

Arizona State University  
GIS Manual  
for use with the  
Lower Colorado Basin  
Fish Database

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## Summary

In 1994 W.L. Minckley embarked upon building a GIS database of western North American fishes. Parts of this database are now sufficiently complete to be released publically to allow others to use this resource towards improving the management of the unique native fish resources in this region. Two databases have been produced, a point and a summary database. The point database consists of almost 36,000 individual records of native and introduced fishes for the Lower Colorado River Basin. The summary dataset being released is a user friendly version of the point database summarized by watersheds and river reaches. This document provides the background to both datasets, e.g., what they were constructed from, their geographic extent, limitations, and a guide to using this data with ArcView.

## Acknowledgements

Funding to produce this document and the summary dataset was provided by the US Bureau of Reclamation and the US Fish and Wildlife Service. Funding to compile the original point dataset came from American Rivers, US Bureau of Reclamation, US Forest Service, US Fish and Wildlife Service, and the National Science Foundation over the period of 1994-2002.

The following museum collections allowed us to incorporate data from their holdings into the database: Academy of Natural Sciences of Philadelphia; American Museum of Natural History; Arizona State University; California Academy of Sciences; Cornell University; Field Museum of Natural History; Florida State Museum; Museum of Comparative Zoology, Harvard; Museum of Southwestern Biology, Albuquerque; New Mexico State University; Oklahoma State University; Texas Natural History Collections UT Austin; Tulane University; US National Museum of Natural History; University of Alabama Ichthyology Collection; University of Arizona; University of Colorado; University of Michigan Museum of Zoology; University of Nevada, Las Vegas; University of Nevada, Reno; University of Washington. The Arizona Game and Fish Non-Game Fish Branch (AZGFNGFB) generously provided a copy of their internal database.

Thanks to Rob Clarkson, Paul Marsh, Rachael Remington, and Mike Schwemm for comments on earlier drafts.

A final special thanks is due to Jana Fry-Hutchins. She was the GIS brains behind the original project, and has been extremely helpful ever since.

## Introduction

This project was initiated by W.L. Minckley who saw a need to integrate existing data for southwestern fishes into a single database. Once assembled, this database could be used to examine the decline and conservation priorities for this imperiled fauna, as well as to look at various other questions relating to their biogeography, ecology, and evolution. This effort began formally in 1994 with a project funded by American Rivers to examine fishes in the Gila River Basin. As was typical for Minckley, he rapidly expanded this effort to include most of the Lower Colorado River Basin, and a graduate student, Heidi Blasius built a database for northwestern Mexican drainages as well. Over time, various agencies have contributed to this effort in various ways from funding to supplying data resulting in the current version of the dataset.

## Database Content, Completeness, and Errors

The goal of the database is to provide complete coverage of fish occurrence in the southwestern USA and northwestern Mexico. The data sources include museum specimens, primary and gray literature, and the Arizona Game and Fish Non-Game Fish Branch (AZGFNGFB) database.

No database is ever complete, and this is no less true for this one. In terms of museum records probably > 99% of all records were incorporated. For primary literature this is considerably less, although much of the older primary literature typically is duplicated by specimens and hence already included. Virtually no primary literature after 1973 has been incorporated, although this likely represents only a few unique records. Only a fraction of the available gray literature has been included. The AZGFNGFB provided their database as of mid 1999 and was included. A listing of primary and gray literature which has been included can be found in Appendix 2.

After missing records, incorrect ones are the next biggest problem. In some cases specimens may be misidentified, but these at least can be rechecked at a later time. If no specimens exist then the identification cannot be verified and has to be taken at face value. Other errors also may exist that were introduced when data were manipulated or added into our database. Furthermore, errors could exist in the digitizing of points that result in a record being put at an incorrect geographic location.

For completeness sake, a few native fish records that were lacking in the point database, but are known to be present, were added to the summary database. These are listed in Table 1. These are from areas with few modern museum specimen collections. *Cottus "bairdii"* was only recently discovered within the White River Valley, hence the lack of records. Its taxonomic status is yet to be fully resolved. Many other "gaps" in the database exist, although these usually affect widespread species that are undoubtedly still present. Our modern coverage of federally listed species is complete and up to date.

Table 1. Native fish records not in the point database, but added to the summary database as post 1981 records.

species	location	watershed number (field: unique_id2)
<i>Cottus "bairdii"</i>	Lower White River	6
<i>Pantosteus clarki</i>	Lower White River	6
<i>Rhinichthys osculus</i>	Lower White River	6
<i>Crenichthys baileyi</i>	Middle Moapa River	95
<i>Rhinichthys osculus</i>	Middle Moapa River	95
<i>Catostomus latipinnis</i>	Upper Virgin River	67
<i>Pantosteus clarki</i>	Upper Virgin River	67
<i>Xyrauchen texanus</i>	Lake Mead	98

For introduced fishes some entries in the database were problematic due to a lack of identification (e.g., *Lepomis* sp.) or for having been identified as hybrids. Records of these introduced fishes were arbitrarily reidentified as the most common representative of that genus. Table 2 documents the species and number of records changed.

Please notify Peter Unmack of any errors you may find via email, peter.unmack@asu.edu.

Table 2. Reidentifications of problematic records of introduced fishes.

Original designation	# of records	reidentification
<i>Ameiurus</i> sp.	20	<i>natalis</i>
<i>Ictiobus</i> sp.	1	<i>cyprinellus</i>
<i>Ictiobus</i> hybrid	1	<i>bubalus</i>
<i>Lepomis</i> sp.	41	<i>cyanellus</i>
<i>Lepomis</i> spp.	2	<i>cyanellus</i>
<i>Lepomis</i> hybrid	6	<i>cyanellus</i>
Centrarchidae hybrid	38	<i>cyanellus</i> , 1 as <i>macrochirus</i>
<i>Oncorhynchus</i> sp.	32	<i>mykiss</i>
<i>Oncorhynchus</i> hybrid	7	<i>mykiss</i>
Salmonidae hybrid	61	<i>mykiss</i>
<i>Oreochromis</i> sp.	29	<i>mossambica</i>
Cichlidae hybrid	2	<i>mossambica</i>
<i>Poecilia</i> sp.	7	<i>latipinna</i>
<i>Pomoxis</i> sp.	21	<i>nigromaculatus</i>
<i>Richardsonius</i> sp.	1	<i>balteatus</i>
<i>Tilapia</i> sp.	5	<i>zilli</i>
<i>Xiphophorus</i> sp.	1	<i>maculatus</i>

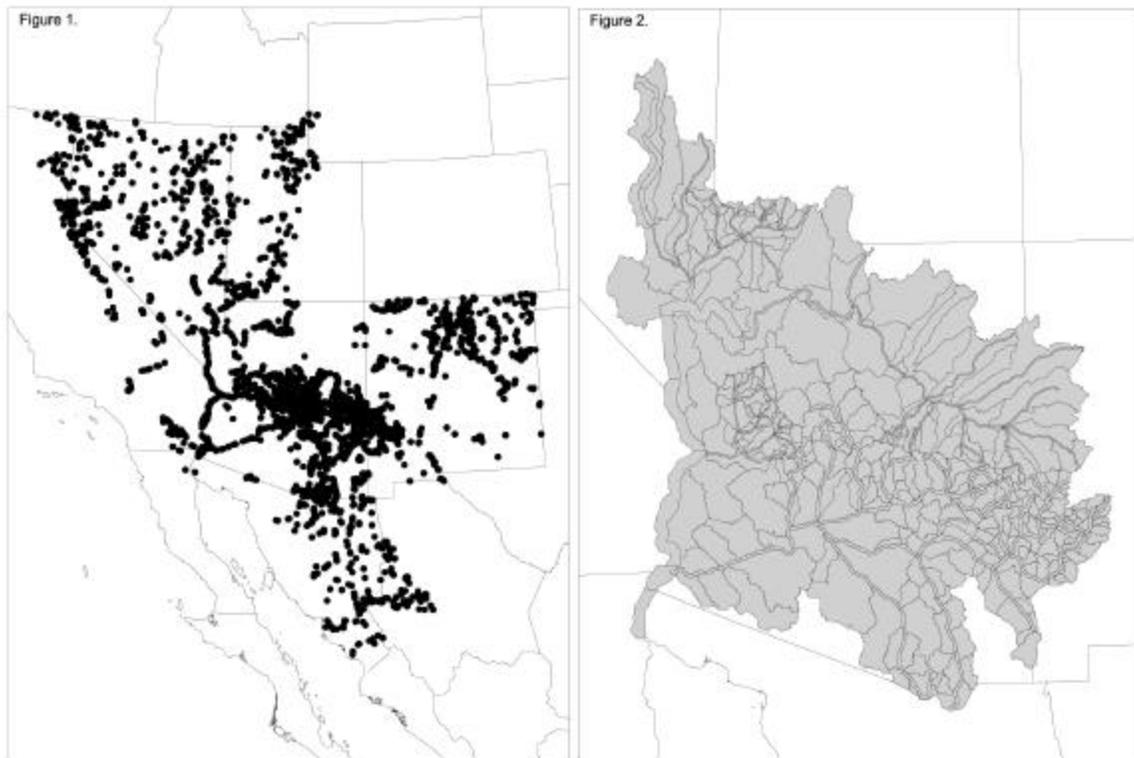
## Geographic Coverage

The point database (Figure 1) has mostly focused on the Lower Colorado River Basin (minus Salton Sea, California) and the northwestern Mexican drainages (from the Mayo River north). Both datasets are considered largely complete based upon the data in hand (see Database completeness and errors for further explanation). The point database is also partially complete for all of the Great Basin and New Mexico based upon museum records.

All of the Lower Colorado Basin except the Salton Sea has been included in the summary database (see Figure 2). Great Basin and New Mexico data are too incomplete to release, and will not be completed in the foreseeable future.

Figure 1 (left). Point database showing all records

Figure 2 (right). Geographic coverage of the summary dataset showing individual watersheds.



## Point Database

Original output obtained from various museums were brought into Excel and manipulated to make it compatible with our database. Primary and gray literature were entered by hand. Fields were added containing data on the river basin each record occurred in, and whether the record was native, introduced, native reintroduced, native archaeological, or captive (e.g., hatchery stock). These data then were digitized from 1:250,000 USGS topographic maps. All records were checked based on drainage information and visually to identify incorrect points. Based on random inspection of the data most points fall within 1 km of their actual true geographic locality. The Lower Colorado Basin portion of the point database from which the summary database (see below) was constructed contains 19,369 native fish records and 16,339 exotic fish records.

## Summary Database

The summary database was constructed by a series of scripts which summarized species occurrence by watershed and combined them all together into a single GIS coverage. Watersheds were designated somewhat arbitrarily, areas with smaller catchments and many native fish records were split up, areas with few or no native fish records tended to be larger. Overall, the watersheds were a compromise between having hundreds of little watersheds which is very cumbersome versus having large watersheds with little ability to discriminate where the fish occur. Data are provided for all native fishes covering all records, (1840 through 2001) and current records, [1981 through 2001 (except *Oncorhynchus gilae*, 1999-2001 and *O. apache* 2001 only)]. Nine archaeological records were also included (Miller 1955, Minckley & Alger 1968). All records for exotic fishes that are still present today are included. No native fish reintroductions are included. Perennial stream and land use coverages for Arizona were obtained from ALRIS (Arizona Land Resources Information System). These data are not considered accurate, or complete, and are included only as an approximation. See Appendix 1 for specific details on the data fields within the GIS coverage.

## **How to Use the GIS Summary Database**

This section outlines what software is required to use the data, the conventions used in this text, software definitions, how to bring the data into ArcView, and how to manipulate and export data. Finally, two specific examples of how to manipulate the data are given.

The goal of this manual is to provide basic information on how to use this file. It is written such that someone without prior knowledge of the software can work with the dataset in at least a basic manner. I have tried to write this in such a way as to go beyond using this one dataset. Once you are familiar with the conventions and terminology, you should be able to jump in at almost any point within this document. This comes at the cost of some repetition. I have also tried to mention aspects of the software or include hints that are useful when using ArcView beyond the general scope of this dataset. Some aspects of this write up will seem strange the first time you read them, however, once you reach the end and have worked through the dataset in ArcView, most of it should make reasonable sense.

### **What software do I need?**

ArcView is required to view the summary dataset. This document is written based upon ArcView 3.x.

### **Information on the summary dataset file type and format**

This dataset, in GIS language, is in the format called a shapefile. In ArcView language a shapefile is also referred to as a theme. A shapefile always consists of three separate files (but can also have as many as seven additional files). Each of the separate files always has the same name, but different extensions, e.g., .shp, .shx, and .dbf. The first two store geometric data for features in the shapefile and the last has information on the data attributes for the features. It is important that you do not delete or overwrite any of these files. ArcView exports data tables in .dbf (dbase) format, and if you overwrite the existing copy of the .dbf file, the shapefile will be corrupted and data will be incorrect. A simple way to avoid this problem is always save any exported tables into a different directory than your shapefiles.

## Conventions used in this document

**Go** - indicates go to the menu item as listed across the top of the program, e.g., file, edit, view, etc. (Figures 3 and 4). Subsequent items under that menu are listed after a hyphen. The entire statement is in italics and single quotations, e.g., '*go file-new project.*'

Popup box names are capitalized, e.g., Field Calculator Box. Text strings on buttons within popup boxes or within the boxes themselves are enclosed in double quotes, e.g., "new set," except in situations such as ok or yes buttons.

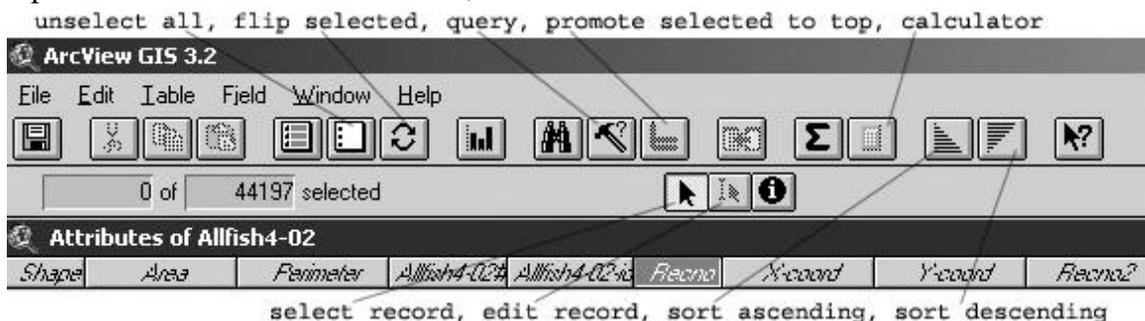
Equations or queries to be entered into the Field Calculator Box or Query Box are enclosed in double quotes, e.g., "[Agch0001]\*2)". Do not include the quotes when entering the equation or query.

Some menu items and popup boxes are available as shortcuts via buttons found in two rows below the menu items (Figures 3 and 4). In this document I always refer to the menus for commands, but Figures 3 and 4 are a guide to the equivalent buttons that can also be used. If you hold the mouse pointer over these buttons the name of the button will appear in the bottom left corner of the program (some names are slightly different to those given in Figures 3 and 4 due to space limitations).

Figure 3. Menu and button guide when displaying a view in ArcView.



Figure 4. Menu and button guide when displaying a table in ArcView. The lower row represents the fields within the table, *Recno* is the active field.



## Definitions and hints

**Theme** - graphical representation of the data. It may be in the form of a shapefile, grid, Arc/Info coverage, image, etc.

**View** - the window which displays themes.

**On** - To visualize a theme once it is brought into a view, you must turn it on by clicking in the small box directly to the left of the theme's name along the left side of the view. A checkmark will indicate whether the theme is turned on or not.

**Table** - spatially referenced data in a dbase file. It contains all the data associated with the theme.

**Record** - Rows in the table representing data to describe a single incident within the database. Record data runs from left to right in rows.

**Field** - Columns in the table representing a particular aspect of the data table. Field names are located along the top row of the table.

**Legend** - represent the table of contents of the theme (field names and values from its data table) and how they are displayed within a view or layout. A theme's legend is found on the left side of a view and can be altered by double clicking on the themes name.

**Active** - a theme or table field must be active to perform operations on it. This can include editing, saving as, or undertaking other actions such as zoom to theme or display properties.

To make a theme active, click once on the theme's name on the left side of a view (not the on/off checkmark box).

To make multiple themes active, hold down the shift key while you click on additional themes.

To make a field in a table active, click on the field title, and it will appear darker than the other field titles.

I also use the term active for a view or table, this means bring it to the front within ArcView.

To make a project, view, table, or layout visible (assuming it is already open) use '*go window-<its\_name>*' to bring it to the front. If it is not already open, make the project window visible, '*go window-<the\_project\_name>*,' click the appropriate icon (e.g., view, table, etc.) to bring up a list, then double click on the desired item from that list.

Whenever editing values within tables (and some popup boxes, but none used here) via the keyboard, always hit enter, or click on another cell to complete the edit, otherwise your last edit will be lost.

## **Bringing the shapefile into ArcView**

### **Extracting the shapefile**

From cdrom

Make a new directory on your hard drive and copy all files from the cdrom to the new directory. Select all of the newly copied files, right click the mouse button and select properties, then deselect the read only check mark towards the bottom.

From the website, <http://www.peter.unmack.net/gis/fish/colorado>

Right click on the file and choose save to disk or open. If you choose open, and have winzip installed your machine, it will automatically open the file. If you choose save, double click the file once saved and this will start winzip.

Winzip

Within winzip, click extract, and choose a directory to put the files to. If you do not have winzip, go to [www.winzip.com](http://www.winzip.com) and download a trial version. Once winzip is installed, double click on the coloradofishes.zip file and follow the instructions above.

### **Starting ArcView and opening the shapefile**

The next step is to start ArcView and open a new project. If you are not prompted to start with a new project then *'go file-new project.'*

Within the project window click on the view icon, then click on "new" or double click the view icon. All work within ArcView is conducted within a project file.

Next *'go view-add theme,'* select the directory containing the unzipped shapefile, click on coloradofishes.shp, then click ok. This adds the shapefile to the view and makes it active. Click once in the small box beside the theme name to turn it on (display it graphically).

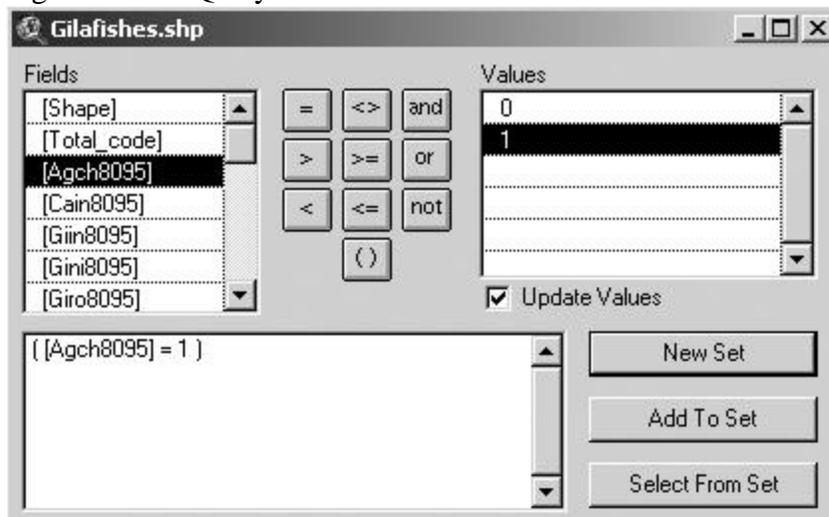
## Manipulating the appearance of themes

When first brought into a view, a theme is given certain default properties and a random color. The coloradofishes theme will need to have its display manipulated in order to be able to visualize any of the data within it. The display can be manipulated by either the Query Box or the theme's Legend Edit Box. The Query Box allows you to visualize one or a combination of values in a field, but can only display in one color. The Legend Edit Box allows you to visualize the contents of a field in multiple ways. The first section explains how to use the Query Box and change the selection color, the second explains how to alter the appearance of the theme via the Legend Edit Box.

### How to use the Query Box

The Query Box (Figure 5) operates on values within the data table. By running a query you select certain records in the table equal to your query. These selected records are then visualized by their associated features in the graphical display of the data in the theme. You can select a single value or a range of values using the Query Box as well as combinations of values within multiple fields. It is also possible to add two queries together ("add to set") or query a set of already selected records ("select from set"). For the purposes of this dataset you likely only ever use the "new set" button.

Figure 5. The Query Box.



Helpful hint: Before undertaking a query on theme you may wish to change the display of the theme's legend (explained under the next heading). Usually one selects the transparent color option. That way, when you then run a query, only the selected features are highlighted with the selection color and everything else is transparent. This will become more apparent later.

*'Go theme-query'* brings up the Query Box with the name of the active theme on the title bar (Figure 5). The left side, called "fields," contains a list of fields from the table, the right side, called "values," shows values within a given field, and between them are various mathematical and Boolean operators (Figure 5). Make sure the small box beside the text "update values" is checked. When you single click on a field on the left side, all of the values within that field appear on the right side.

To display watersheds containing a given species

Double click on the field you wish to query (it will appear in the blank box).

Single click on the equal button in the middle section.

Select a value in the right side by double clicking it. (Note: values can also be typed in via the keyboard, or via copy and paste.)

Click on "new set" (it will perform the query and the display will update in the view).

Watersheds with the selected value from the query are now colored with the selection color. If you are doing regular queries, move the Query Box to the edge of ArcView until you need it again, otherwise close it.

To change the selection color

*'Go window-untitled'* (or the name of your project if you have saved it).

*'Go project-properties'* to bring up the Project Properties Box.

Click on "selection color," choose your color and select ok

Click ok to close the Project Properties Box.

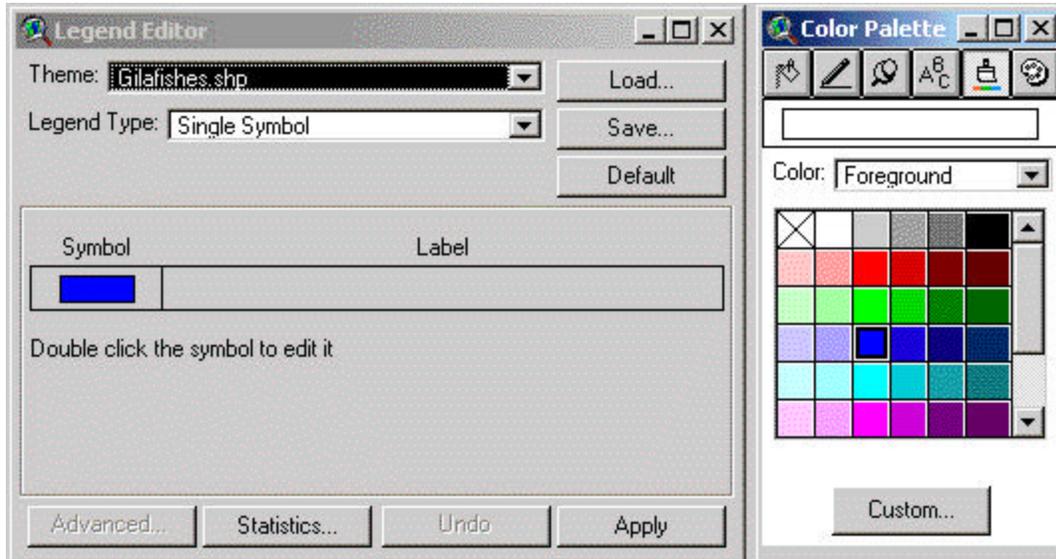
To go back to the view *'go window-view1.'* The change in the selection color will be reflected in the selected features of the theme.

Now unselect all features, *'go theme-clear selected features.'*

## How to alter a legend's properties via the Legend Edit Box

The second way to view data associated with the theme is to alter the legend of a theme. As mentioned above under Query Box, it is often useful to make the color of a theme transparent. The first section outlines how to do this, latter parts demonstrate slightly more complicated uses of the Legend Edit Box.

Figure 6. The Legend Editor Box and Palette Box. As you click on different colors within the color palette box the color in the box under symbol also changes.



Double click on the desired theme's name on the left side of the view (not in the on/off checkbox, but out to the right side of it). This brings up the Legend Editor Box (Figure 6).

Double click on the colored box under "symbol." This brings up the Palette Box. Click on the little paintbrush along the top (second from the right, Figure 6), this shows the color selection.

Click on any color in the Palette Box, then click on the top left color box with an X through it, this makes the color transparent (i.e., no color). You will see the colored box in the Legend Editor has lost its color.

When you have finished selecting the color, click "apply" at bottom right of the Legend Editor Box.

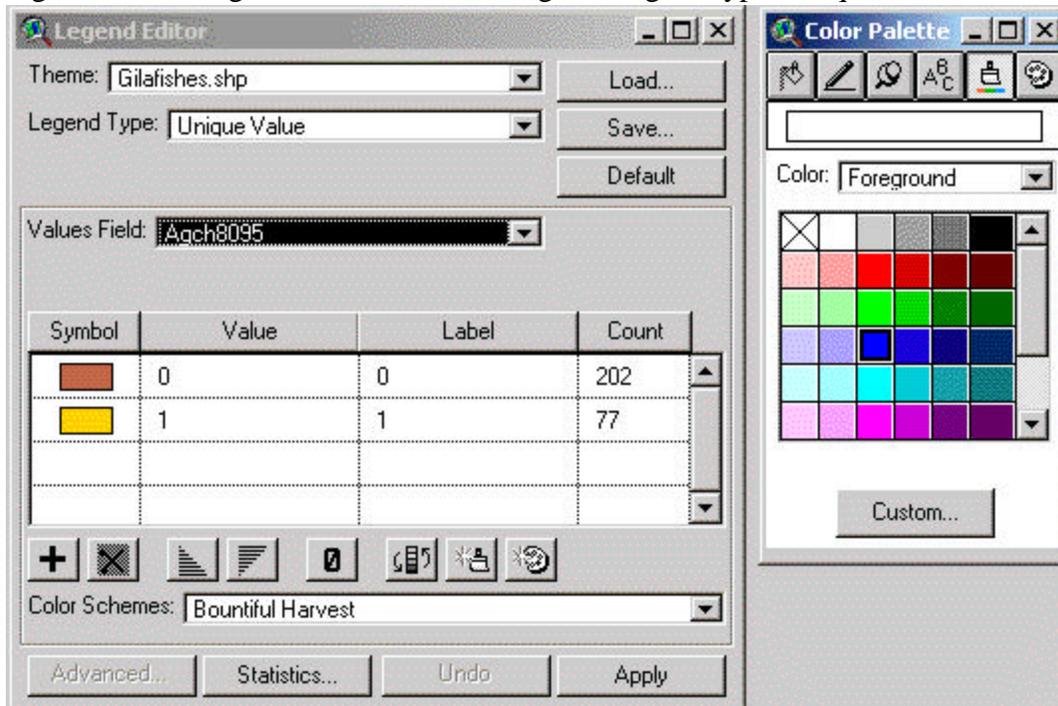
You can either close or move both boxes so they no longer obscure the view, or close them if no longer needed.

All you now see is the outline of the watersheds.

Now when you run a query on the theme, only the selected features are colored.

An alternative method to using the Query Box for visualizing fields and their associated values is to set the field to display the data by (Figure 7).

Figure 7. The Legend Editor Box showing the "legend type" unique value.



Double click on the desired theme on the left side of the view to bring up the Legend Editor Box.

On the second drop down menu from the top ("legend type"), select unique value (Figure 7).

A third drop down menu will appear ("values field"), select the field of interest.

To change the shading or color, double click on one of the boxes under "symbol" to bring up the Palette Box, you can only alter the boxes one at a time. Once you have altered one box click on the second and make your selections in the Palette Box.

When your selections are complete click on "apply" at bottom right of the Legend Editor box.

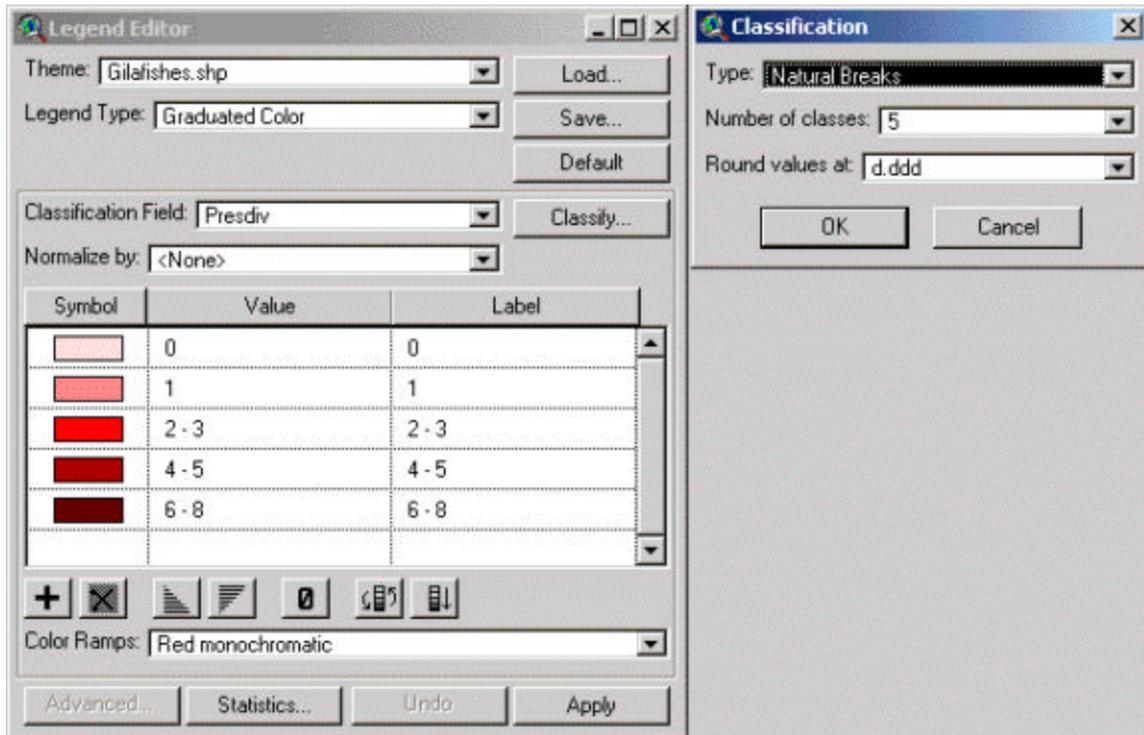
You will now see that by the theme name on the left side of the view there are two colored boxes each with a label.

Close or move both popup boxes so they no longer obscure the view.

Helpful hint: In addition to being able to change the colors, you can also manually change the values represented by the box displayed and the label text in the sections to the right of the colored boxes within the Legend Editor Box (Figure 7). One usually only changes the values when using data classes (explained below).

A few fields within the coloradofishes theme have more than two values (e.g., Total\_rich, Pres\_rich, Thre\_rich, Per\_threat, Abs\_decl, Perc\_decl, Total\_exot, see Appendix 1 for an explanation of these fields). One way to display these is to follow the instructions as above and select graduated color as the "legend type" rather than unique value (Figure 8).

Figure 8. The Legend Editor Box showing legend type graduated color and the Classification Box.



Select the field of interest under "classification field," it will automatically display a series with even breaks.

The values of the series and labels can also be changed manually.

If you want to change the number of class (colored boxes), choose the "classify" button, fourth from the top right of the Legend Editor Box.

You can set the number classes to whatever value you prefer (Figure 8).

When you have finished your selections click "apply."

Once you have created a legend, it can be saved by clicking the "save" button in the Legend Editor Box. It will prompt you for a path and file name. To use this legend at a later date click the "load" button and select the legend file, it will then prompt you for the field, make your selection and click ok. Saved legends have a .avl file extension by default.

## Editing tables

There are five types of data editing within tables. An individual cell's value can be changed; selected values (either manually or via the Query Box) within a field can be recalculated; the entire field can be recalculated; individual records can be added or deleted; or individual fields can be added or deleted. The only editing types you should need to undertake on this table are adding new fields and calculating values in the new field based on selected records. How to perform both forms of editing are described below.

### Adding a new field

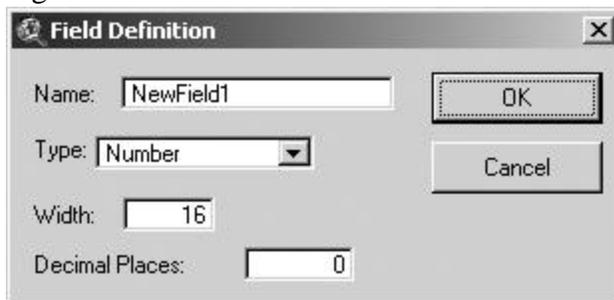
To view the table make the desired theme active, then *'go theme-table.'*

To edit the table first you have to set editing on, *'go table-start editing.'*

To add a new field *'go edit-add field.'*

It will pop up a Field Definition Box (Figure 9).

Figure 9. The Field Definition Box.



Enter a new name up to ten characters long, (you can enter a longer name, it will make an alias to the 10 character name, this is not too important unless you are exporting the table, otherwise both fields will have the same name in the exported table).

Leave the type as number if you want to do mathematical computations, or change it to string if you want to add text.

Make sure the field is wide enough otherwise values will be truncated, the default should be more than adequate for this file.

Decimal points should be unnecessary and can be left as zero.

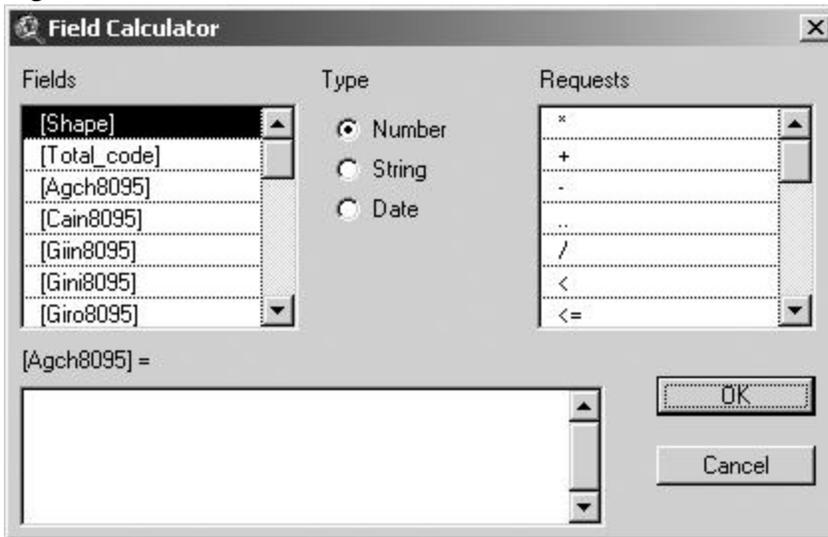
Click ok, this will add the new field with the name you specified at the end of the table.

Fields can also be deleted. Make the field active, then *'go edit-delete field,'* you will be asked to confirm its deletion, now the field is removed. Fields can be temporarily moved by clicking and holding down the mouse button and dragging them. Unfortunately, it is not possible to permanently change the position of fields. They all return to their original positions when the file is saved.

## Calculating values in a field using the Field Calculator Box

The Field Calculator Box (Figure 10) is used for calculating values in a field when editing a table. If any records are selected, the calculator will only change the values of those selected records. If no records are selected, it will change all values in that field. Any existing values will be replaced. It is usually wise to unselect all records first to be sure none are selected, *'go edit-select none'* (unless of course you deliberately want to edit only the selected records). Whenever conducting edits, it is always better to export the entire theme first as a backup, then conduct edits on the copied theme. Exporting is covered after this section.

Figure 10. The Field Calculator Box.



Make the field you wish to edit active.

Bring up the Field Calculator Box *'go field-calculate'* (Figure 10).

Add the equation to the blank box in the bottom. (Since it already incorporates [active\_field] =, only add the right hand side of the equation after the equal sign.)

To add formulas to the Field Calculator Box, double click on the items within the lists of fields and requests.

While the calculator can perform a wide range of operations, the only ones needed here would be addition, subtraction, division, and multiplication. Any number of fields can be strung together in an equation.

Remember to save your table periodically, *'go table-save edits.'* If you stop editing via *'go table-stop editing,'* you will be prompted to save the file irrespective of whether you made any changes or not. I do not recommend using save as, export a backup copy of the theme before editing it.

## Exporting data

There are three data types that can be exported, a table (dbase, text, or info), shapefile, or grid. Only the first two are covered here.

### Exporting a theme's table

In order to export a theme's table you must bring it into the project and make it active. This could involve several steps depending on whether the table or theme has already been brought into the project. The following instructions assume the theme whose table you wish to import is already contained within a view in the project.

First open the desired view with the theme whose table you wish to export, '*go window-<the\_project\_name>*,' click on the view icon, then open the desired view.

Within the view, click on the theme's name to make the theme active.

To bring the table into the project '*go theme-table*,' this opens the table and makes it active.

Once the table is active you can either export the entire table, or export some selected records. If any records are selected, only those records will be exported, if none are selected the entire table is exported. All fields are exported (you cannot export only a few fields).

To determine if any records are selected scroll up to the top of the table using the scroll bar on the right side of it then '*go table-promote*,' this brings all selected records to the top of the table.

Alternatively, if you don't want any records to be selected '*go edit-select none*' and it will unselect all records in that table.

The easiest way to select specific records is to use the Query Box, '*go table-query*.' Construct your query, click "new set," then the selected records are ready for export. An alternative is to click on a record, then hold the shift key down and select additional records, or you can select a series of adjacent records by depressing the shift key and moving the mouse up or down the table.

To export the data '*go file-export*,' this brings up the File Type Box.

Select the file type you want, click ok.

Choose the location and name to save the file.

A dbase file is probably the best format as it is easily opened within most spreadsheet programs. If you work upon a dbase file in another program be sure and save it to the program's format, as dbase files have strange quirks that should be avoided, otherwise you may lose any changes you make.

## Exporting a shapefile

In order to export a theme to a shapefile you must make it active.

To make the theme active go to the project window '*go window-<the\_project\_name>*,' click on the view icon, then open the desired view.

Within the view, click on the theme's name to make the theme active.

If any features are selected only those features and their associated records will be exported. To unselect all records '*go theme-clear selected features.*'

To export the shape file '*go theme-convert to shapefile.*'

Select the name and location and save the file.

ArcView will automatically ask if you want to add the new shapefile to the view.

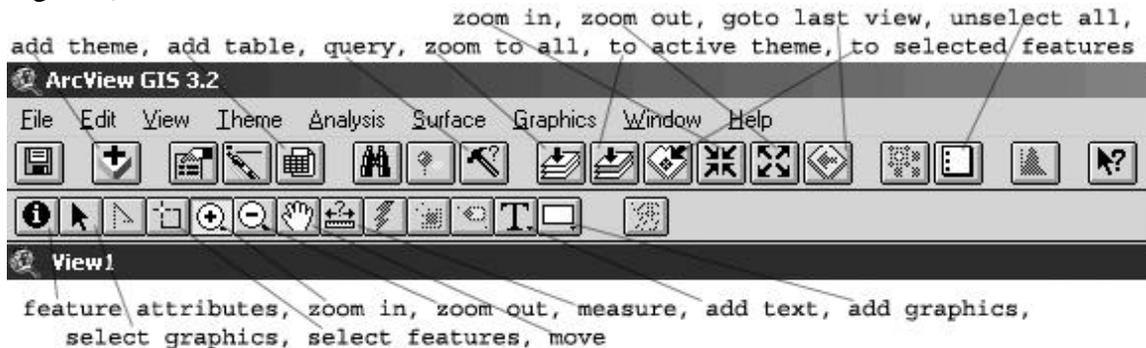
All fields in the table are exported to the new shapefile.

## Miscellaneous commands and useful information

### View extent

Within a view there are several ways to alter the extent of the view. This is achieved through buttons under the menus (Figure 11).

Figure 11. Menu and button guide when displaying a view in ArcView (this is a repeat of Figure 3).



From left to right and top to bottom they are:

- |                      |  |
|----------------------|--|
| zoom to all          | zoom to the extent of all themes in a view                                 |
| to active theme      | zoom to the extent of active themes  |
| to selected features | zoom to the extent of selected features or records within the active theme |
| zoom in              | zooms in by a given ratio from the center of the view                      |
| zoom out             | zooms out by a given ratio from the center of the view                     |
| go to last view      | return to the previous view extent   |
| zoom in              | either click or drag a box to zoom to that extent                          |
| zoom out             | either click or drag a box to zoom out                                     |
| move                 | drag the hand to move the extent of the view                               |

## **Feature attributes**

The feature attributes button provides a listing of attributes from the data table for the feature(s) you click on for an active theme within a view. No records are selected as in the Query Box. When a feature is clicked the Identify Results Box pops up. Once up, it can be resized or moved, when additional features are clicked on the attributes automatically update in the Identify Results Box.

## **Selecting features**

The select features button (4th from left, bottom row) is especially useful when editing a shapefile or selecting records in the table based upon their features. To select features of the active theme either draw a box or click on a specific feature. To continue to add to the selection hold the shift key down. You can also unselect features by clicking on them a second time when more than one feature is selected.

## **Editing shapefiles**

To edit a shapefile '*go theme-start editing.*' Use the select features button, the select graphics button, or the Query Box to select features. The various commands for cut, copy, paste, and undo are all available under the edit menu or via the usual keyboard commands. You can only edit one shapefile at a time. If you wish to copy some features to a new shapefile it is best to select them all at once and export those features to a new shapefile. Copying and pasting records to a new file often causes the data table attributes to be lost.

## **Measurement tool**

If you wish to use the measurement tool you first need to set the "map units" and "distance units" under view properties, '*go view-properties.*' These will vary depending upon the themes you are viewing. The units have to be correct, otherwise the values ArcView provides will be incorrect. For coloradofishes.shp set the "map units" to meters. You can set the "distance units" to whatever value you desire.

## **Projections**

It can be important to know the projection of a theme. If themes are projected differently they cannot be overlaid spatially. There is no easy way to reproject files within ArcView. Additionally, you have to know the existing projection of the theme in order to be able to project it to a new projection. Coloradofishes.shp has the following projection parameters: projection UTM; zone 12; units meters; spheroid CLARKE1866. To reproject this requires ArcInfo.

## Examples

I provide two examples to demonstrate some of the ways you can manipulate the data to change the way it can be displayed. This is achieved by making new fields and calculating values within the coloradofishes shapefile. The first example is a simple one, the second is more complex.

### **Example 1. How to create a field showing *Agosia chrysogaster* occurrence by watershed with separate values for past, past and present, and no records**

Export the coloradofishes shapefile to a new shapefile and bring it into the view (ArcView will automatically prompt you). This will ensure that you have your original copy intact in case you make any mistakes.

Make the newly exported shapefile active, and bring in its table, '*go theme-table.*'

Put table into edit mode, '*go table-start editing.*'

Ensure no records are selected, '*go edit-select none.*'

Create a new field called Agchall, '*go edit-add field.*'

Check the new Agchall field is active (a new field by default is made active).

Open the Field Calculator Box, '*go field-calculate.*'

Make the equation equal to " $[\text{Agch0001}] + [\text{Agch8001}]$ " and click ok.

Save the file, '*go table-save edits.*'

Switch editing off, '*go table-stop editing.*'

In the new field Agchall, a value of 0 indicates no records, 1 represents records prior to 1981 with no collections after 1981, and 2 includes present day records (post 1981). This new field's values are best displayed within a view via the Legend Editor Box.

## Example 2. How to create a new field to show conservation priorities based on fish data

In this example, I designate conservation priorities for native fishes based on the intactness of the fauna (i.e., it is either fully intact, or not intact) and the percentage of threatened species occurring there today. This utilizes two fields, Perc\_decl and Perc\_thre, and creates three new fields. An explanation of what the results represent is provided at the end of this example.

Export the coloradofishes shapefile to a new shapefile and bring it into the view (ArcView will automatically prompt you). This will ensure that you have your original copy intact in case you make any mistakes.

Make the newly exported shapefile active, and bring in its table, *'go theme-table.'*

Put table into edit mode, *'go table-start editing.'*

Create a new field called Intact, *'go edit-add field.'*

You will need to select specific records initially. Perform the following query, *'go table-query, ' "([Perc\_decl]=0)",* click on "new set."

Check the new Intact field is active (a new field by default is made active).

Open the Field Calculator Box, *'go field-calculate.'*

Make the equation equal to "1" and click ok.

Go back to the Query Box and change the query to "([Perc\_decl]>0) and ([Perc\_decl]<100)", click on "new set."

Open the Field Calculator Box, *'go field-calculate.'*

Make the equation equal to "0" and click ok.

Go back to the Query Box and change the query to "([Perc\_decl]=100)", click on "new set."

Open the Field Calculator Box, *'go field-calculate.'*

Make the equation equal to "-1" and click ok.

Create a second new field called Threat, *'go edit-add field.'*

Perform the following query, *'go table-query, ' "([Per\_threat]>=40) and ([Per\_threat]<=100)",* click on "new set".

Check the new Threat field is active (a new field by default is made active).

Open the Field Calculator Box, *'go field-calculate.'*

Make the equation equal to "20" and click ok.

Go back to the Query Box and change the query to "([Per\_threat]>=20) and ([Per\_threat]<40)", click on "new set".

Open the Field Calculator Box, *'go field-calculate.'*

Make the equation equal to "10" and click ok.

Go back to the Query Box and change the query to "([Per\_threat]=0)", click on "new set."

Open the Field Calculator Box, *'go field-calculate.'*

Make the equation equal to "0" and click ok.

Create a third new field called Priority, '*go edit-add field.*'  
Ensure no records are selected, '*go edit-select none.*'  
Check the new Priority field is active (a new field by default is made active).  
Open the Field Calculator Box, '*go field-calculate.*'  
Make the equation equal to "([Intact]+[Threat])" and click ok.  
Go back to the Query Box and change the query to "([Per\_threat]=9999)", click on "new set."

Open the Field Calculator Box, '*go field-calculate.*'  
Make the equation equal to "9999" and click ok.

Save the edits, '*go table-save edits.*' Do not use save edits as.  
Switch editing off, '*go table-stop editing.*'

Within the view, double click on the theme to bring up the Legend Editor Box.  
Click on "load," go to the directory with the dataset and select priority.avl.  
Select the field Priority and hit ok.  
Hit "apply."

You will now see the legend and display have changed to reflect the values in the new field.

In the new field, a value of 9999 indicates no native fishes have been recorded, -1 indicates native fishes have been extirpated, 0 are records with no threatened fishes and a non-intact fauna, 1 are records with no threatened fishes and an intact fauna, 10 have between 20 and 39% threatened fishes and a non-intact fauna, 11 have between 20 and 39% threatened fishes and an intact fauna, 20 have greater than 40% threatened fishes and a non-intact fauna, 21 have greater than 40% threatened fishes and an intact fauna.

## References

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## Appendix 1. Field Definitions for the Dataset

This lists the content of each field in the data table in the order in which they appear.

### Watershed fields

Shape = internal field used by ArcView.

Area = area of the watershed in square meters.

Date = date this version of coloradofishes.shp was created

Maj\_drain = major drainage name

Min\_drain = minor drainage name

Unique\_id2 = designated watershed code. (You must always retain this field as this is the unique identifier for each watershed.)

### All records of the 31 native fishes in the Lower Colorado Basin in alphabetical order

Agch0001 = records of *Agosia chrysogaster* - longfin dace from 1840 - 2001.

Cain0001 = records of *Catostomus insignis* - Sonoran sucker from 1840 - 2001.

Cala0001 = records of *Catostomus latipinnis* - flannelmouth sucker from 1840 - 2001.

Calc0001 = records of *Catostomus* sp. "Little Colorado" - Little Colorado sucker from 1840 - 2001.

Crba0001 = records of *Crenichthys baileyi* - springfish from 1840 - 2001.

Coba0001 = records of *Cottus "bairdii"* - mottled sculpin from 1840 - 2001.

Cyar0001 = records of *Cyprinodon arcuatus* - Santa Cruz pupfish from 1840 - 2001.

Cyma0001 = records of *Cyprinodon macularius* - desert pupfish from 1840 - 2001.

Gicy0001 = records of *Gila cypha* - humpback chub from 1840 - 2001.

Giel0001 = records of *Gila elegans* - bonetail chub from 1840 - 2001.

Gijo0001 = records of *Gila jordoni* - Pahranaagat roundtail chub from 1840 - 2001.

Giin0001 = records of *Gila intermedia* - Gila chub from 1840 - 2001.

Gini0001 = records of *Gila nigra* - headwater chub from 1840 - 2001.

Giro0001 = records of *Gila robusta* - roundtail chub from 1840 - 2001.

Gise0001 = records of *Gila seminuda* - Virgin River chub from 1840 - 2001.

Leab0001 = records of *Lepidomeda albivallis* - White River spinedace from 1840 - 2001.

Leat0001 = records of *Lepidomeda altivelis* - Pahranaagat spinedace from 1840 - 2001.

Lemo0001 = records of *Lepidomeda mollispinis* - Virgin River spinedace from 1840 - 2001.

Levi0001 = records of *Lepidomeda vittata* - Little Colorado spinedace from 1840 - 2001.

Mefu0001 = records of *Meda fulgida* - spikedace from 1840 - 2001.

Moco0001 = records of *Moapa coriacea* - Moapa dace from 1840 - 2001.

Onap0001 = records of *Oncorhynchus apache* - Apache trout from 1840 - 2001.

Ongi0001 = records of *Oncorhynchus gilae* - Gila trout from 1840 - 2001.

Pacl0001 = records of *Pantosteus clarki* - desert sucker from 1840 - 2001.

Padi0001 = records of *Pantosteus discobolus* - bluehead sucker from 1840 - 2001.

Plar0001 = records of *Plagopterus argentissimus* - woundfin from 1840 - 2001.

Pooc0001 = records of *Poeciliopsis occidentalis* - Gila topminnow from 1840 - 2001.  
Ptlu0001 = records of *Ptychocheilus lucius* - Colorado pikeminnow from 1840 - 2001.  
Rhos0001 = records of *Rhinichthys osculus* - speckled dace from 1840 - 2001.  
Tico0001 = records of *Tiaroga cobitis* - loach minnow from 1840 - 2001.  
Xyte0001 = records of *Xyrauchen texanus* - razorback sucker from 1840 - 2001.

### **Present records of the 28 extant native fishes in the Lower Colorado Basin in alphabetical order**

Agch8001 = records of *Agosia chrysogaster* - longfin dace from 1981 - 2001.  
Cain8001 = records of *Catostomus insignis* - Sonoran sucker from 1981 - 2001.  
Cala8001 = records of *Catostomus latipinnis* - flannelmouth sucker from 1981 - 2001.  
Calc8001 = records of *Catostomus* sp. "Little Colorado" - Little Colorado sucker from 1981 - 2001.  
Coba8001 = records of *Cottus "bairdii"* - mottled sculpin from 1981 - 2001.  
Crba8001 = records of *Crenichthys baileyi* - springfish from 1981 - 2001.  
Cyma8001 = records of *Cyprinodon macularius* - desert pupfish from 1981 - 2001.  
Gicy8001 = records of *Gila cypha* - humpback chub from 1981 - 2001.  
Giel8001 = records of *Gila elegans* - bonytail chub from 1981 - 2001.  
Gijo8001 = records of *Gila jordoni* - Pahrnagat roundtail chub from 1981 - 2001.  
Giin8001 = records of *Gila intermedia* - Gila chub from 1981 - 2001.  
Gini8001 = records of *Gila nigra* - headwater chub from 1981 - 2001.  
Giro8001 = records of *Gila robusta* - roundtail chub from 1981 - 2001.  
Gise8001 = records of *Gila seminuda* - Virgin River chub from 1981 - 2001.  
Leab8001 = records of *Lepidomeda albivallis* - White River spinedace from 1981 - 2001.  
Lemo8001 = records of *Lepidomeda mollispinis* - Virgin River spinedace from 1981 - 2001.  
Levi8001 = records of *Lepidomeda vittata* - Little Colorado spinedace from 1981 - 2001.  
Mefu8001 = records of *Meda fulgida* - spikedace from 1981 - 2001.  
Moco8001 = records of *Moapa coriacea* - Moapa dace from 1981 - 2001.  
Onap8001 = records of *Oncorhynchus apache* - Apache trout from 2001.  
Ongi8001 = records of *Oncorhynchus gilae* - Gila trout from 1999 - 2001.  
Pacl8001 = records of *Pantosteus clarki* - desert sucker from 1981 - 2001.  
Padi8001 = records of *Pantosteus discobolus* - bluehead sucker from 1981 - 2001.  
Plar8001 = records of *Plagopterus argentissimus* - woundfin from 1981 - 2001.  
Pooc8001 = records of *Poeciliopsis occidentalis* - Gila topminnow from 1981 - 2001.  
Rhos8001 = records of *Rhinichthys osculus* - speckled dace from 1981 - 2001.  
Tico8001 = records of *Tiaroga cobitis* - loach minnow from 1981 - 2001.  
Xyte8001 = records of *Xyrauchen texanus* - razorback sucker from 1981 - 2001.

## Miscellaneous fields relating to native fishes

Total\_rich = total native fish richness (1840 - 2001). A value of 9999 indicates no native fishes have been recorded from that watershed.

Pres\_rich = present day native fish richness (1981 - 2001) (except for Apache and Gila trout whose present records are from post 2001 and 1999 respectively). A value of 9999 indicates no native fishes have been recorded from that watershed.

Thre\_rich = present day threatened species diversity (1981 - 2001) (except for Apache and Gila trout whose present records are from post 2001 and 1999 respectively). Values include all extant native fishes except *Agosia*, *Catostomus*, *Pantosteus*, and *Rhinichthys*. A value of 9999 indicates no native fishes have been recorded from that watershed. Note that our designations as threatened are not based on any official list, but are an attempt to reflect their true current status. Threatened is being used in a broad sense to cover any species whose existence is under some threat.

Per\_threat = threatened richness divided by present richness times 100. This represents the percentage of present threatened native species (except for Apache and Gila trout whose present records are from post 2001 and 1999 respectively). Cells with a value of 9999 indicate no native fishes have been recorded from that watershed.

Abs\_decl = the actual number of species lost prior to 1981 (except for Apache and Gila trout whose present records are from post 2001 and 1999 respectively). This is derived from total richness minus present richness. Cells with a value of 9999 indicate no native fishes have been recorded from that watershed.

Perc\_decl = present richness divided by total richness times 100. This represents the percentage decline of native species prior to 1981 (except for Apache and Gila trout whose present records are from post 2001 and 1999 respectively). Cells with a value of 9999 indicate no native fishes have been recorded from that watershed.

## Records for the 49 exotic species still present in the Lower Colorado Basin in alphabetical order

Amru0001 = records of *Ambloplites rupestris* - rock bass from 1840 - 2001.

Amme0001 = records of *Ameiurus melas* - black bullhead from 1840 - 2001.

Amna0001 = records of *Ameiurus natalis* - yellow bullhead from 1840 - 2001.

Amne0001 = records of *Ameiurus nebulosus* - brown bullhead from 1840 - 2001.

Caau0001 = records of *Carassius auratus* - goldfish from 1840 - 2001.

Chgu0001 = records of *Chaenobryttus gulosus* - warmouth from 1840 - 2001.

Cicy0001 = records of *Cichlasoma cyanoguttatum* - Texas cichlid from 1840 - 2001.

Cini0001 = records of *Cichlasoma nigrofasciatum* - convict cichlid from 1840 - 2001.

Cosp0001 = records of *Colossoma* sp. - pacu from 1840 - 2001.

Ctid0001 = records of *Ctenopharyngodon idellus* - grass carp from 1840 - 2001.

Cylu0001 = records of *Cyprinella lutrensis* - red shiner from 1840 - 2001.

Cyca0001 = records of *Cyprinus carpio* - carp from 1840 - 2001.

Dope0001 = records of *Dorosoma petenense* - threadfin shad from 1840 - 2001.

Eslu0001 = records of *Esox lucius* - northern pike from 1840 - 2001.

Fuze0001 = records of *Fundulus zebrinus* - plains killifish from 1840 - 2001.

Gaaf0001 = records of *Gambusia affinis* - eastern mosquitofish from 1840 - 2001.

Icpu0001 = records of *Ictalurus punctatus* - channel catfish from 1840 - 2001.  
 Icbu0001 = records of *Ictiobus bubalus* - smallmouth buffalo from 1840 - 2001.  
 Iccy0001 = records of *Ictiobus cyprinellus* - bigmouth buffalo from 1840 - 2001.  
 Ichn0001 = records of *Ictiobus niger* - black buffalo from 1840 - 2001.  
 Lecy0001 = records of *Lepomis cyanellus* - green sunfish from 1840 - 2001.  
 Lema0001 = records of *Lepomis macrochirus* - bluegill from 1840 - 2001.  
 Lemc0001 = records of *Lepomis microlophus* - redear sunfish from 1840 - 2001.  
 Mido0001 = records of *Micropterus dolomieu* - smallmouth bass from 1840 - 2001.  
 Mipu0001 = records of *Micropterus punctulatus* - spotted bass from 1840 - 2001.  
 Misa0001 = records of *Micropterus salmoides* - largemouth bass from 1840 - 2001.  
 Moch0001 = records of *Morone chrysops* - white bass from 1840 - 2001.  
 Momi0001 = records of *Morone mississippiensis* - yellow bass from 1840 - 2001.  
 Mosa0001 = records of *Morone saxatilis* - striped bass from 1840 - 2001.  
 Nocr0001 = records of *Notemigonus crysoleucus* - golden shiner from 1840 - 2001.  
 Oncl0001 = records of *Oncorhynchus clarkii* - cutthroat trout from 1840 - 2001.  
 Onmy0001 = records of *Oncorhynchus mykiss* - rainbow trout from 1840 - 2001.  
 Orau0001 = records of *Oreochromis aurea* - blue tilapia from 1840 - 2001.  
 Ormo0001 = records of *Oreochromis mossambica* - Mossambique mouthbrooder from 1840 - 2001.  
 Papl0001 = records of *Pantosteus plebeius* - Rio Grande sucker from 1840 - 2001.  
 Pefl0001 = records of *Perca flavescens* - yellow perch from 1840 - 2001.  
 Pipr0001 = records of *Pimephales promelas* - fathead minnow from 1840 - 2001.  
 Pola0001 = records of *Poecilia latipinna* - sailfin molly from 1840 - 2001.  
 Pome0001 = records of *Poecilia mexicana* - Mexican molly from 1840 - 2001.  
 Pore0001 = records of *Poecilia reticulata* - guppy from 1840 - 2001.  
 Poan0001 = records of *Pomoxis annularis* - white crappie from 1840 - 2001.  
 Poni0001 = records of *Pomoxis nigromaculatus* - black crappie from 1840 - 2001.  
 Pyol0001 = records of *Pylodictis olivaris* - flathead catfish from 1840 - 2001.  
 Riba0001 = records of *Richardsonius balteatus* - redbreasted shiner from 1840 - 2001.  
 Satr0001 = records of *Salmo trutta* - brown trout from 1840 - 2001.  
 Safo0001 = records of *Salvelinus fontinalis* - brook trout from 1840 - 2001.  
 Stvi0001 = records of *Stizostedion vitreum* - walleye from 1840 - 2001.  
 Thar0001 = records of *Thymallus arcticus* - Arctic grayling from 1840 - 2001.  
 Tizi0001 = records of *Tilapia zilli* - red-breasted tilapia from 1840 - 2001.a

## Summary exotic fish field

Total\_exot = the sum of all exotic species still present in the Lower Colorado Basin.

## Appendix 2. Primary and Gray Literature Included in the Point Database

This list contains all of the literature included in the point database including records beyond the Lower Colorado Basin.

### Primary literature

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