greatly affects performance). | 4326 |

Calls

bh3\_get\_pressure\_csquares\_size

bh3\_boundary\_subdivide

bh3\_habitat\_boundary\_clip

bh3\_habitat\_grid

bh3\_sensitivity\_layer\_prep

bh3\_sensitivity\_map

bh3\_disturbance\_map.

### Function public.bh3\_create\_csquares

Purpose

Creates an in-memory table of c-squares of the specified cell size within the specified polygon boundary.

The output geometries may be clipped by the boundary polygon(s).

Approach

Calls the bh3\_create\_finshnet function to create a grid within the bounding box of the unioned boundary geometries and returns the grid cells intersecting the boundary geometries, optionally clipping them by the boundary.

Parameters:

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Default value** |
| boundary\_schema | name | Schema of table containing single AOI boundary polygon and bounding box. |  |
| boundary\_table | name | Name of table containing single AOI boundary polygon and bounding box. | “boundary” |
| boundary\_clip | boolean | If true grid will be clipped by boundary polygon. | false |
| cell\_size\_degrees | numeric | Cell size in degrees. | 0.05 |
| output\_srid | integer | SRID of output table. | 4326 |

Returns

An in-memory table of c-squares of the specified cell size within the specified polygon boundary.

Calls

bh3\_find\_srid

bh3\_create\_fishnet

### Function public.bh3\_create\_fishnet

Purpose

Creates an in-memory table of c-squares of the specified cell of the specified dimensions.

Approach

Cross joins sequences of row and column numbers generated by calling the generate\_sequence function and creates boxes calling the ST\_MakeBox2D function.

Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Default value** |
| num\_rows | integer | Desired number of grid rows. |  |
| num\_cols | integer | Desired number of grid columns. |  |
| size\_x | double precision | Desired width of grid cell. |  |
| size\_y | double precision | Desired height of grid cell. |  |
| origin\_x | double precision | X coordinate of grid origin. | 0 |
| origin\_y | double precision | Y coordinate of grid origin. | 0 |
| Srid | integer | SRID of output grid. | 4326 |

Returns

An in-memory table of c-squares of the specified cell of the specified dimensions.

Calls

No nested calls

### Function public.bh3\_disturbance\_map

Purpose

Creates the disturbance map from sensitivity and pressure maps.

Approach

Creates a table of pressure c-squares calling the bh3\_get\_pressure\_csquares function.

Then, using a cursor, the disturbance map table is populated computing surface and subsurface disturbance scores surface and subsurface abrasion sensitivity scores from the sensitivity map with categorised combined surface and sub-surface abrasion scores from the pressure c-squares using case expressions and a geometry as the intersection of sensitivity and pressure c-square geometries.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_schema | name | Schema of table containing single AOI boundary polygon and bounding box. |  |
| pressure\_schema | name | Schema in which pressure source tables are located (all tables in this schema that have the required columns will be used). |  |
| sensitivity\_map\_schema | name | Schema in which sensitivity map table is located. |  |
| output\_schema | name | Schema in which output tables will be created (will be created if it does not already exist; tables in it will be overwritten). |  |
| start\_year | integer | Earliest year for Marine Recorder species samples to be included. |  |
| end\_year | integer | Latest year for Marine Recorder species samples and pressure data to be included. | Current date and time |
| boundary\_table | name | Name of table containing single AOI boundary polygon and bounding box. | “boundary” |
| sensitivity\_map\_table | name | Table name of sensitivity map. | “sensitivity\_map” |
| pressure\_map\_table | name | Table name of pressure map, created in output\_schema. | “pressure\_map” |
| sar\_surface\_column | name | SAR surface column name in pressure source tables. | “sar\_surface” |
| sar\_subsurface\_column | name | SAR sub-surface column name in pressure source tables. | “sar\_subsurface” |
| output\_srid | integer | SRID of output tables (reprojecting greatly affects performance). | 4326 |

Returns

Table of error records from cursor loop.

Calls

bh3\_drop\_temp\_table

bh3\_get\_pressure\_csquares

bh3\_find\_srid';

### Function public.bh3\_find\_srid

Purpose

Finds the SRID of the geometries in the specified geometry column of the specified geometry table.

If the geometries do not have the same single SRID zero is returned.

Approach

Uses a select query to obtain distinct SRIDs directly from the geometries in the speficied table and geometry column.

Prameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Default value** |
| table\_schema | name | Schema of the geometry table. |  |
| table\_name | name | Name of the geometry table. |  |
| geom\_column | name | Name of the geometry column. | “the\_geom” |

Returns

The table SRID if all geometries share the same SRID, otherwise 0.

Calls

No nested calls

### Function public.bh3\_get\_pressure\_csquares

Purpose

Creates an in-memory table of categorised pressure c-squares from the tables in the specified pressure\_schema.

All tables in pressure\_schema that have the required columns will be included.

Approach

Computes summary values of disturbance scores for each table in pressure\_schema that has the columns “c\_square”, “year”, sar\_surface\_column, sar\_subsurface\_column and “the\_geom”, aggregating by c\_square, categorises the scores into sar\_surface and sar\_subsurface scores between one and four and returns the union of the resulting row sets.

Paramerters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_schema | name | Schema of table containing single AOI boundary polygon and bounding box. |  |
| pressure\_schema | name | Schema in which pressure source tables are located (all tables in this schema that have the required columns will be used). |  |
| start\_year | integer | Earliest year for Marine Recorder spcies samples to be included. |  |
| end\_year | integer | Latest year for Marine Recorder species samples and pressure data to be included. | Current date and time |
| boundary\_table | name | Name of table containing single AOI boundary polygon and bounding box. | “boundary” |
| sar\_surface\_column | name | SAR surface column name in pressure source tables. | “sar\_surface” |
| sar\_subsurface\_column | name | SAR sub-surface column name in pressure source tables. | “sar\_subsurface” |
| output\_srid | integer | SRID of output tables (reprojecting greatly affects performance). | 4326 |

Returns

An in-memory table of categorised pressure c-squares from the tables in the specified pressure\_schema.

Calls

bh3\_find\_srid

### Function public.bh3\_get\_pressure\_csquares\_size

Purpose

Obtains the size of c-squares from the geometries of the tables in the selected pressure schema.

Approach

A union query averages the width and height of [multi-]polygon geometries in all tables in the selected pressure schema.

The query is the same as used in bh3\_get\_pressure\_csquares except for the boundary filter, which is unnecessary and skipped for performance reasons.

The polygons are expected to be squares of equal size. The average width/height is returned as long as their standard deviation is less than 0.00000001.

Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Default value** |
| pressure\_schema | name | Name of the schema that holds the pressure tables. |  |
| start\_year | integer | Earliest year for squares to be included. |  |
| end\_year | integer | Latest year for squares to be included. | Current date and time |
| sar\_surface\_column | name | Name of the surface SAR column. | “sar\_surface” |
| sar\_subsurface\_column | name | Name of the sub-surface SAR column. | “sar\_subsurface” |
| output\_srid | integer | SRID of spatial reference system in which c-squares are to be measured. | 4326 |

Returns

Cell size in the units of the spatial reference system identified by output\_srid (normally degrees).

Calls

bh3\_find\_srid

### Function public.bh3\_habitat\_boundary\_clip

Purpose

Creates habitat\_sensitivity table for the selected AOI in the selected output schema.

Approach

The AOI polygon/s is/are split into smaller parts with no more than 256 vertices each. These smaller parts are spatially joined to the habitat table and the intersection of overlapping polygons is computed. The resulting polygons are then aggregated by the gid of the original habitat records, computing the union of the pieces of the original polygons.

Despite the extra steps and multiple geometry repairs between them, this is substantially faster than computing intersections directly with large boundary polygons.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| habitat\_types\_filter | character varying[] | Array of EUNIS L3 codes to be included or excluded. |  |
| output\_schema | name | Schema of the output habitat sensitivity table. |  |
| output\_table | name | Name of the output habitat sensitivity table. | “habitat\_sensitivity” |
| habitat\_schema | name | Schema of the habitat table. | “static” |
| habitat\_table | name | Name of the habitat table. | “uk\_habitat\_map\_wgs84” |
| sensitivity\_schema | name | Schema of the habitat sensitvity lookup table. | “lut” |
| sensitivity\_table | name | Name of the habitat sensitvity lookup table. | “sensitivity\_broadscale\_habitats” |
| boundary\_subdivide\_schema | name | Schema of the subdivided boundary table defining the AOI. | “static” |
| boundary\_subdivide\_table | name | Name of the subdivided boundary table defining the AOI | “boundary\_subdivide” |
| habitat\_types\_filter\_negate | boolean | If false, the EUNIS L3 codes in habitat\_types\_filter are included, if true they are excluded. | False |
| exclude\_empty\_mismatched\_eunis\_l3 | boolean | Controls whether habitats whose EUNIS L3 code is not matched in sensitivity\_table are excluded (true) or included (false). | True |
| remove\_overlaps | boolean | Controls whether bh3\_habitat\_remove\_overlaps is called to remove overlaps from output\_table. | false |

Returns

A single error record. If execution succeeds its success field will be true and the remaining fields will be empty.

Calls

bh3\_drop\_temp\_table

bh3\_find\_srid

bh3\_repair\_geometries

bh3\_habitat\_remove\_overlaps';

### Function public.bh3\_habitat\_grid

Purpose

Creates a gridded version of the habitat\_sensitivity\_table.

Approach

Creates a c-square grid table within the specified boundary and intersects it with polygons from the previously created, ungridded habitat\_sensitivity\_table, calling the fast ST\_ClipByBox2D in a loop over a cursor.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_schema | name | Schema of table containing single AOI boundary polygon and bounding box. |  |
| habitat\_sensitivity\_schema | name | Schema of the habitat sensitivity table. |  |
| output\_schema | name | Schema of the output gridded habitat sensitivity table. |  |
| boundary\_table | name | Name of table containing single AOI boundary polygon and bounding box. | “boundary” |
| habitat\_sensitivity\_table | name | Name of habitat sensitivity table. | “habitat\_sensitivity” |
| output\_table | name | Name of gridded habitat sensitivity output table. | “habitat\_sensitivity\_grid” |
| cell\_size\_degrees | numeric | Cell size in degrees. | 0.05 |

Returns

Table of error records from cursor loop.

Calls

bh3\_drop\_temp\_table

bh3\_find\_srid

bh3\_create\_csquares

### Function public.bh3\_habitat\_remove\_overlaps

Purpose

Removes overlapping polygons from the input habitat sensitivity table.

Approach

First, the input habitat\_sensitivity table is spatially self-joined intersecting overlapping geometries into a temporary table combining attributes from both left and right sides of the join. The resulting joined row set is then split into its constituent rows each of which is one overlapping geometry with its original attributes. Any duplicate overlaps in this split row set are ranked by sensitivity and confidence keeping only top ranked rows. The unique overlapping polygons in this last row set are then erased from the input habitat sensitivity table. Finally, the resulting set of input habitat sensitivity table rows with overlaps removed and the set of overlapping polygons with the highest sensitivity/confidence are merged using a union query and the resulting rows are inserted into the previously emptied input habitat\_sensitivity table.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| habitat\_sensitivity\_schema | name | Schema of the input habitat sensitivity table. |  |
| habitat\_sensitivity\_table | name | Name of the input habitat sensitivity table. |  |

Returns

A single error record. If execution succeeds its success field will be true and the remaining fields will be empty.

Calls

bh3\_drop\_temp\_table

bh3\_repair\_geometries

### Function public.bh3\_sensitivity

Purpose

Retrieves sensitivity rows from the specified table.

Approach:

Performs a select query against the specified source table standardising the return table”s schema.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| source\_table | sensitivity\_source | Source table for habitat sensitivity scores (enum value one of { ‘broadscale\_habitats’, ‘eco\_groups’, ‘rock’, ‘rock\_eco\_groups’ , ‘eco\_groups\_rock’ }). |  |

Returns

An in-memory table of sensitivity rows with standardised schema.

Calls

No nested calls

### Function public.bh3\_sensitivity\_layer\_prep

Purpose

Creates the sensitivity maximum and mode tables from the habitat table and Marine Recorder species sensitivity rows for the specified time period and habitats within the specified boundary polygon(s).

Approach

Retrieves Marine Recorder species sensitivity rows for the specified time period and habitats and clips them by the boundary polygon(s).

Creates the output sensitivity maximum table and populates it by joining the habitat table to the clipped species sensitivity table, aggregating by the habitat table gid, inserting the maximum surface and sub-surface abrasion sensitivity and number of samples plus the habitat table’s maximum surface and sub-surface sensitivity and confidence scores into the output sensitivity maximum table.

Creates the output sensitivity mode table and populates it by joining the habitat table to the clipped species sensitivity table, separately counting the total number of samples as well as counting and ranking the frequencies of all different surface and sub-surface abrasion sensitivity scores, aggregating by habitat table gid, and inserting the top ranked rows plus the habitat table’s maximum surface and sub-surface sensitivity and confidence scores into the output sensitivity mode table provided the number of samples divided by the polygon area in square metres is at least 0.00000005.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_schema | name | Schema of table containing single AOI boundary polygon and bounding box. |  |
| habitat\_schema | name | Schema of input habitat\_table. |  |
| output\_schema | name | Schema in which output tables will be created (will be created if it does not already exist; tables in it will be overwritten). |  |
| sensitivity\_source\_table | sensitivity\_source | Source table for habitat sensitivity scores (enum value one of { ‘broadscale\_habitats’, ‘eco\_groups’, ‘rock’, ‘rock\_eco\_groups’, ‘eco\_groups\_rock’ }). |  |
| start\_year | integer | Earliest year for Marine Recorder species samples to be included. |  |
| end\_year | integer | Latest year for Marine Recorder species samples and pressure data to be included. | Current date and time. |
| boundary\_table | name | Name of table containing single AOI boundary polygon and bounding boxs. | “boundary” |
| habitat\_types\_filter | character varying[] | Array of eunis\_l3 codes of habitats in habitat\_table to be included (or excluded if habitat\_types\_filter\_negate is true). |  |
| habitat\_types\_filter\_negate | boolean | If true condition built with habitat\_types\_filter is to be negated, i.e. EUNIS L3 codes in habitat\_types\_filter will be excluded. | False |
| habitat\_table | name | Name of habitat sensitivity output table. | “habitat\_sensitivity” |
| habitat\_table\_grid | name | Name of gridded habitat sensitivity output table. | “habitat\_sensitivity\_grid” |
| output\_table\_max | name | Table name of species sensitivity maximum map. | “species\_sensitivity\_max” |
| output\_table\_mode | name | Table name of species sensitivity mode map. | “species\_sensitivity\_mode” |
| output\_srid | integer | SRID of output tables (reprojecting greatly affects performance). | 4326 |

Returns

A single error record. If execution succeeds its success field will be true and the remaining fields will be empty.

Calls

bh3\_drop\_temp\_table

bh3\_find\_srid

bh3\_species\_sensitivity\_clipped

### Function public.bh3\_species\_sensitivity\_clipped

Purpose

Creates a table of species sensitivity rows within the specified boundary polygon(s).

Approach

Selects rows from a hard coded join of Marine Recorder tables (marinerec.survey srv, marinerec.survey\_event, marinerec.sample, marinerec.sample\_species, marinerec.sample\_biotope\_all) and lut.eunis\_correlation\_table with the specified sensitivity table within the specified boundary polygon(s).

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_schema | name | Schema of table containing single AOI boundary polygon and bounding box. |  |
| sensitivity\_source\_table | sensitivity\_source | Source table for habitat sensitivity scores (enum value one of { ‘broadscale\_habitats’, ‘eco\_groups’, ‘rock’, ‘rock\_eco\_groups’, ‘eco\_groups\_rock’ }). |  |
| start\_year | integer | Earliest year for Marine Recorder species samples to be included. |  |
| end\_year | integer | Latest year for Marine Recorder species samples and pressure data to be included. | Current date and time |
| boundary\_table | name | Name of table containing single AOI boundary polygon and bounding box. | “boundary” |
| habitat\_types\_filter | character varying[] | Array of eunis\_l3 codes of habitats in habitat\_table to be included (or excluded if habitat\_types\_filter\_negate is true). | NULL |
| habitat\_types\_filter\_negate | boolean | If true condition built with habitat\_types\_filter is to be negated, i.e. EUNIS L3 codes in habitat\_types\_filter will be excluded. | false |
| output\_srid | integer | SRID of output tables (reprojecting greatly affects performance). | 4326 |

Returns

An in-memory table of species sensitivity rows.

Calls

bh3\_find\_srid

bh3\_sensitivity

### Function public.bh3\_sensitivity\_map

Purpose

Creates the sensitivity map from the habitat sensitivity and species sensitivity tables.

Approach

Creates the species\_sensitivity\_mode\_final\_table as the union of a spatial left join between the species\_sensitivity\_mode and species\_sensitivity\_max tables, erasing the species\_sensitivity\_max geometry from the species\_sensitivity\_mode geometry, and the unaltered spatial left join between the species\_sensitivity\_mode and species\_sensitivity\_max tables.

Creates the species sensitivity all areas table as the union of the species\_sensitivity\_mode\_final and species\_sensitivity\_max tables.

Creates the habitat\_sensitivity\_final table as the union of a spatial left join between habitat\_sensitivity\_table and species\_sensitivity\_all\_areas\_table, erasing the species\_sensitivity\_all\_areas\_table geometry from the habitat\_sensitivity\_table geometry, and the unaltered spatial left join between habitat\_sensitivity\_table and species\_sensitivity\_all\_areas\_table.

Creates the output sensitivity map as the union of the habitat\_sensitivity\_final and species\_sensitivity\_all\_areas tables.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| habitat\_sensitivity\_schema | name | Schema of the habitat sensitivity table. |  |
| species\_sensitivity\_schema | name | Schema of the species sensitivity table. |  |
| output\_schema | name | Schema in which output table will be created (will be created if it does not already exist; tables in it will be overwritten). |  |
| habitat\_sensitivity\_table | name | Name of habitat sensitivity table. | “habitat\_sensitivity”. |
| species\_sensitivity\_max\_table | name | Table name of species sensitivity maximum map. | “species\_sensitivity\_max”. |
| species\_sensitivity\_mode\_table | name | Table name of species sensitivity mode map. | “species\_sensitivity\_mode”. |
| output\_table | name | Table name of output sensitivity map. | “sensitivity\_map”. |
|  | SRID of output tables (reprojecting greatly affects performance). | 4326. |  |

Returns

A single error record. If execution succeeds its success field will be true and the remaining fields will be empty.

Calls

bh3\_drop\_temp\_tables

### Function public.bh3\_safe\_difference

Purpose

Wrapper around ST\_Difference with exception handling.

Approach

Calls ST\_Difference on the unaltered input parameters.

If it throws an exception it is called again on the input geometries buffered by 0.00000001.

If that also fails an empty polygon is returned.

Parameters:

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| geom\_from | geometry | Geometry from which to erase geom\_erase (first parameter passed into ST\_Difference). |  |
| geom\_erase | geometry | Geometry to erase from geom\_from (second parameter passed into ST\_Difference). |  |

Returns

ST\_Difference of the two (possibly buffered) geometries, or if that fails an empty polygon.

Calls

No nested calls

### Function public.bh3\_safe\_union\_transfn

Purpose

State transition function for bh3\_safe\_union custom aggregate, which is a wrapper around ST\_Union with exception handling.

Approach

Calls ST\_Union on the unaltered input parameter.

If it throws an exception it is called again on the input geometry buffered by 0.00000001.

If that also fails an empty polygon is returned.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| agg\_state | geometry | State object. ST\_Union of input geometries. |  |
| el | geometry | Input geometry. |  |

Returns

ST\_Union of the (possibly buffered) geometries, or if that fails an empty polygon.

Calls

No nested calls

### Function public.bh3\_boundary\_subdivide

Purpose

Selects AOI polygons from boundary\_schema.boundary\_table identified by boundary\_filter, splits them into smaller parts with no more than 256 vertices each and unions them into a single AOI polygon and its bounding box.

Approach

Calls the ST\_Subdivide function to split the AOI polygons identified by boundary\_filter into smaller parts with no more than 256 vertices each.

These polygons are stored in table output\_schema.output\_table\_subdivide and then unioned into a single AOI polygon and its bounding box stored in

table output\_schema.output\_table.

Parameters

| **Name** | **Type** | **Description** | **Default value** |
| --- | --- | --- | --- |
| boundary\_filter | integer[] | Array of primary key values (gid) of AOI polygons in boundary\_table to be included (or excluded if boundary\_filter\_negate is true). |  |
| output\_schema | name | Schema in which output tables are created. |  |
| output\_table | name | Name of table containing single, unioned AOI polygon and bounding box. Defaults to ''boundary''. |  |
| output\_table\_subdivide | name | Name of table containing split AOI polygons. Defaults to ''boundary\_subdivide''. |  |
| boundary\_schema | name | Schema of table containing AOI boundary polygons. Defaults to ''static''. |  |
| boundary\_table | name | Name of table containing AOI boundary polygons. Defaults to ''unofficial\_country\_waters\_simplified\_wgs84''. |  |
| boundary\_filter\_negate | boolean |  | false |
| output\_srid | integer | SRID of output tables. | 4326 |

Returns

A single error record. If execution succeeds its success field will be true and the remaining fields will be empty.

Calls

bh3\_find\_srid

bh3\_safe\_union