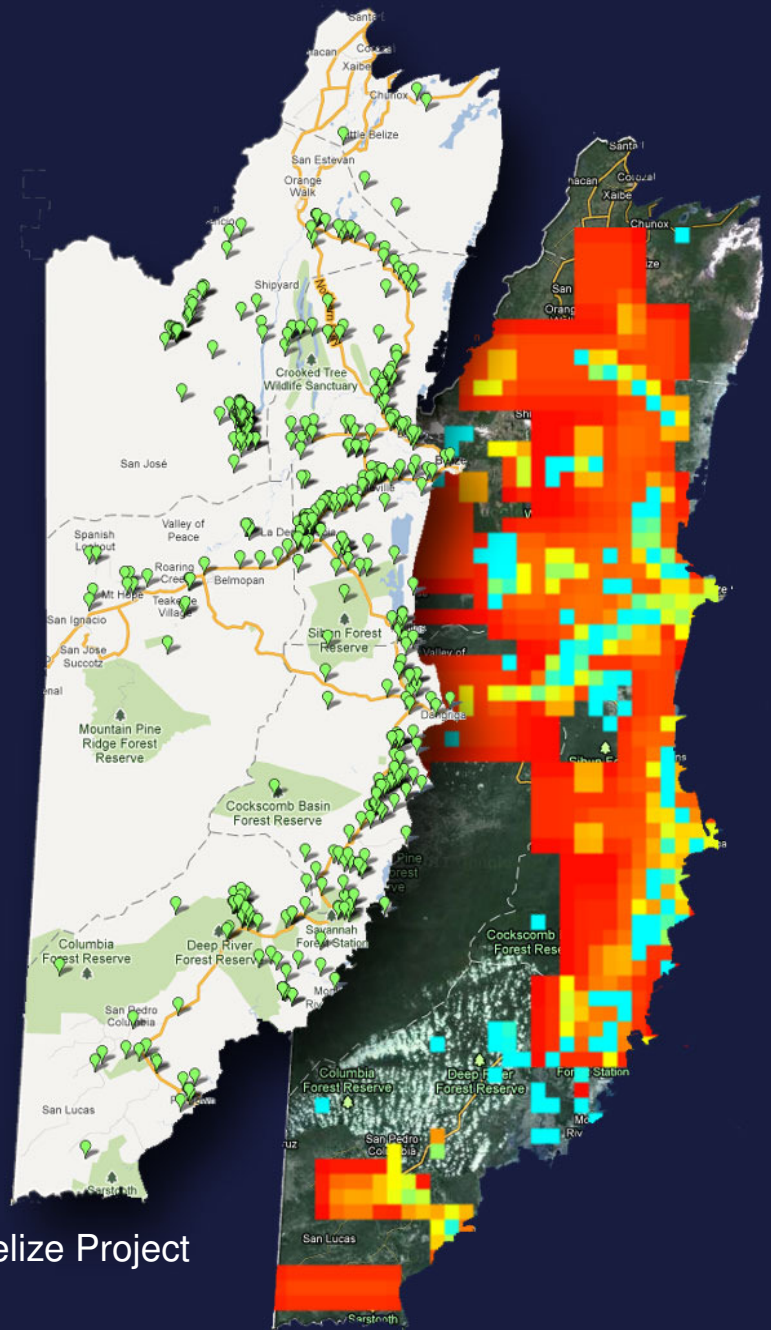# Belizean Savanna Plant Collection (BSPC)
Web Map Interface
User Guide

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December 2011

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http://www.eeo.ed.ac.uk/sea-belize/

Table of Contents

1. Executive summary

Belizean Savanna Plant Collection (BSPC) Web Map Interface is a web application which enables people to mine data of savanna species in Belize by geographical means and browse them on maps.

Savanna Ecosystem Assessment (SEA) Belize Project (http://www.eeo.ed.ac.uk/sea-belize/) has collected about 7800 of botanical records in Belize to support savanna ecosystem conservation. The collections are already published on the web (http://dps.plants.ox.ac.uk/bol/seabelize), where people can search the collections by keywords such as species and collector names.

Geographical location is an important attribute of botanical collections. It enables us to analyse the spatial distribution of each species or the flora of each place. However, to exploit these geographical contexts in BSPC, traditional word search is an insufficient approach.

The BSPC Web Map Interface helps you to get a subset of the SEA Belize collections by both/either taxonomic keywords and/or geographical ways like "within Rio Bravo conservation area" and maps the locations of the collections on Google Maps.

To make the most of geographical functionality, we also restored the locations of historical records in BSPC whose locations had never existed before or being lost basing on their textual descriptions as many as possible.

The geographical functionality would provide a comprehensive picture of savanna flora in Belize to a wide range of users. It would help botanists plan an effective field trip by showing sites where the collection effort is insufficient, environmental scientists draw what is going on the Belizean savanna and conservation managers see what species their conservations sites bear.

2. Interface Overview

2.1. How to start BSPC Web Map Interface

BSPC Web Map Interface is accessible through the web. The URL of the application is as follows.

http://xweb.geos.ed.ac.uk/~belize/

You can also access this application by following the link in SEA Belize Project website. (http://www.eeo.ed.ac.uk/sea-belize/)

Though this application is intended to work on either Microsoft Internet Explorer (ver. 7 ~), Mozilla Firefox (3.6.8 ~) or Google Chrome (15.0 ~), we recommend you **NOT to use Internet Explorer** for this application. Otherwise, the performance of the application would be very low due to matters we can not touch.

2.2. Basic parts of the interface

The user interface consists of three major parts; SEARCH CONSOLE, MAP and LAYER PANEL (Fig. 2-1).
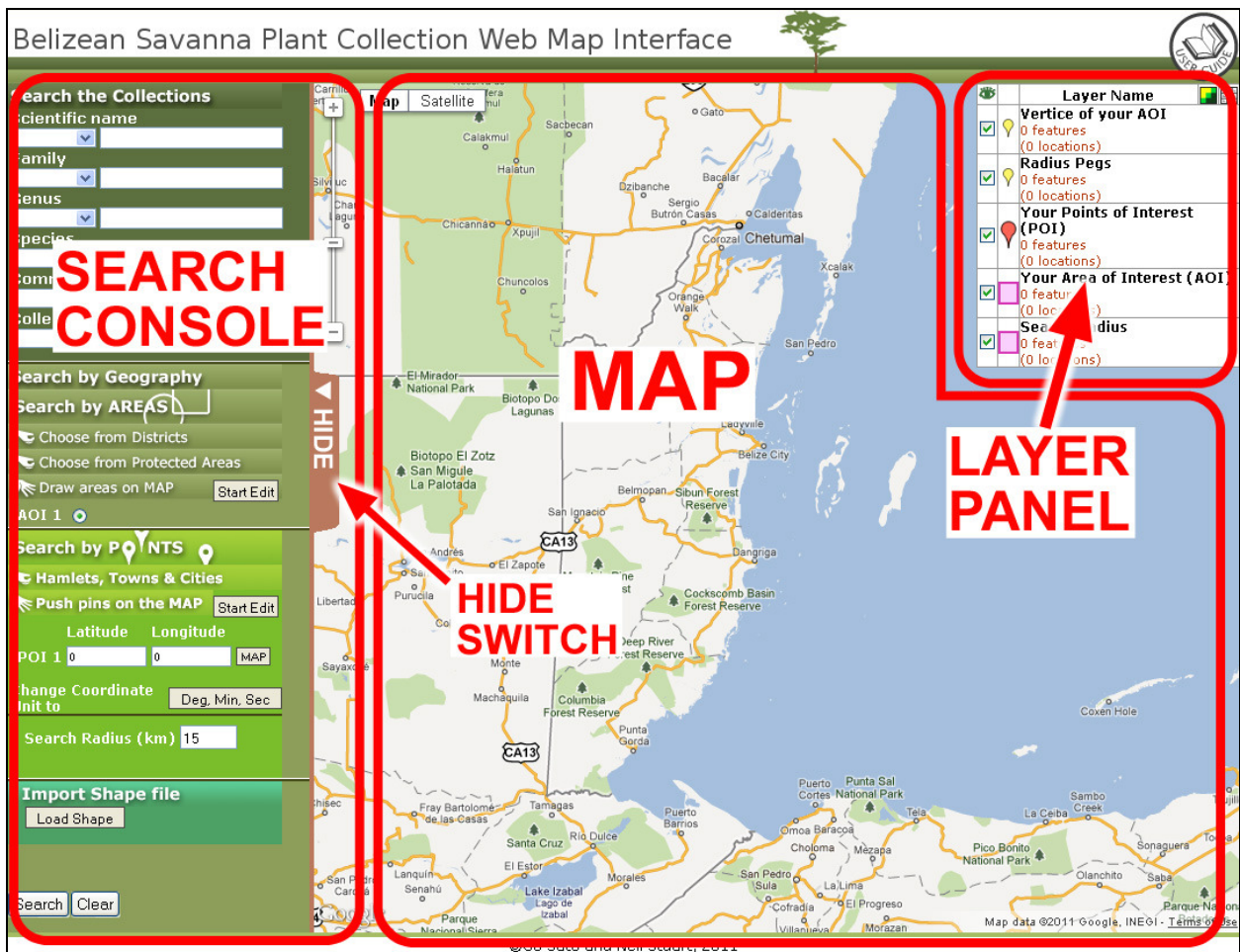
Fig. 2-1

The map displays all your geographical criteria and results of your search on Google Maps. The map could be used as a "sand box" when you define your areas of interest for geographical searches.

The search console is a panel on the left of the map. This is what you interact with when you define your search criteria for our botanical collections (Chapter 3 and 4). The search console could be closed by clicking the "HIDE" switch (Fig. 2-1) so that you can see your search results on a broaden map space. The console could be opened again by clicking "SEARCH CONSOLE" which could be found on the left edge of the browser window.

The layer panel settles in the right of the map. In this application, objects on the map including your search criteria and results are assorted and plotted on virtual slides called "layers". The layers are overlaid or superimposed on Google Maps in the order shown in the layer panel. The layer panel also gives you some control over each layer including its visibility (Chapter 4).

3. Search Collections by Keywords on Taxonomic Records

BSPC Web Map Interface provides you a dynamic user interface which helps you define not only simple but also detailed search criteria for textual search on taxonomic records of savanna plant collections in Belize.

The interface allows you to find savanna species by the following three ways.

   a)   Scientific name (genus and species)   [§3.1.]

   b)   Combination of family name, genus and/or species epithets   [§3.2.]

   c)   Common name (vernacular name) of the species.   [§3.3.]

When you attempt to search collections using two or all of a) ~ c), the application would search collections which match AT LEAST ONE of the search conditions. For example, if you input

   - "*Miconia chamissois*" for scientific name and

   - "*Wild Craboo*" for common name

to the interface, you would retrieve collections of BOTH *Miconia chamissois* and *Byrsonima crassifolia* (Wild Craboo).

In addition, you can find collections collected by particular persons [§3.4.] For example, if you input "*Miconia chamissois*" for scientific name and "Schipp, W.A." for collector, the system would provide you the collections of *Miconia chamissois* collected by William Schipp.

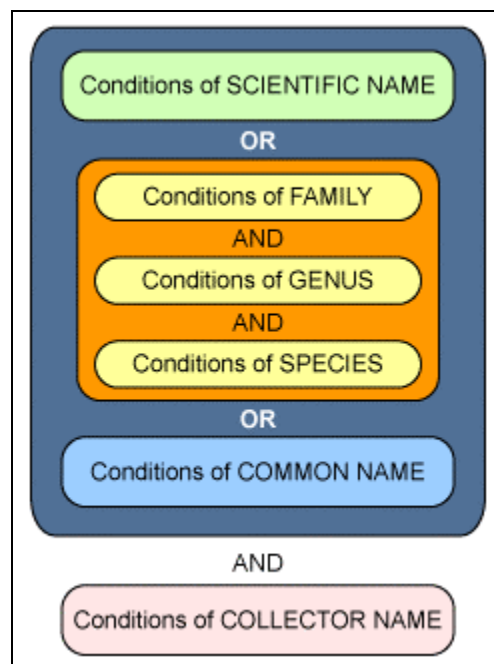The logical relationships among these keyword categories in this system are summarised in Fig. 3-1.

Fig. 3-1

3.1. How to Input Search Keywords (Case of Scientific Names)

This section illustrates the general steps to search collections by keywords taking a search by scientific names for example. The application has some features which help you define detailed and accurate search conditions like suggestion list function. Those features would be also explained in here.

A) To search collections by scientific names, fill the field entitled "**Scientific Name**" on the search console.

Fig. 3-2

B) After you type one or some letters in there, a suggestion list will drop down like Fig. 3-1.

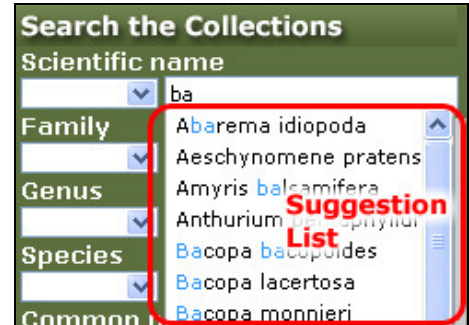This list covers all matching scientific names in our collections.

C.1) Once you found the right name on the suggestion list, move the caret (light-grey shading) to there using the MOUSE cursor and LEFT CLICK to finalise your choice. Or you can move the caret with UP/DOWN arrow keys and choose by pressing ENTER key on your keyboard (Fig. 3-2).

Fig. 3-3

C.2) You may not wish to chose one from our suggestions. To do so, press ESC key on the top-left corner of your keyboard to close it without selection.
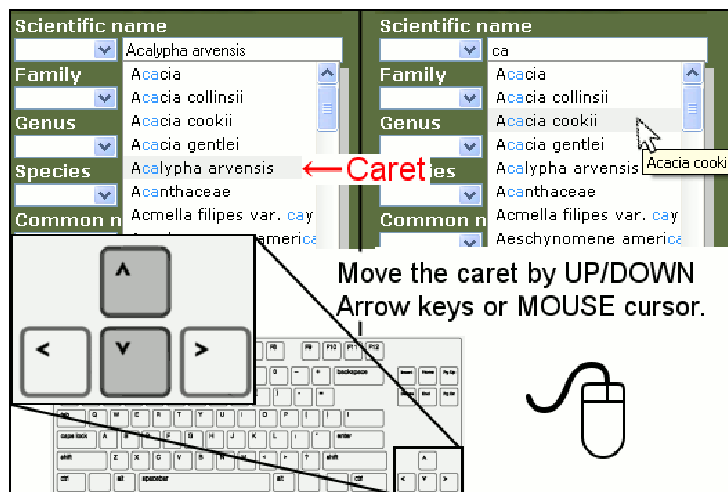
D) Once you select a name from suggestions in C.1), a blank field would appear below the current field like Fig. 3-3. You can add another scientific name by repeating A) ~ C.1)

Fig. 3-4

E) You may wish to EXCLUDE particular collections by scientific names. To do so, choose "NOT" from the list on the right hand of the name (Fig. 3-4).

From the second field, "NOT" would appear like "AND NOT" and "OR NOT". In most of these cases, use "AND NOT" to exclude the plant name from your search results (see also the lower half of Fig. 3-5).

Fig. 3-5

F) You may wish to remove blank fields like that shown up in Fig. 3-6 to tidy up your screen. To remove a blank field, CLICK the field and press DELETE key on the keyboard.

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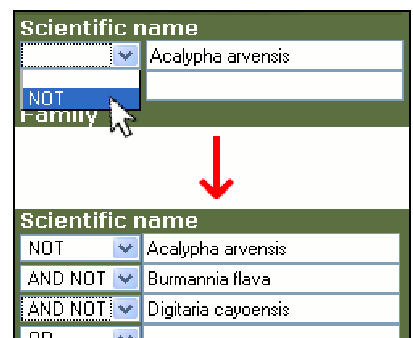Note that DELETE key will not remove the top first field and others which are not empty. If you failed to remove a blank field except the first one, the field may contain invisible characters such as white space. If so, delete all characters in the field and try again.

G) Once you entered all keywords for scientific names, press "**Search**" button in the bottom of the search console.

Behind the Screen 1 ~*for advanced usage*~

When combining your keywords, the system gives higher precedence to AND than OR (i.e. AND has stronger adherence than OR). Given the example shown in Fig. 3-7, the search conditions would be adhered and integrated like the following.

Fig. 3-8

```
SEARCH COLLECTIONS WHOSE SCIENTIFIC NAMES CONTAIN EITHER
('miconia' AND 'albi') OR ('mimosa' AND 'ham')
```

Note that upper/lower cases do not matter when searching collections.

In this case, the system will find out and return collections whose scientific names are
  - Miconia albicans   (containing both 'miconia' and 'albi')
  - Mimosa bahamensis (containing both 'mimosa' and 'ham')
but will not return
  - Miconia chamissois (containing both 'miconia' and 'ham')
  - Mimosa albida   (containing both 'mimosa' and 'albi')

Because of this limitation on the logical relationship between keywords, you can not define a combination of key words like…

```
SEARCH COLLECTIONS WHOSE SCIENTIFIC NAMES CONTAIN
'miconia' AND ('albi' OR 'ham')
```

where OR has stronger adherence than AND.

3.2. Search by combinations of Families, Genera and Species

Instead of scientific names, you can search the collections by family, genus and species epithets. To input keywords for these epithets, follow the steps in §3.1. at "Family", "Genus" and/or "Species" in the search console (Fig. 3-9).

Note that these three categories are dependent with each other. Given the example shown in Fig. 3-10, the system would find collections which satisfy ALL the following criteria.

1) The family name contains "tomata" in somewhere
2) The genus epithet contains "aci" in somewhere
3) The species epithet contains "ata" in somewhere

So, the system would find out the collections of the following species from our collections. (Matches are underlined)

Family	Genus	Species
Melas<u>tomata</u>ceae	<u>Aci</u>otis	rostell<u>ata</u>
Melas<u>tomata</u>ceae	<u>Aci</u>santhera	quadr<u>ata</u>

It is unnecessary to fill all the "Family", "Genus" and "Species" categories. In the example shown in Fig. 3-11, "Family" and "Species" fields are left blank. In this case, you would retrieve collections of ALL species under Acisanthera genus. This kind of "search by taxonomic group" would be the most popular usage of these fields.
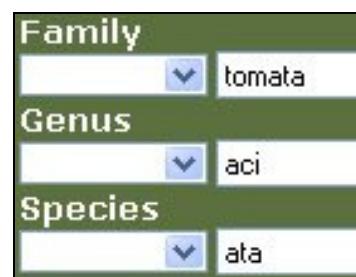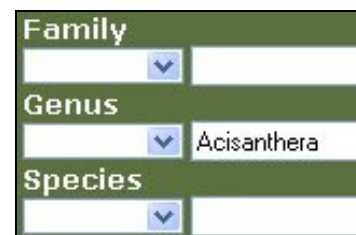
Fig. 3-9

Fig. 3-10

Fig. 3-11

Behind the Screen 2 ~*for advanced usage*~

When searching collections, the system treats the user's keywords selected from suggestion lists differently from others. For example, if you CHOSE "***gentlei***" FROM A SUGGESTION LIST of species, the search results would be as follows.

Collections of	Search results would
*Acacia **gentlei***	INCLUDE
*Crossopetalum **gentlei***	INCLUDE
*Paepalanthus **gentlei***	INCLUDE
*Chamguava **gentlei** var. **gentlei***	EXCLUDE

On the contrary, if you input "***gentlei***" only by typing, the search result will include the collections of all four species listed above.

Let "normalised keywords" denote keywords defined by choosing from suggestion lists and let "unnormalised keywords" refer to those defined without using suggestion lists. For normalised keywords, the system tries to search collections which EXACTLY MATCH the keywords. Meanwhile, for unnormalised keywords, the system attempts to search collections which CONTAIN the keywords in any place.

If you chose a keyword from a list and added/deleted any single character to/from it, the system would not treat the keyword as normalised but unnormalised.

When you want to get every collection which contains your keywords in any part, you have to avoid selecting keywords from suggestion lists. You can discard suggestion lists by pressing ESC key on your keyboard.

3.3. Search by Common Names of Species

Other than scientific names and epithets, you can search our plant collections by common names or vernacular names.

To input keywords for these epithets, follow the steps in §3.1. at "Common name" in the search console (Fig. 3-12)

Fig. 3-12

3.4. Search by the Names of Collectors

In 3.1~3.3, we mentioned how to search collections of particular species. In addition to this, you can narrow down your search result by the names of collectors.

To input keywords for these epithets, follow the steps in §3.1. at "Collector" in the search console (Fig. 3-13)

By leaving all taxonomic fields (scientific name, common name, family, genus and species) blank, you can get all botanical collections collected by particular collectors.

Fig. 3-13

Note that, the system does not consider whether your interested collectors were the main, sub or assistant collector when searching collections. For example, if you attempted to search collections by "Goodwin, Z.A.", you would retrieve the collections documenting her as not only the main collector but also one of the assistants. Also, if you searched collections "NOT" collected by "Goodwin, Z.A.", the system would return you the collections not documenting her as a collector at all.

4. Search Collections by Geography

BSPC Web Map Interface has a powerful GIS functionality which enables you to search botanical collections in geographical or spatial means.

Geographical search hands collections lying in areas of interest (AOI) geographically defined by the user. This interface provides you two approaches to define your own AOI. One lets you define shapeal shapes directly and attempts to find collections possibly inside there. The other let you define your points of interest (POI) and attempt to find collections in the vicinities of them.

4.1 Search Collections within Areas

You may be interested in geographic areas such as administrative boundaries, protected areas and so on. BSPC Web Map Interface already has geographical templates for Districts, Protected Areas and Towns in Belize. These datasets are originally produced by Meerman J.C. (2010, 2011) and provided from Biodiversity & Environmental Resource Data System of Belize (BERDS; http://www.biodiversity.bz)

You can also define your areas of interest without using these templates.

4.1.1. How to Search Collections using Geographical Templates (Case of Administrative Districts)

This section illustrates the general steps to search collections by geographical templates taking a search by administrative districts for example. The interface allows you to look up and choose your interested place by names or from the map.

A) CLICK "**Choose from Districts**" on the search console. Soon, the LIST of Belizean districts will appear below and the SHAPES on the map.
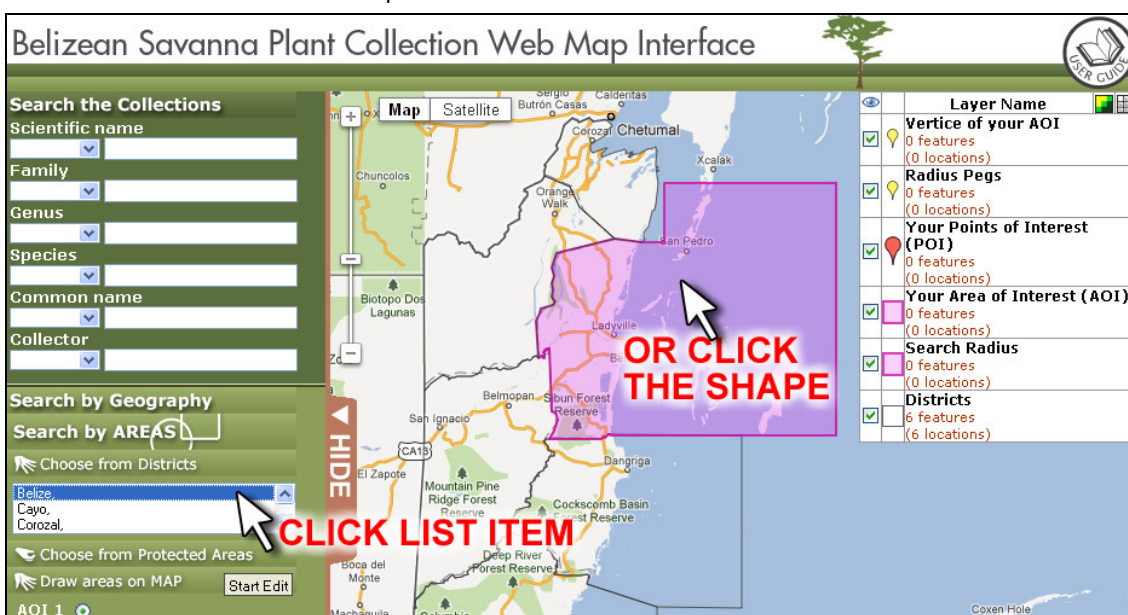

Fig. 4-1

B) Choose an item by CLICKING its name on the list OR inside its shape on the map (Fig. 4-1).

C) You may wish to add another item to your selections. To do so, HOLD CONTROL(CTRL) KEY PRESSED and CLICK additional items on the list or shapes on the map (Fig. 4-2).

D) If you want to remove particular items from your selections, HOLD CTRL KEY PRESSED and CLICK either the list item or the shape on map that you want to deselect (Fig. 4-3).

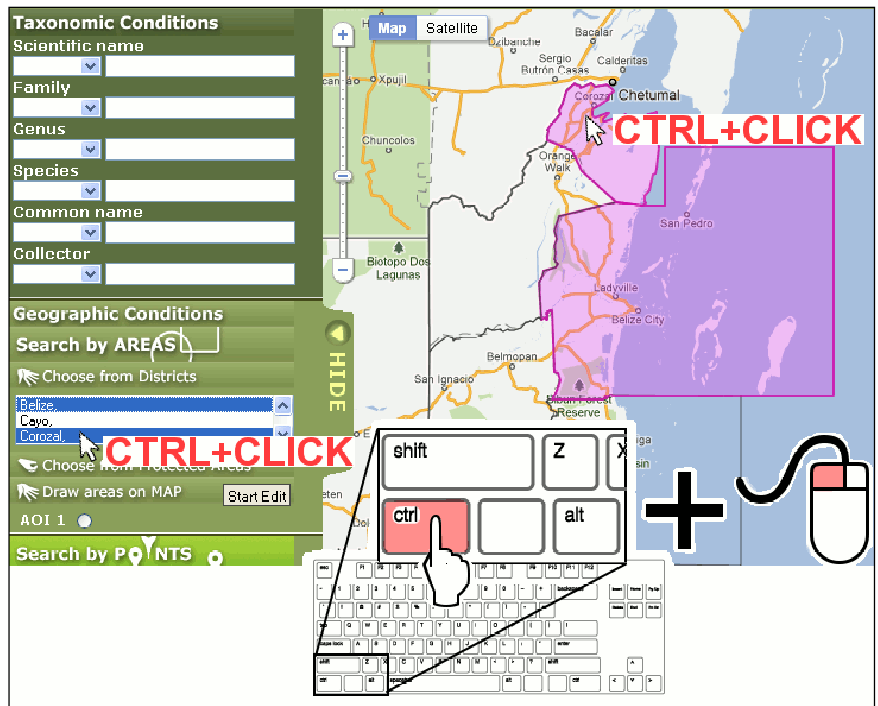E) Once you selected all interested districts, press "**Search**" button in the bottom of the search console.
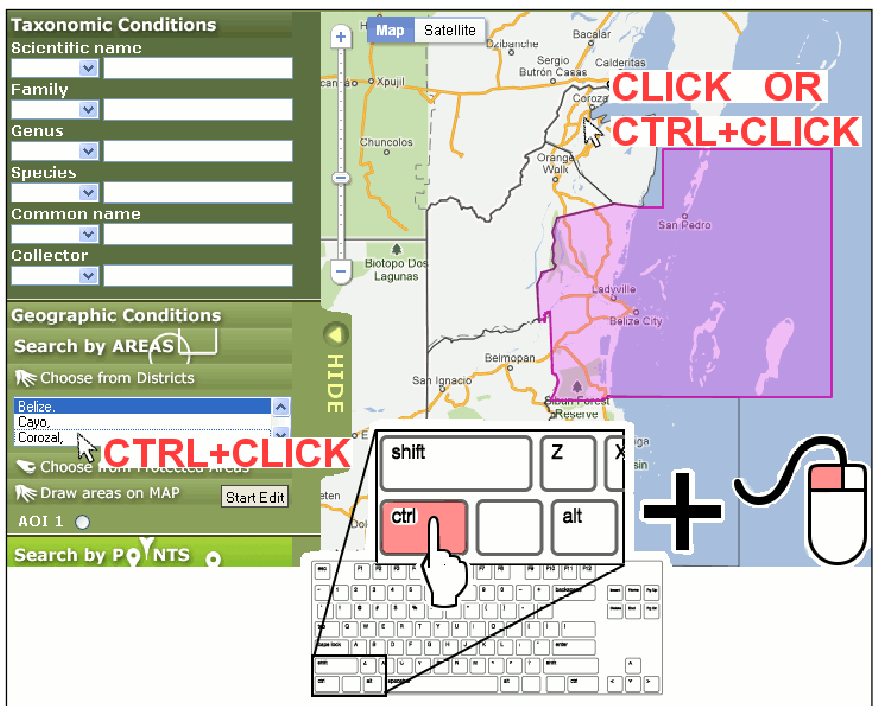

Fig. 4-2 (sequel to Fig. 4-1)

Fig. 4-3 (sequel to Fig. 4-2)

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4.1.2. Search Collections within Protected Areas

BSPC Web Map Interface provides templates of protected areas in Belize to let you find collections within them.

To define your geographical search using these templates, follow the steps in §4.1.1. at "**Choose from Protected Areas**" in the search console (Fig. 4-4).
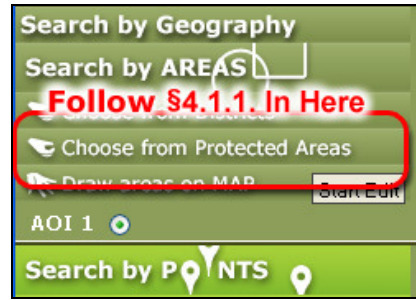

Fig. 4-4

4.1.3. Search Collections within Freeform Areas

You may wish to make quick sketches of your areas of interest (AOI) on the map directly. BSPC Web Map Interface provides a simple tool which enables you to draw freeform shapes as your AOI directly on map.

Note that each shape you draw must consist of one boundary. This means that you can not define areas which contain holes (Fig. 4-5). In addition, your shapes must not contain SELF-CROSSINGS on their boundaries (Fig. 4-6). Otherwise, they would be regarded as INVALID and IGNORED by the system.
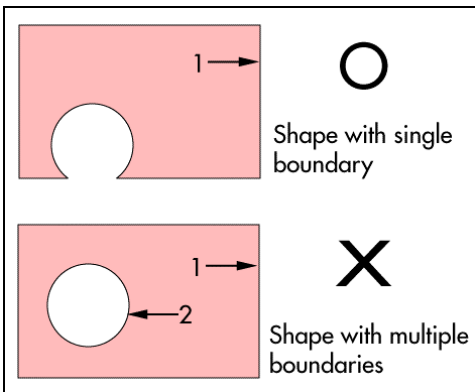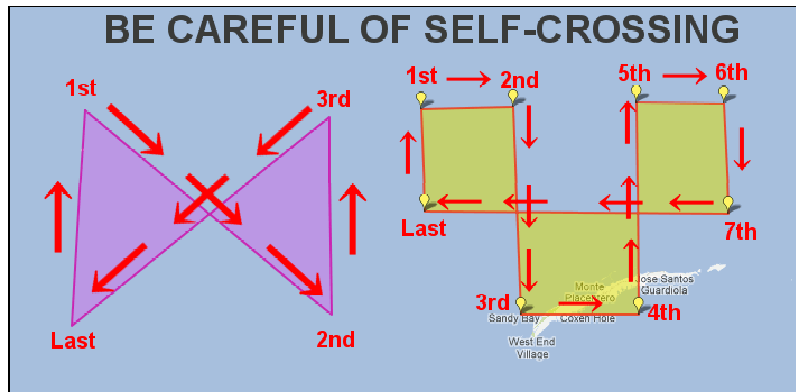

Fig. 4-5

Fig. 4-6

The steps to draw shapes on maps are as follows.

A) CLICK "**Start Edit**" BUTTON next to "**Draw areas on MAP**" on search console (Fig. 4-7).

Fig. 4-7

B) CLICK THE MAP directly to PLACE VERTICES of your shape.

To form a new shape, you would need to place at least 3 vertices (Fig. 4-8).
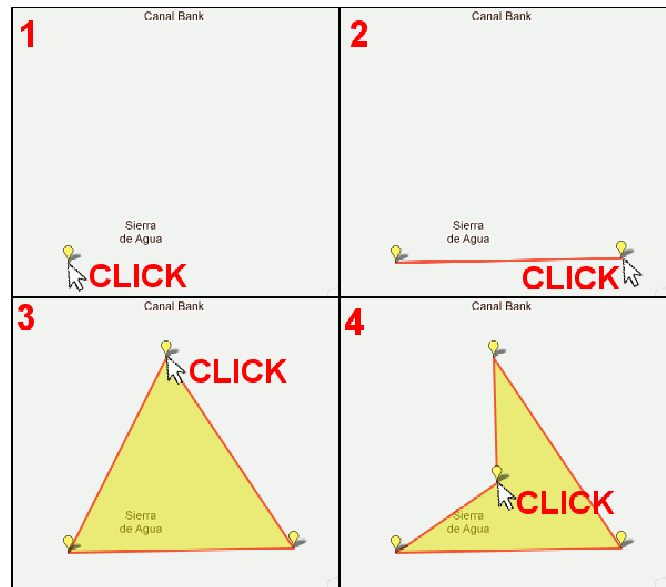
Fig. 4-8

C) To modify the locations of vertices, DRAG AND DROP THE YELLOW PINS (Fig. 4-9).

D) A simple click on the map places a new vertex between the first and last vertices of your AOI (Fig. 4-10(a)).

Although this would be handy for you to scratch a shape on the map, you may wish to add vertices on arbitrary edges to shape details of your AOI.

To do so, HOLD CTRL KEY PRESSED and CLICK SOMEWHERE INSIDE THE SHAPE, NEAR TO the place you want to put a new vertex (Fig. 4-10(b)).

If you are not sure where CTRL key is on your keyboard, see Fig. 4-3.

We apologise in advance that there is a known bug that this function does not work well in MacOS environment.

E) To delete a vertex from your shape, DOUBLE CLICK THE YELLOW PIN placed on the vertex to be deleted (Fig. 4-11).

Fig. 4-9 (sequel to Fig. 3-7)

Fig. 4-10 (sequel to Fig. 3-8)

Fig. 4-11 (sequel to Fig. 3-9)

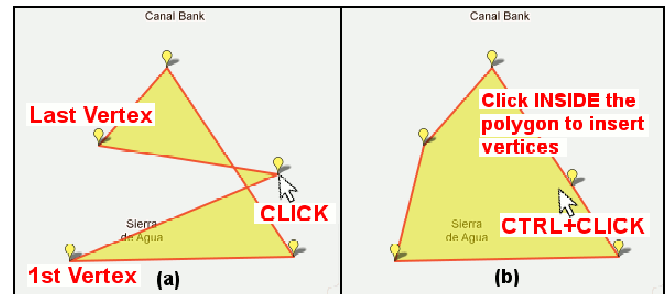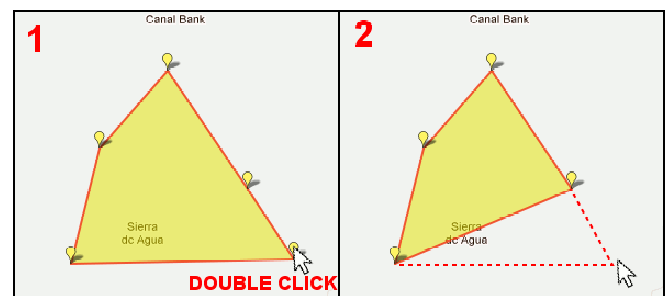F) To delete a whole shape from your map, HOLD SHIFT KEY PRESSED and CLICK SOMEWHERE INSIDE the shape you want to delete (Fig. 4-12).

G) You can create as much shapes as you want.

In the search console, you may find radio buttons labelled "AOI 1", "AOI 2"… below "**Draw areas on MAP**" (see Fig. 4-13).

You can switch the shape under edition using these radio buttons. The shape under edition looks YELLOW coloured and has yellow pins on its vertices, while the other fixed ones look PINK coloured and have no pins (Fig. 4-14).

Initially, there is only one radio button under "Draw areas on MAP" as shown in Fig. 4-7. When you start drawing the first shape, a new selector would appear below the bottommost selector.

So, to ADD A NEW SHAPE to the map, CLICK THE BOTTOMMOST RADIO BUTTON below "**Draw areas on MAP**" and start drawing.
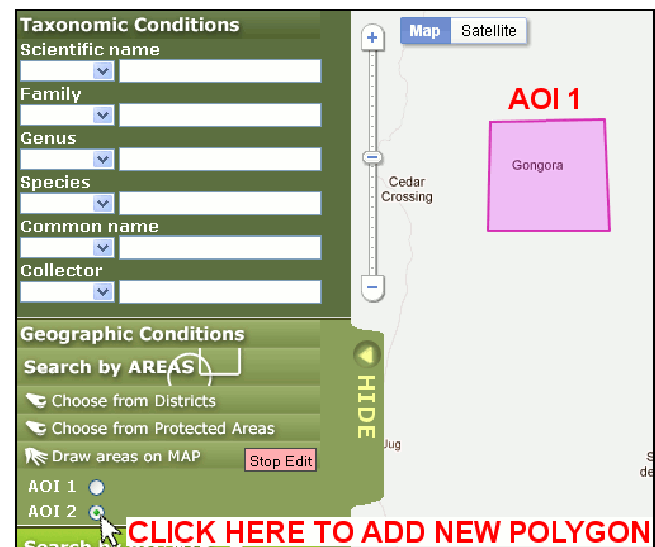
H) Once you have finished drawing your areas of interest, press "**Stop Edit**" to finalise your drawings.

You can add new shapes or modify existing shapes by repeating A) ~ G).

I) Once you drew all the shapes representing your areas of interest, press "**Search**" button in the bottom of the search console.
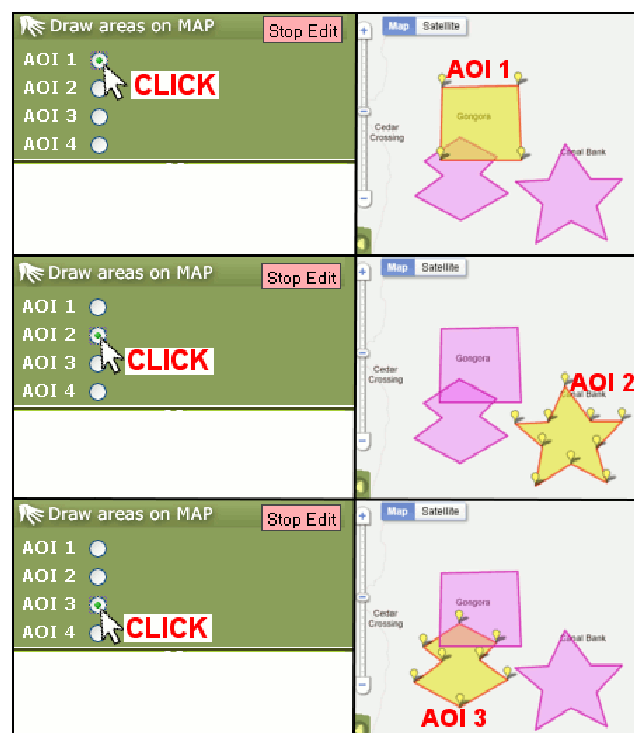

Fig. 4-12 (sequel to Fig. 4-11)

Fig. 4-13

Fig. 4-14

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4.2. Search Collections around Points

You may prefer to search collections which lie in the vicinity of particular points.

BSPC Web Map Interface provides another scheme which enables you to search our collections by geographical points. Once you defined all the points that you are interested in, the application generates areas of interest (AOI) as circles around them and search collections which are inside the AOIs (Fig. 4-15).

The circles represent areas where things inside them are "near to" your points of interests. Their radius depends on the spatial scale you are working in. For example, if you were focusing on a town, a mile may not be a "near distance" for you, but if you were interest in the whole globe, 1000 miles may be quite "near" for you. So, when searching collections around your points of interest (POI), you also have to define the search radius as appropriate.
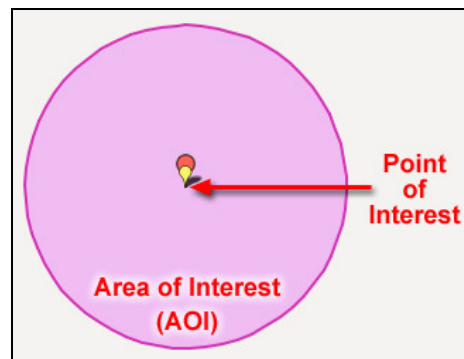
Fig. 4-15

4.2.1. Search Collections around Hamlets, Towns and Cities

A) CLICK "**Hamlets, Towns & Cities**" on the search console. Soon, the LIST of settlements in Belize will appear below in alphabetical order and their centres on the map as blue pins.
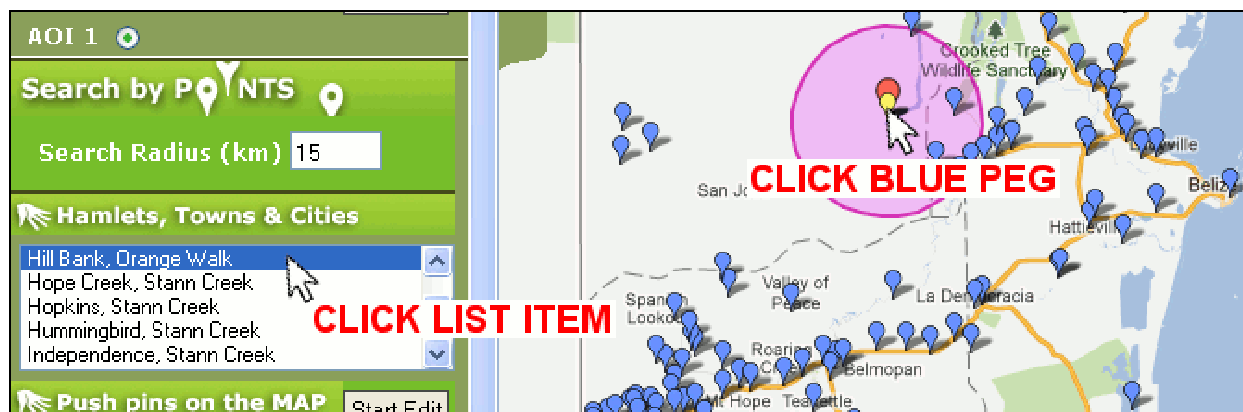
Fig. 4-16

B) CLICK your interested settlement name on the list or blue pin on the map to choose (Fig. 4-16). Soon, a pair of ORANGE and YELLOW PINS and A pink circle would appear. The orange pin represents the point of interest (POI) and the circle the areas of interest (AOI).

C) You may wish to add another item to your selections. To do so, HOLD CONTROL (CTRL) KEY PRESSED and CLICK additional items on the list or blue pins on the map. If you are not sure about where CTRL key is on your keyboard see Fig. 4-2.

D) If you want to remove particular items from your selections, HOLD CTRL KEY PRESSED and CLICK either the list item or the shape on map that you want to deselect.

E) To MODIFY THE RADIUS of circles around the chosen towns, see §4.2.4.

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F) Once you selected all interested towns, press "**Search**" button in the bottom of the search console.

This gazetteer is originally produced by Meerman J.C. (2011) and provided from Biodiversity & Environmental Resource Data System of Belize (BERDS; http://www.biodiversity.bz)

4.2.2. Search Collections around Arbitrary Points

Your point of interest (POI) may not be a place name in our gazetteer. In case of that, you can plot your POI directly on the map.

A) CLICK "**Start Edit**" BUTTON next to "**Push pins on the MAP**" on search console (Fig. 4-17)
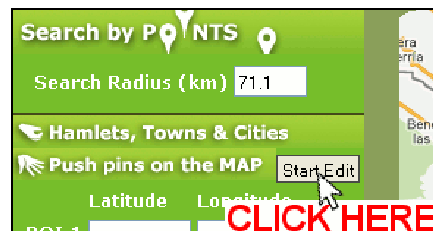
Fig. 4-17

B) CLICK the map. Then a pair of ORANGE and YELLOW PINS and a pink circle will appear on the map. The orange pin represents the point of interest (POI) and the circle the areas of interest (AOI).

You can check the latitude and longitude of the pin you have pushed on the search console (Fig. 4-18).
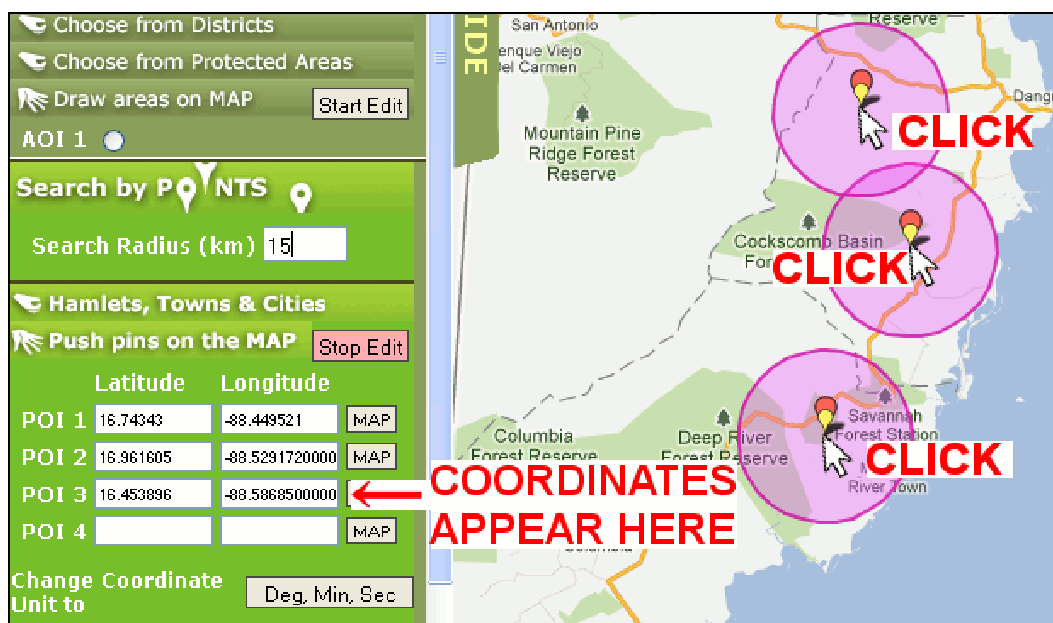
Fig. 4-18

C) You may have specific latitude and longitude values for your POI. In case of that, INPUT THE VALUES INTO the bottommost blank "**Latitude**" and "**Longitude**" fields labelled "POI *N*" (*N* is a number) and CLICK "**MAP**" button. Then, a pin would appear there on the map (Fig. 4-19).

The acceptable writing styles for latitude and longitude values are illustrated in the next section.

The latitude/longitude fields other than the bottommost one are linked to pins that you have already pushed on the map. If you input your coordinates and push "**MAP**" button for these fields, the corresponding pins and circle will move to the new coordinates.

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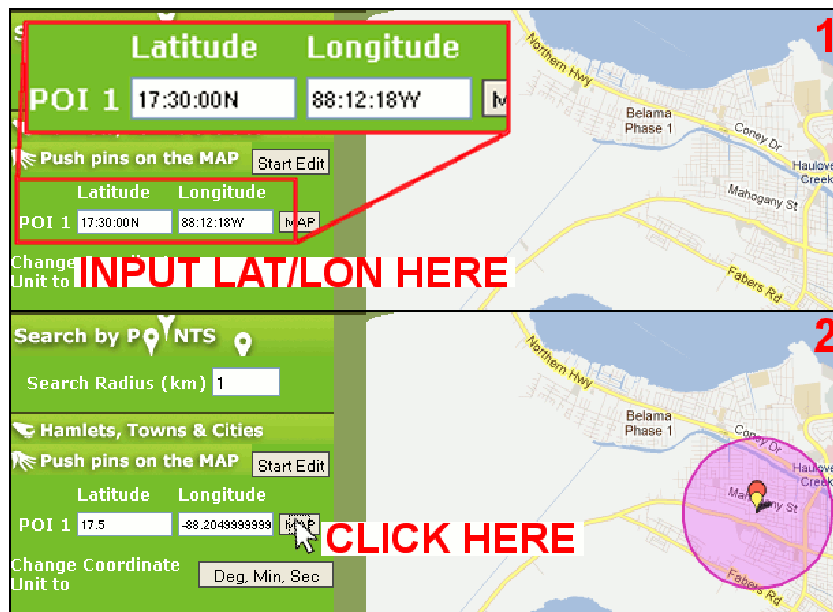
Fig. 4-19

D) To MODIFY the location of a pin, DRAG AND DROP THE ORANGE PIN (Fig. 4-20).

Or, you can modify the location by typing specific lat/lon coordinates into the correspondent fields on the search console. See the 2nd paragraph in step C) for details.

E) To DELETE a pin, HOLD CTRL KEY PRESSED and CLICK THE ORANGE PIN you want to delete. If you are not sure about where the CTRL key is on your keyboard, see Fig. 4-3.

F) To MODIFY THE RADIUS of circles around the chosen towns, see §4.2.4.
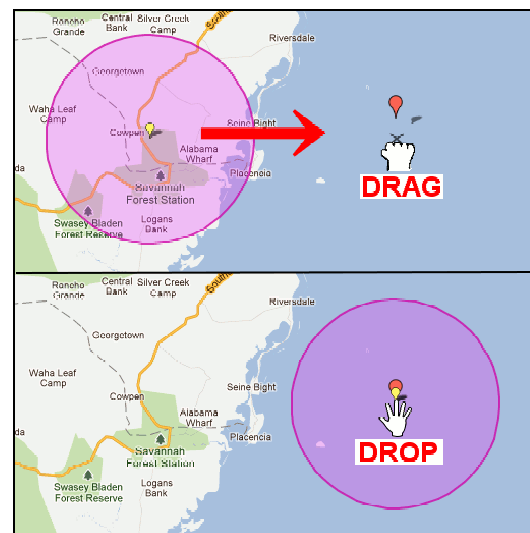
Fig. 4-20

G) Once you plotted all your points of interest on the map, press "**Search**" button in the bottom of the search console.

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4.2.3. How to Input Latitude and Longitude

The formats of latitude and longitude coordinates accepted in step C) of §4.2.2. are shown in Table 2. We accept coordinates in both traditional degree-minute-second (e.g. 17° 30´ 0˝ S) and decimal degree (e.g. -17.5) representations.

PLEASE BE SURE about that your coordinates is measured in WGS84 COORDINATE SYSTEM which is the default for almost all GPS devices. If your coordinates uses another datum (e.g. NAD1927), it could be mapped to an unexpected place on the map.

When your coordinates uses degree-minute-second (DMS) format, values of degrees, minutes and seconds should fit the following domains.

Table 1: Allowed domains of degree, minute and second values

| Element	Value domain
Degree	- For latitude, integer between -89 and 89 - For longitude, integer between -179 and 179
Minute	- Integer between 0 and 59
Second	- Real number equal to or greater than 0 and smaller than 60

If any of degree minute or second does not fit the domain above, neighbours will be affected. For example, if the minute of your coordinate is **80.5** which is neither an integer nor smaller than 60, the system will translate the value to "**1 degree 20 minutes and 30 seconds (= 60 + 20 + 0.5)**" and thus add 1 to degree and 30 to second values.

Table 2: Acceptable coordinate formats in BSPC Web Map Interface.

	Latitude example	Longitude example	Description
1	17.5N	88.205W	Decimal degree ended with cardinal directions (N, S, E, W / either upper or lower case)
2	17.5	-88.205	Pure decimal degree, where southern latitudes and western longitudes are represented as negative numbers.
3	17° 30´ 0˝ N	88° 12´ 18.00˝ W	Traditional degree-minute-second (DMS) represent-ation ended with cardinal directions. Decimal point (period) is allowed. Allowed signs in UTF-8 character code; Degree (°): U+00B0 (Degree sign); Minute (´) : U+00B4 (Acute accent) Second(˝) : U+02DD (Double acute accent)
4	17° 30´ 0˝	-88° 12´ 18.00˝	Traditional DMS representation, where southern latitudes and western longitudes are represented by a negative sign.
5	17:30N or 17:30	88:12:18.00W or -88:12:18	Simplified DMS representation delimited by colons (:). If there was a pair of numbers delimited by a colon, the 1st one would be interpreted as degree and the 2nd as minute value. If there were more than 3 numbers delimited by colons, the first three ones would be interpreted as degree, minute and second and the rest ignored.

4.2.4. Adjust the Search Radius around your Points of Interest

When you search botanical collections around your points of interest (POI), the system creates the areas of interest (AOI) as circles around the POIs and gives you collections which are inside the AOIs.

The radius is uniformly applied to all circles and its default value is 15 kilometres which is the maximum distance documented as "near from a town" in our collections. However, this value may be too large or small for you.

As mentioned in the beginning of this chapter, the size of AOIs around POIs depends on the spatial scale you are focusing on.

Fig. 4-21

To CHANGE the AOI radius, INPUT the radius value in the field titled "**Search Radius (km)**" and PRESS ENTER key (Fig. 4-21). Again, this radius would be uniformly applied to all your POIs and you can not set different radii to different points.

You can also modify your search radius by DRAGGING THE YELLOW PIN of one of your POIs on the map (Fig. 4-22).
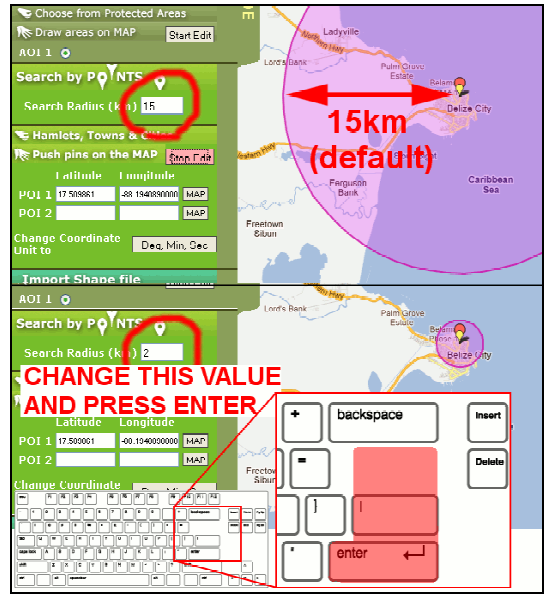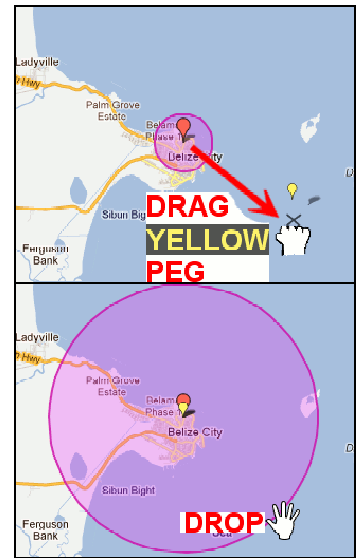

Fig. 4-22

4.3. Search Collections by Geographies Imported from Shapefiles

As shown in 4.1 and 4.2, BSPC Web Map Interface provides you a rich set of tools which help you search collections by geography. However, you may wish to define your areas of interest (AOI) and/or points of interest (POI) using other powerful GIS applications.

BSPC Web Map Interface has a tool for importing ESRI Shapefiles as AOI/POI. Because Shapefile is one of the most popular file exchange formats for geographical applications, this tool encourages you to define your AOIs using popular GIS software such as ArcGIS and Quantum GIS.

The heart of our Shapefile importer is the open source modules originally developed by Jason Kohles.

(http://search.cpan.org/~jasonk/Geo-ShapeFile-2.51/ShapeFile.pm)

4.3.1. How to Import Shape files

A) CLICK "**Load Shape**" button near the bottom of the search console. Then a dialogue box would appear (Fig. 3-21).

B) A Shapefile consists of 3 mandatory files (*.shp, *.shx, *.dbf) and optional files (e.g. *.prj, *.sbn).

The dialogue requires the geometry data file (*.shp) and index file (*.shx) and asks for the projection information file (*.prj).

CLICK "**Browse…**" button next to each field. Then another dialogue will pop up to let you choose the file (Fig. 3-21).

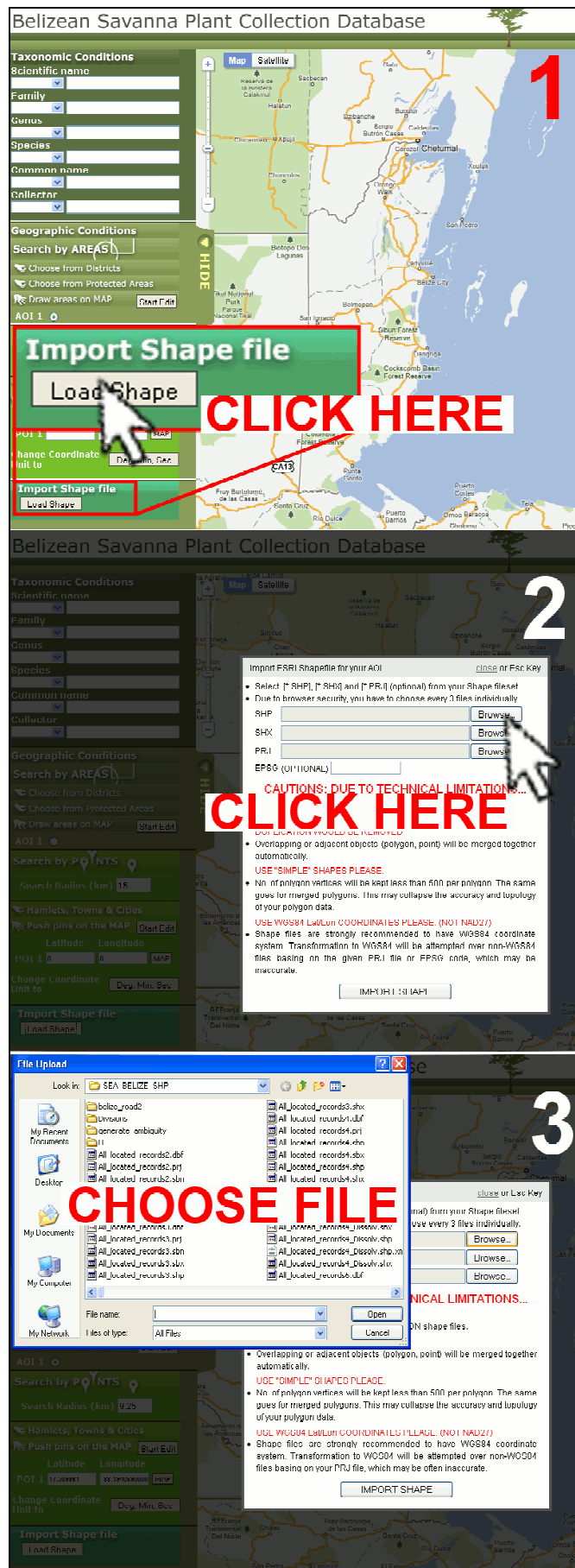You may expect that once you chose either *.shp, *.shx or *.prj file, the interface would

Fig. 3-21

automatically select the rest two ones because they share the same name. Unfortunately, you have to choose all the files individually because of security policies of web browsers (Internet Explorer, Firefox and Chrome).

*.prj file is mandatory only when your shapefile's coordinate system is not WGS84 which is the default for almost all GPS devices. When the shapefile references a coordinate system different from WGS84, the system attempts to transform the coordinates into WGS84 using information in *.prj file.

Alternatively, if you can figure out the EPSG code of your shapefile from its metadata or by other means, you can give that code instead of *.prj file. In most cases, EPSG code would bring better transformation than *.prj file.

It would be the best if you transform your shapefile's coordinate system to WGS84 preliminarily. A way of transformation is shown in §4.3.3.

C) Once you chose the files, CLICK "**IMPORT SHAPE**".

4.3.2. Restrictions on Use of Shape files for Collection Search

Due to technical limitations, the geometries imported from your shapefile may be changed from the original following these restrictions. These changes will not be fed back to the original shapefile.

1) If the coordinate system or projection of your shapefile is not WGS84, the system will attempt to transform it to WGS84 coordinate system.

    We can not guarantee the accuracy of coordinate transformation and strongly recommend you to check whether the coordinate system of your shapefile is WGS84 before import. If not, we suggest you to transform your shapefile to WGS84 using other tools such as Quantum GIS and ArcGIS.

2) In order to reduce the data volume, the precision of latitude and longitude coordinates will be reduced to 6 decimal places in decimal degree which could is equivalent to 10 centimetre of positional accuracy.

3) In order to search collections swiftly, shapes whose areas are smaller than 20,000m^2 (equivalent to a 141m X 141m square) will be removed.

4) In order to remove points unnecessary for spatial matching and reduce the data volume, overlapping or adjacent shapes/points will be merged together.

5) For shapes with holes (see Fig. 4-5), all holes would be filled up.

6) Due to Google Maps' limitations, the maximum number of shape vertices will be limited to 500 per shape. If a shape exceeded this limit by default or by merging with adjacent shapes, the system would attempt

to reduce its vertices, which may collapse the accuracy and topology of the original geometry. The system uses Douglas-Peucker algorithm for vertex reduction.

7) In order to search collections swiftly, when the total number of vertices of all your AOIs exceeds 1000, the system will attempt to reduce the total as much as possible. The reduction may degrade the positional accuracy of your AOIs up to 200 metres. Note that this restriction will not be applied when importing shapefiles but searching the database.

The vertices of AOIs generated by means other than importing shapefiles (§4.1 ~ 4.2) would be also counted in this limitation (Each AOI circle created in §4.2 have 38 vertices).

4.3.3. How to Change the Coordinate Systems to WGS84.

Although BSPC can transform the coordinate system of shapefiles to WGS84, we recommend you to use other applications to prepare your shapefile in WGS84. This section introduces you an example of converting a shapefile in North American Datum 1927 (NAD27) to WGS84 using a free GIS application called Quantum GIS.

A) Start Quantum GIS and CLICK ![button] button to open "**Add Vector Layer**" window (Fig. 3-22).

If you can not find the button, click "**View**" on the top of the window and go down to "**Toolbars**" in the menu and make sure that "**Manage Layers**" is checked.

B) In the dialogue box, CLICK "**Browse**" button in "**Source**" section and choose the shapefile you want to use in BSPC Web Map Interface. Leave other settings as default and CLICK "**Open**" (Fig. 3-22).

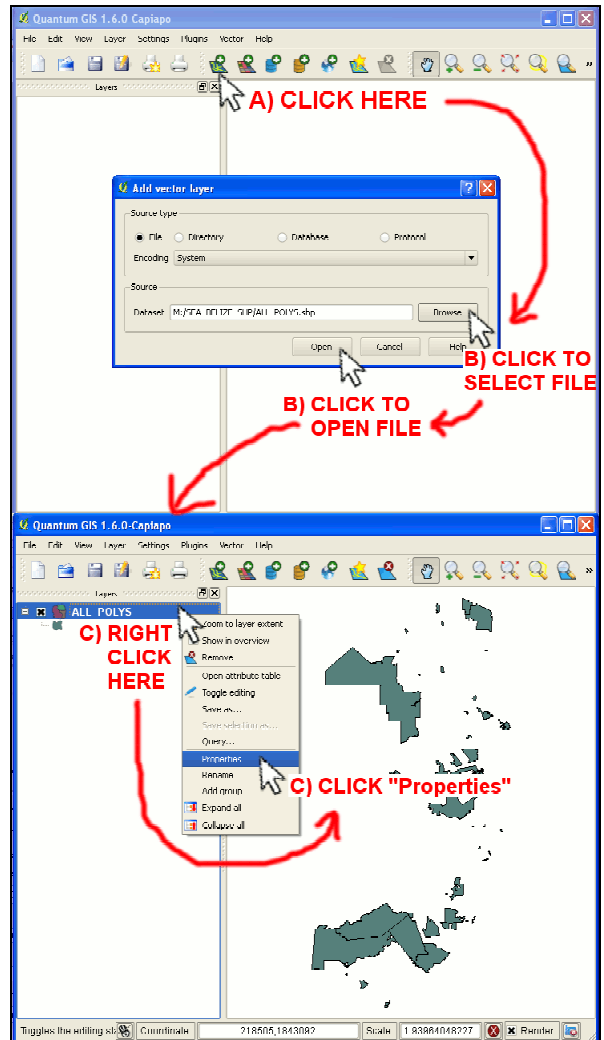Then, the name of your shapefile would appear in "**Layers**" panel. If you can not

Fig. 3-22

find the panel, click "**View**" on the top of the window and go down to "**Panels**" in the menu and confirm that "**Layers**" is checked.

C) In "**Layers**" panel, move your mouse cursor over the file name you opened and CLICK THE RIGHT MOUSE BUTTON. Then seek "**Properties**" in the menu and click it (Fig. 3-22). Then, "**Layer Properties**" window will open.

D) In the layer property window, CLICK "**General**" in the left hand menu. Then click "**Specify CRS**" in "**Options**" section to open "**Coordinate Refer-ence System Selector**" window (Fig. 3-23).

E) In the top list of the CRS selector window, you would find that a particular item is coloured in navy (Fig. 3-23). If the "**Coordinate Reference System**" and "**Authority ID**" are "**WGS 84**" and "**EPSG:4326**" respectively, your shapefile DOES NOT NEED any transformation and you can stop the process here. IF NOT, keep following the steps.

CLICK "**OK**" to close the window.

F) In "**Layers**" panel, move your mouse cursor over your file name again and CLICK THE RIGHT MOUSE BUTTON again. Then, choose "**Save as…**" to open "**Save vector layer as…**" window (Fig. 3-24).

G) In "**Save vector layer as…**" window, click "**Browse**" button on the right of "**CRS**" label to open "**Coordinate Reference System Selector**" window again (Fig. 3-24).

H) In "**Search**" section of the CRS selector window, TYPE "*4326*" in the field and CLICK "**Find**" button. Please be sure that "**ID**" is selected in "**Search for**" dropdown list (Fig. 3-24).

Confirm that "**WGS 84**" is chosen on the top list and CLICK "**OK**".
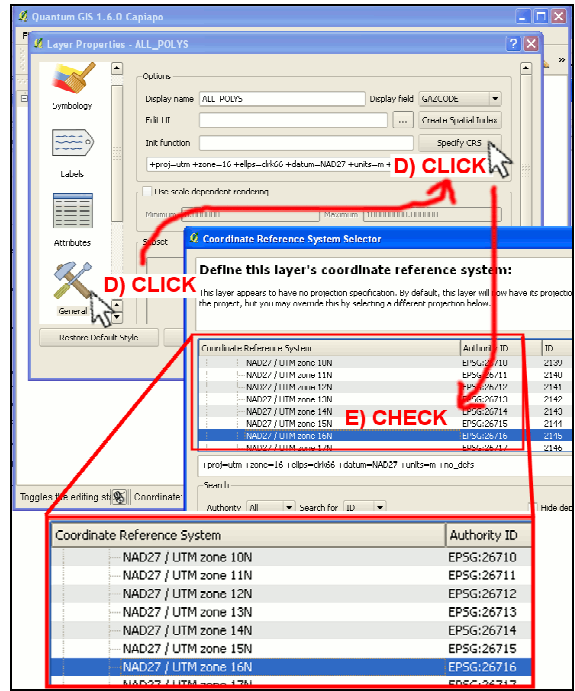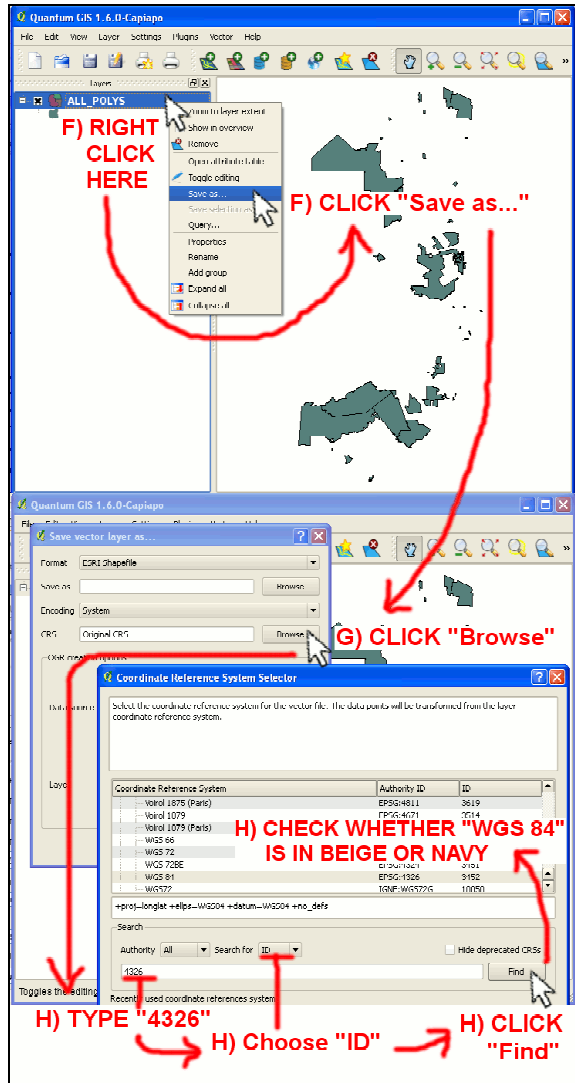
4326 is the unique code given to WGS84 by European Petroleum Survey Group (EPSG) in International

Fig. 3-23

Fig. 3-24

Association of Oil and Gas Producers (OGP) which has created a de facto standard code system to reference geographical coordinate systems in the world.

I) CLICK another "**Browse**" button on the right of "**Save as**" label and decide the name for your new shapefile transformed to WGS84.

J) Confirm that "**ESRI Shapefile**" is chosen in "**Format**" list on top of the window and CLICK "**OK**" button to start transformation.

How to import shapefiles to BSPC Web Map Interface is in §3.3.1.

4.4. Search by Multiple Areas/Points of Interest

You can use multiple areas of interest (AOI) chosen, drawn and/or imported by the tools in 4.1 ~ 4.3 at the same time to search botanical collections. AOI also includes the search domain circles around your points of interests (POI).

When you defined multiple AOIs, you would retrieve collections within AT LEAST ONE of your AOIs.

If you wish to search collections which are
   - outside of particular areas,
   - inside the intersection of two or more areas or
   - inside some areas except other areas
   - within certain distance from the borders of areas
please use the functions of GIS applications (e.g. union, intersect, differ, buffer etc.) to create the final shapes of your AOIs and export the shapes to our application via shapefile format (see also §4.3.).

Biodiversity & Environmental Resource Data System of Belize (BERDS) provides free shapefile data (country borders, districts, protected areas etc.) related to Belize, which are useful for creating your own AOIs.

BERDS: http://www.biodiversity.bz/

4.5. Combination with Keyword Criteria

You can use geographical search criteria with keyword criteria explained in chapter 3. In case of this, the system would search collections that match the keyword criteria within at least one of your AOIs.

5. Explore the Search Results

Once you set your search criteria properly and push the "**Search**" button, you would find the map populated with new pins which are the collections matching with your criteria.

This section explores how you can play with the search results.

5.1. What you see on the map

Fig. 5-1 shows the result of querying savanna plant collections found inside Rio Bravo Conservation Area which is coloured in pink.

On the top of the layer panel, a new layer named "Query *N*" (*N* is integer) appears and stores the result of your newest query.

On the map, the query results are plotted as pins. A pin may be linked to multiple collections because botanists often collect different plants in one place.

For the results of spatial queries, the pins are coded in four colours. The pin colours represent the confidence or certainty of spatial matching. In other words, the pin colour roughly shows the chance of whether each collection was found inside at least one of your areas of interest (AOI). Table 3 shows colour codes for the pins.
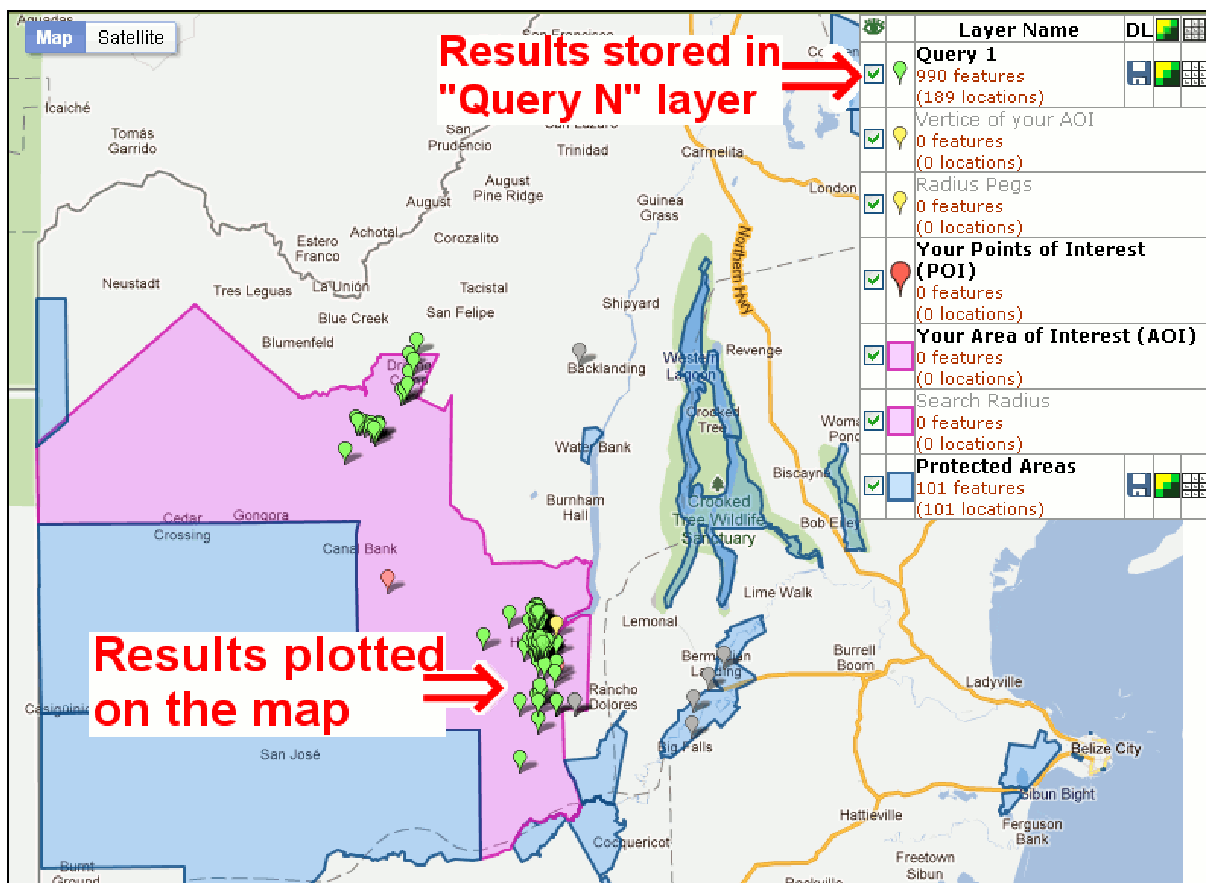

Fig. 5-1

Table 3: Colour-codes for pins used in spatial query results

Colour	Certainty (Probability of collection-found-there)
GREEN	Over 90% (Very sure)
YELLOW	70% ~ 90% (Sure)
RED	30% ~ 70% (Not confident)
GREY	Under 30% (Ignorable)

For the results of queries which consist of keyword criteria only, all the pins would be coloured in green. The others appear only when you search collections by geography.

5.2. Why are there Some Pins Outside Your Areas of Interest?

If you look Fig. 5-1 carefully, you would find out that there are some grey pins outside the AOI (pink shape).

This is not an error. It is because we store the collection locations not as points but areas.

Our collections date from 1890 to 2010. The collectors were professional botanists but land surveyors. The locations of modern collections are measured with GPS devices while the others are not known how they are measured. So the fact is we can not believe in latitude/longitude coordinates documented in historical collections.

For such collections, we attempt to estimate their collection site using textual descriptions like "*Western Highway, 8mi SW of Hattieville*".

These textual descriptions contain certain ambiguities. Given a collection whose location is documented as "*RioBravo Conservation and Management Area*", it is impossible to guess where inside the preservation area the collection was collected.

Hence, we defined areas instead of specific points as geographical footprints for historical collections. The system relies on an assumption that a collection is found somewhere inside its footprint but never outside.
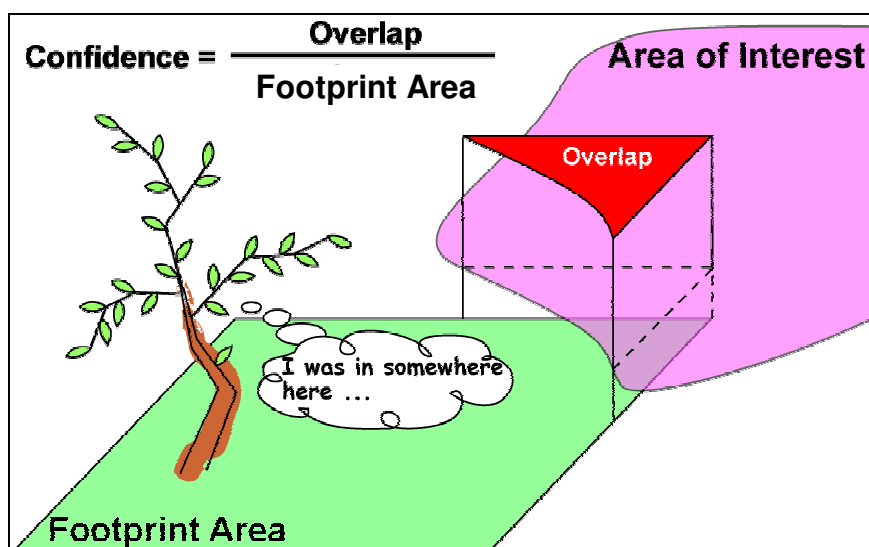

Fig. 5-2

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For searches by geography, the system attempts to find collections whose footprints overlap user's AOI and return the ratio of overlapping area as confidence (certainty) of spatial matching. (Fig. 5-2)

You may wonder what the locations of the pins mean. Generally, the pin locations are meaningful for modern collections whose locations are measured by GPS but historical collections. Usually, the pins of historical collections are placed on the centroids of their footprints. Though, we use pins to plot collections on the map shape because most footprint shapes overlap with each other and will make the map chaos and useless.

You can check the certainty of spatial matching as a collection property by following the steps in 5.3.

5.3. See the Collection Details on Map

BSPC Web Map Interface provides you the following information about each collection.

Table 4: Collection information provided on BSPC Web Map Interface

Attribute	Description
ID #	Identification number of the collection in our database.
Family	
Genus	The taxonomy of the collection plant.
Species	
Common names	Vernacular names of the collection plant
Collector(s)	Main (and assistant) collector(s) of the collection
Collection date	Date when the collection was made
Habitat	Comments on the habitat of the collection site
Determined by	Persons who determined the species of the collection plant
Determination date	Date when determination was done.
Determination Notes	Comments on determination
Country	Of course, "Belize"
District	The administrative district where the collection was found
Certainty of Spatial Matching	How sure the collection matches your criteria of geographical search. See §5.2. for further details
Location notes	Textual descriptions about the location of the collection
Documented latitude	Latitude and longitude values recorded in the collection as the collection location.
Documented longitude	
Mapping latitude	Latitude and longitude of the collection on the map. Because documented latitude and longitude are often inconsistent with the location notes, historical collections are sometimes mapped on a location different from the documented coordinates. See §5.2. for how mapping coordinates are calculated.
Mapping longitude	

To check the collection details,

A) CLICK a pin of your search results on the map. The list of collections found there will appear in a balloon (Fig. 5-3).

B) CLICK a list item in the balloon. Then you can see the collection details.

C) Among the properties, you will see that the names of collectors and determiners are shown in blue like the list items in B). By clicking these names, you can see the profiles of each person.

D)   To close the collection details, CLICK the list item you have clicked in B) again.

E)   To CLOSE the balloon, CLICK the ☒ button on the right shoulder of the balloon.
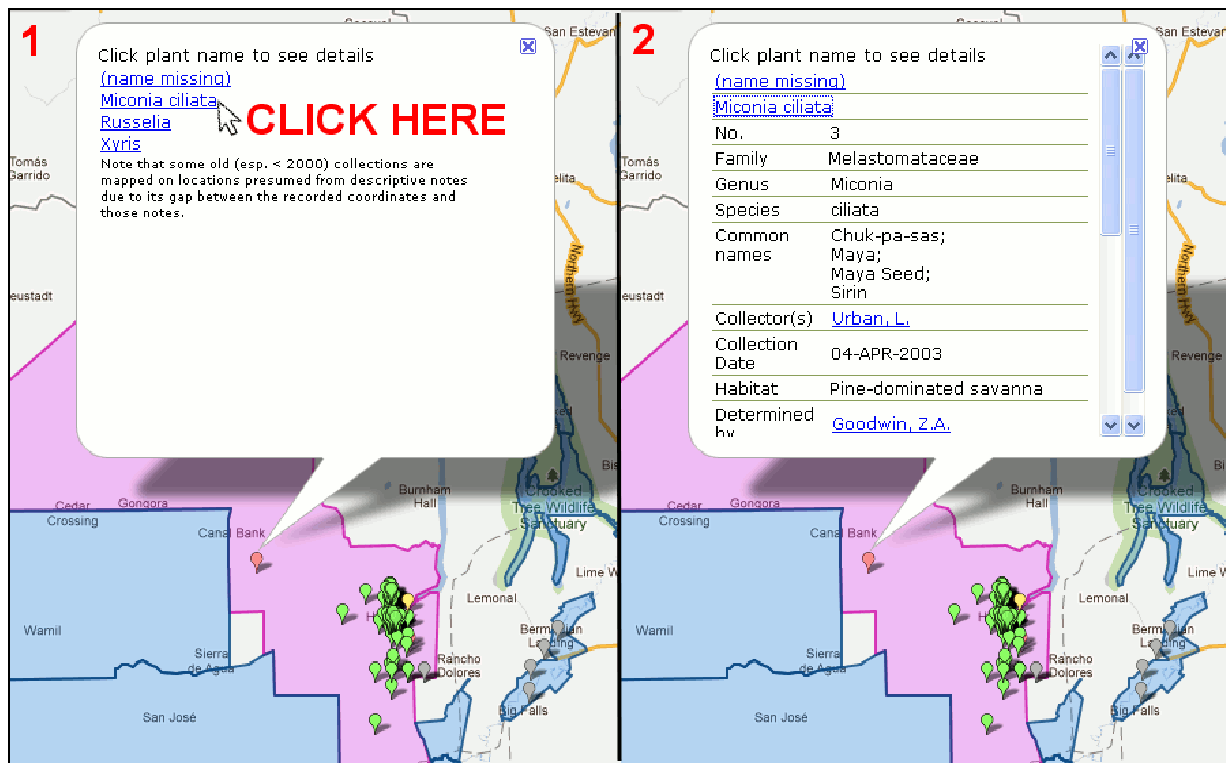

Fig. 5-3

5.4. See the Collection Details on a Table

A) By CLICKING ▦ button on the layer panel (Fig. 5-4), you can open the table of collections and their attributes on another window (Fig. 5-5). The collection attributes or columns available on this table are shown in Table4.

Fig. 5-4

B) If the layer has more than 100 collections, the table would be divided into multiple pages. To change the pages, use the buttons in the right bottom of the window (see the right-bottom corner of Fig. 5-5). Each button works as follows

> Next…Show the next page
>
> Previous…Show the previous page
>
> First…Show the first page
>
> Last…Show the last page
>
> Buttons with numbers…Show the page of the number.

C) The maximum number of collections in page is 100 but you may wish to display more in a page. To do so, click the dropdown list sitting in the top left of the table (see the upper left corner of Fig. 5-5). The allowed page sizes are 100, 200, 500, 1000 and ALL.
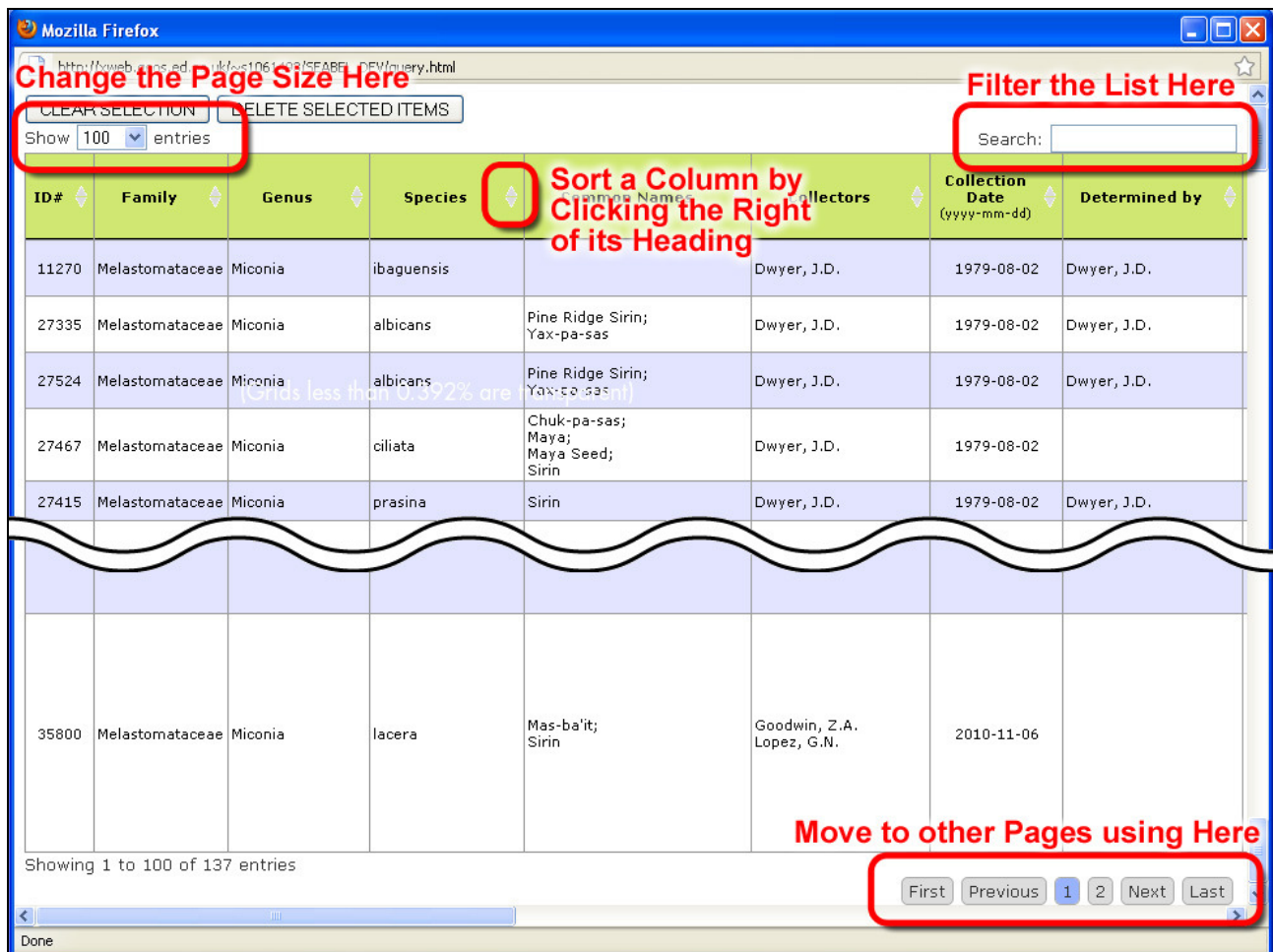

Fig. 5-5

D) You may prefer to change the order or sort the collections by particular columns (attributes). By default, the collections are sorted by the certainty of spatial matching.

To sort the table, click ◊ switch on the right of headings of your interested columns (see the centre of the top of Fig. 5-5). By clicking, the switch will change from ◊ to ▲ indicating that the column is sorted by ascending order. To sort by descending order, click the switch again. Then the shape of the switch will become ▼ indicating sorted by descending order.

You may wish to use multiple columns to sort the table. To do so, PRESS SHIFT key on your keyboard and CLICK all the switches of your interested columns. If you are not sure where SHIFT key is, see Fig. 4-12.

E) You can filter the list by keywords. To do so, type a keyword into "**Search**" field on the right shoulder of the table (see the upper right corner of Fig. 5-5). Then, you can browse only the collections containing your keyword in any place.

The list view is powered by Datatables (http://datatables.net/) which is a very powerful open source module developed by Allan Jardine.

5.5. Remove Particular Collections from your Search Results

You may wish to remove particular collections like those whose certainty of spatial matching are low from the layer of search results. To do so, …

A) Open the collection table of the layer you want to manipulate following step A) in §5.4.

B) CLICK a row of the table to select the collection that you want to remove.

C) To select multiple collections for deletion, HOLD CONTROL (CTRL) key PRESSED and CLICK the rows. If you are not sure where CTRL key is, see Fig. 4-3.

D) CLICK "**DELETE SELECTED ITEMS**" button on the left shoulder of the table. Then, the selected collections would be removed from the layer (Fig. 5-6).

Fig. 5-6

Note that because pins on the map are often tagged to multiple collections, you may find no changes on the map by this. Pins would only be deleted when all linked collections are deleted in the list view.

In addition, this deletion process would only affect the result data of your query and do nothing against the top copy in our server.

5.5. Analyse the Occurrence of Species

You may wish to see the occurrence of particular species basing on our collections. Our application provides a tool which enables you to generate a grid of probability distribution or occurrence of particular species.
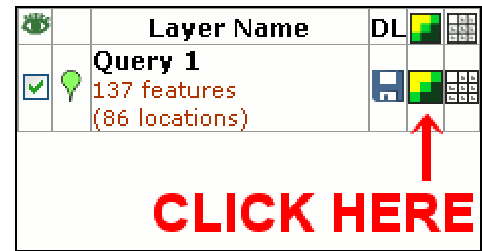

Fig. 5-7

A) MAKE A LAYER of collections of particular species using our keyword search functions (see also §3.1. ~ 3.2).

In this section, we take an example of a layer which consists of collections of *Miconia* genus.

B) CLICK button on the layer panel, then "**Coverage Map Generator**" window will appear.

C) Select the grid interval from "**Resolution (grid interval)**" dropdown list (Fig. 5-8). The listed intervals are defined in degree, minute or seconds. The approximate size of each interval is also noted.
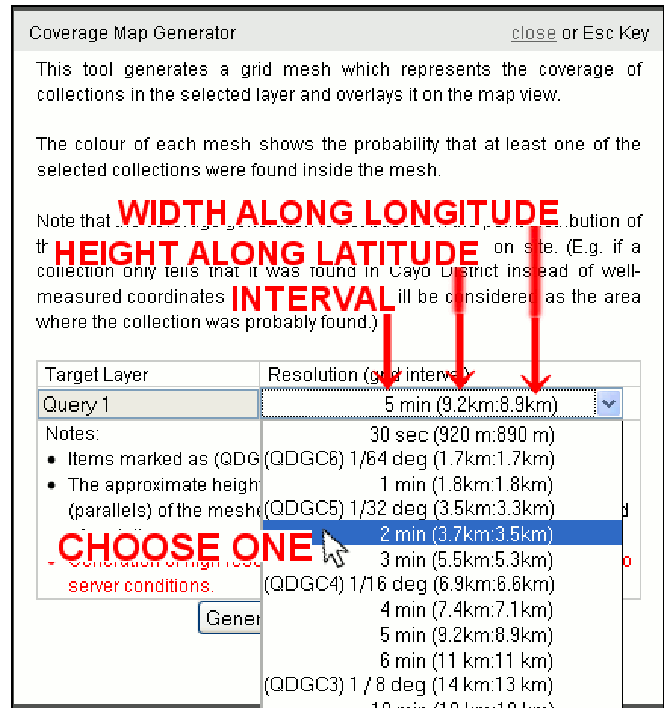
Note that when the grid interval doubles, the processing time would quadruple. We recommend you not to choose from intervals smaller than 5 minutes (default value) because it may consume hours of time.

Fig. 5-8

D) Once you select the grid interval, CLICK "**Generate Coverage**". After a while, a new layer named "**Query *N* Coverage**" (*N* is an integer) will appear on the map (Fig. 5-9).
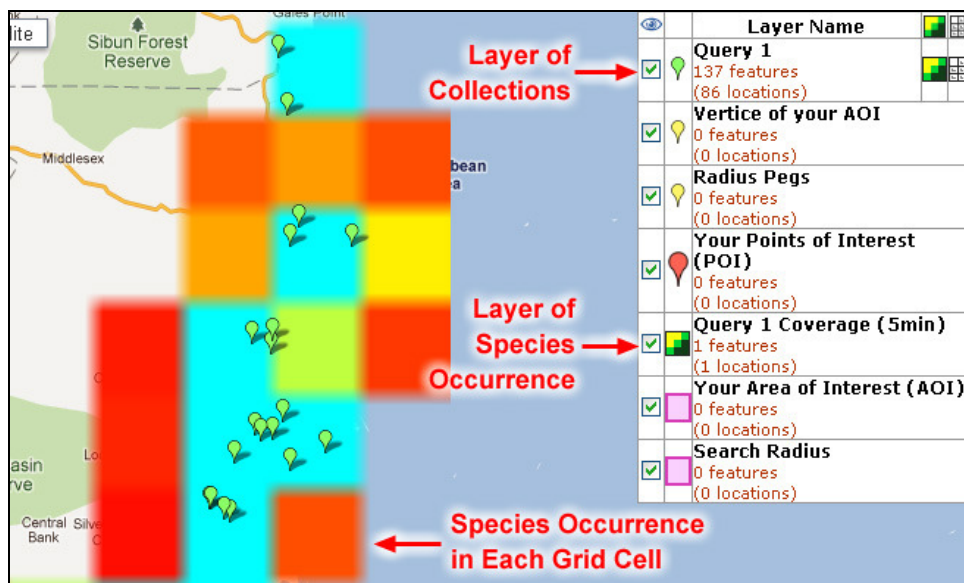

Fig. 5-9

E) The colour coding of probability distribution is shown in Fig. 5-11. You can also open the same chart by
    CLICKING ▪ on the left hand of the coverage layer in the layer panel (Fig. 5-10).
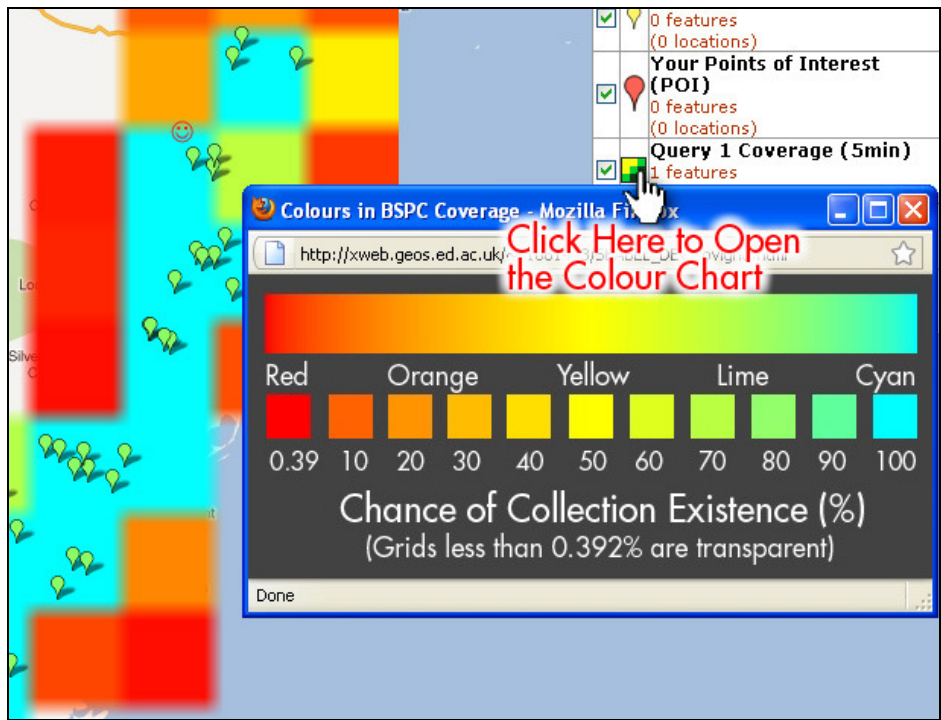

Fig. 5-10

Fig. 5-11

5.6. How is the Occurrence in Each Cell Calculated?

The colour of each cell generated in §5.5 represents how much chance AT LEAST ONE of the collections in a layer was found in the cell. When the layer consisted of collections of a species, the cell colour represents the occurrence of the species in the cell basing on botanist's collection.

Fig. 5-13 illustrates how the application calculates the probability for each cell. Each collection has a footprint area which is explained in §5.2. If a cell contained the whole footprint of a collection of a species, the occurrence of the species would be 100% at the cell (Fig. 5-13 (a)). If the cell and footprint intersected with each other and the intersection occupied 70% of the footprint area, the species' occurrence would be 70% (Fig. 5-13 (b)).

Fig. 5-13 (c) illustrates the calculation for cells intersecting with two or more footprints. In this case, the chance of "**no collections are inside the cell**" is the product of 30% and 60% which is 18%, so the chance of "**at least one collection is inside the cell**" would be 100% - 18% = 82%.
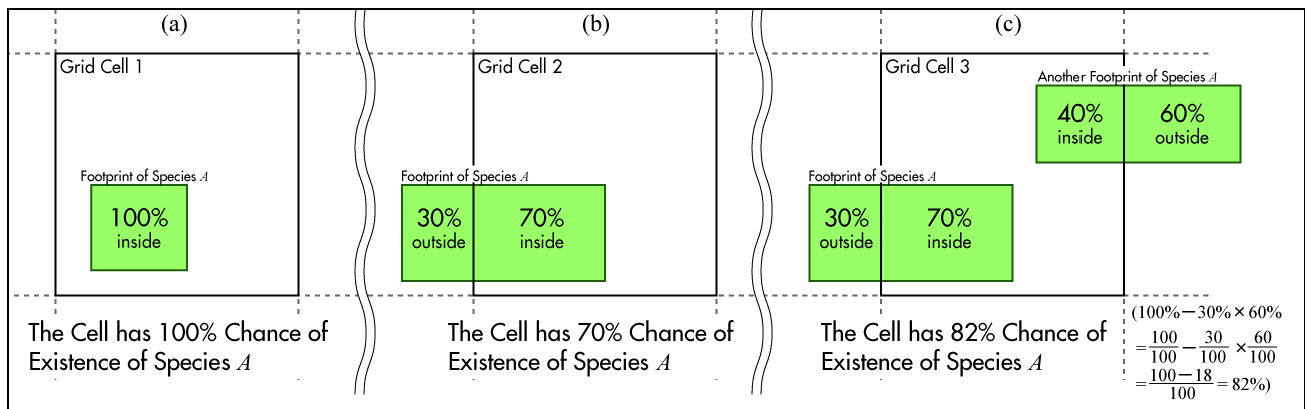

Fig. 5-13

For a grid calculated from a layer which consists of collections of single species, cells colourised in CYAN or GREEN has more than 70% of collection occurrence (see Fig. 5-11) and are likely to contain habitats of the species. RED and ORANGE cells say that the species occurrence are less than 30% in there, but this may occurs because the collection effort in these cells has been very low or none.

To remove biases from RED and Orange cells, you have to check whether they contain any savanna land patches or sufficient number of botanical collections. If a cell does not contain any savanna, the low occurrence could be reasonable. The data of savanna patches in Belize is available in SEA Belize Project website (http://www.eeo.ed.ac.uk/sea-belize/) (Cameron I.D. et al 2011).

6. If You Have Any Questions about BSPC Web Map Interface

Contact us through the following addresses.

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   Go Sato

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References

Cameron I.D., Stuart N., Goodwin Z.A. and Moss D. 2011

The Savanna Ecosystems Map of Belize 2011

Savanna Ecosystem Assessment Belize. http://www.eeo.ed.ac.uk/sea-belize/savanna_map.html

Meerman J.C. 2010.

Belize Basemap (boundaries, districts)

BERDS. http://www.biodiversity.bz/downloads/disclaimer.phtml?dcid=121364

Meerman J.C. 2011.

Belize Protected Areas (Polygon) Dataset (2010)

BERDS. http://www.biodiversity.bz/downloads/disclaimer.phtml?dcid=100053

Meerman J.C. 2011.

Belize Settlements (Point) Dataset

BERDS. http://www.biodiversity.bz/downloads/disclaimer.phtml?dcid=13