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Appendix F – rat_lib.tcl library, rating functions

1.0   General Information

1.1   Application Description

The rat_lib.tcl file is located in the /rfc_arc/lib directory and contains various functions that can be called by programs to aid in retrieving rating curves and in converting stage to flow and vice-versa. It is written in tcl with Postgres sql. Here is a description of the available functions:

- GetFlow - returns the integer flow for the given stage, lid, PE, source and date. It makes sure the correct rating has been retrieved by first calling GetRC (described below). It applies the datum adjustment first and then the appropriate shift to the given stage before applying the rating table. It determines where this shifted stage is in the given rating table and then calculates the flow as follows:
  - Below rating:
    - Linear extrapolation by using the bottom two points of the rating curve to calculate slope (m) and y-intercept (b).
  - Above rating:
    - Logarithmic extrapolation using the last two points of the rating curve.
  - Within rating:
    - If exact stage value is part of table it just returns the corresponding flow.
    - If stage value is between two points, the flow is calculated using logarithmic interpolation.
- GetStage - returns the stage for the given flow, lid, PE, source and date. It makes sure the correct rating has been retrieved by first calling GetRC (described below). It determines where the flow is in the given rating table, converts to stage (as described above for GetFlow) and then applies the appropriate shift (the datum adjustment is not applied).
- GetRC - calls the functions GetShift and GetTable (described below) to retrieve the desired shift table and corresponding rating table for the given lid, PE (SHEF Physical Element – HG, HP, HS, etc.), source, and, optionally, date. The rating curve is 'cleaned up' by eliminating pairs where the stage and/or flow is the same or less than the previous pair. In other words, it makes sure the stages and flows continuously increase. It returns the information in the SHTBL and RTBL arrays (see Attachments A and B for array members). If a shift and rating have been previously retrieved within the program, it will check if it already has the correct tables before calling GetShift and GetTable.
- GetShift - retrieves the shift table from the database table ratingshift for the given lid, PE, source, and, optionally, date. If the date is not given it will retrieve the entry with the most recent date, otherwise it will get the first entry with a valid

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date less than or equal to the passed date. Returns the information in the SHTBL array.

- GetTable - retrieves the rating table from the database table rating for the given lid, PE, source, and optionally, table number and date. When called from GetRC the inputs correspond to the shift table which was just retrieved. When called outside of this function, if the table number is not given it will retrieve the entry with the most recent date, if the table is given but not the date it will retrieve the entry with the most recent date for that table. Returns the information in the RTBL array.

- InsShift - inserts a new shift table into the database table ratingshift given an array with all the SHTBL elements (see Attachment A) defined. This function is not currently used by any archive database applications and so has only been minimally tested.

- InsTable - inserts a new rating table into the database table rating given an array with all the RTBL elements (see Attachment B) defined. This function is not currently used by any archive database applications and so has only been minimally tested.

- UpdShift - updates a shift table already defined in the database table ratingshift given an array with all the SHTBL elements (see Attachment A) defined. This function is not currently used by any archive database applications and so has only been minimally tested.

- UpdTable - updates a rating table already defined in the database table rating given an array with all the RTBL elements (see Attachment B) defined. This function is not currently used by any archive database applications and so has only been minimally tested.

1.2   Design Considerations

If you just want to convert stage to flow or flow to stage, note that the only functions you need to call from your program are GetFlow and GetStage. Both of these use the GetRC function to make sure they have the needed rating and shift tables and GetRC calls GetShift and GetTable to retrieve them.

1.3   Application Assumptions

In order for the program to find a rating table a corresponding shift table (same lid, pe1, pe2, src, tbl, and date >= rating table date) must exist. See Attachments A and B for table definitions.

1.4   Enhancements/Bug Fixes/Changes

Build OB7.2
This application was updated to take into account the change in the version of Tcl/Tk, the upgrade of the OS in ob7.2, the change in RDBMS from Informix to Postgres, and the changes in the *rating* and *ratingshift* table structures. These changes are as follows:

• Table *rating* changed in ob7.2 to accommodate a request from the National RATINGS team led by Dave Reed. Part of the change takes advantage of a feature that exists in Postgres but not in Informix, i.e. having a column as an array.

• Table *ratingshift* has a couple of changes due to the new *rating* table structure. These are: added column "src" and changed the primary key to be in sync with the *rating* table.

Documentation was updated to reflect these changes.

Build OB5
Procedures were changed to take into account Build OB5 archive database changes to table *rating*.

Build OB4
All of the procedures were converted from esql/C to Tcl/TK.

2.0   Configuration Information

The calling program must include the following:
- Load the pgtcl library:
    - load libpgtcl.so
- Include the library file:
    - source /rfc_arc/lib/rat_lib.tcl
- Define and set the debugging variable IBUG (where 1=on and 0=off):
    - set IBUG 0
- Open the database and define the connection handle as 'pgconn':
    - set pgconn [pg_connect $dbname]
- May need to define SHTBL, RTBL, IBUG and pgconn variables as global:
    - global SHTBL RTBL IBUG pgconn

3.0   User How-To

The procedure argument lists, return values and global variables are as follows:

- GetFlow {lid pe1 pe2 src date stage}
    - Inputs:
        - lid = location id of stage value
        - pe1 = first part of Physical Element code (H)
        - pe2 = second part of Physical Element code (G, P)
        - src = source of rating (usgs, usace, etc.)
        - date = date of stage value in form CCYYMMDD
        - stage = stage value to convert to flow

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- o Return value:
  - ▪ -1 = no table found, unable to convert
  - ▪ >= 0 = flow as an integer
- o Global variables:
  - ▪ SHTBL - array for information about the shift table
    - • calls GetRC to retrieve correct table
  - ▪ RTBL - array for information about the rating table
    - • calls GetRC to retrieve correct table
  - ▪ IBUG - controls debugging (0=off, 1=on)
    - • if IBUG is not set in calling program it will default to 0
  - ▪ WRN - contains warning information as follows:
    - • -1 = no table found
    - • 0 = within table
    - • 1 = below table
    - • 2 = above table
    - • 3 = flow could not be calculated
      - o NOTE: flow value will be returned as 0 so need to check WRN for unable to calculate
- • GetStage {lid pe1 pe2 src date flow}
  - o Inputs:
    - ▪ lid = location id of stage value
    - ▪ pe1 = first part of Physical Element code (H)
    - ▪ pe2 = second part of Physical Element code (G, P)
    - ▪ src = source of rating (usgs, usace, etc.)
    - ▪ date = date of stage value in form CCYYMMDD
    - ▪ flow = flow value to convert to stage
  - o Return value:
    - ▪ -1 = no table found, unable to convert
    - ▪ >= 0 = stage
  - o Global variables:
    - ▪ SHTBL - array for information about the shift table
      - • calls GetRC to retrieve correct table
    - ▪ RTBL - array for information about the rating table
      - • calls GetRC to retrieve correct table
    - ▪ IBUG - controls debugging (0=off, 1=on)
      - • if IBUG is not set in calling program it will default to 0
    - ▪ WRN - contains warning information as follows:
      - • -1 = no table found
      - • 0 = within table
      - • 1 = below table
      - • 2 = above table
      - • 3 = stage could not be calculated
        - o NOTE: stage value will be returned as 0 so need to check WRN for unable to calculate
- • GetRC {lid pe1 pe2 src {date 0}}

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- o Inputs:
    - lid = location id of desired rating table
    - pe1 = first part of Physical Element code (H)
    - pe2 = second part of Physical Element code (G, P)
    - src = source of rating (usgs, usace, etc.)
    - Optional:
        - date = date of desired rating table in form CCYYMMDD - if no date is given it will get the most recent table
- o Return value:
    - 0 = no table found
    - 1 = table found
- o Global variables:
    - SHTBL - array for information about the shift table
        - if this variable has been previously defined it will check the contents against the table being requested
    - RTBL - array for information about the rating table
        - if this variable has been previously defined it will check the contents against the table being requested
    - IBUG - controls debugging (0=off, 1=on)
        - if IBUG is not set in calling program it will default to 0
- GetShift {lid pe1 pe2 src {date 0}}
    - o Inputs:
        - lid = location id of desired rating table
        - pe1 = first part of Physical Element code (H)
        - pe2 = second part of Physical Element code (G, P)
        - src = source of rating (usgs, usace, etc.)
        - Optional:
            - date = date of desired rating table in form CCYYMMDD - if no date is given it will get the most recent table
    - o Return value:
        - 0 = no table found
        - 1 = table found
    - o Global variables:
        - SHTBL - array for information about the shift table
            - if this variable has been previously defined it will check the contents against the table being requested
        - IBUG - controls debugging (0=off, 1=on)
            - if IBUG is not set in calling program it will default to 0
        - pgconn - database connection handle
            - must be defined before calling this procedure
- GetTable {lid pe1 pe2 src {tbl 0} {date 0}}
    - o Inputs:
        - lid = location id of desired rating table
        - pe1 = first part of Physical Element code (H)
        - pe2 = second part of Physical Element code (G, P)
        - src = source of rating (usgs, usace, etc.)

- Optional:
  - tbl = table number - if no table given it will get most recent based on date
  - date = date of desired rating table in form CCYYMMDD - if no date is given it will get the most recent table for given table number
  - o Return value:
    - 0 = no table found
    - 1 = table found
  - o Global variables:
    - RTBL - array for information about the rating table
      - if this variable has been previously defined it will check the contents against the table being requested
    - IBUG - controls debugging (0=off, 1=on)
      - if IBUG is not set in calling program it will default to 0
    - pgconn - database connection handle
      - must be defined before calling this procedure
- InsShift {new_shtbl}
  - o Inputs:
    - new_shtbl = previously defined array with the same elements as SHTBL (see Attachment A).
  - o Return value:
    - number of rows inserted (0 means nothing inserted - error)
  - o Global variables:
    - IBUG - controls debugging (0=off, 1=on)
      - must be defined before calling this procedure
    - pgconn - database connection handle
      - must be defined before calling this procedure
- InsTable {new_rtbl}
  - o Inputs:
    - new_rtbl = previously defined array with the same elements as RTBL (see Attachment B).
  - o Return value:
    - number of rows inserted (0 means nothing inserted - error)
  - o Global variables:
    - IBUG - controls debugging (0=off, 1=on)
      - must be defined before calling this procedure
    - pgconn - database connection handle
      - must be defined before calling this procedure
- UpdShift {new_shtbl}
  - o Inputs:
    - new_shtbl = previously defined array with the same elements as SHTBL (see Attachment A).
  - o Return value:
    - number of rows updated (0 means nothing updated - error)
  - o Global variables:

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- ▪ IBUG - controls debugging (0=off, 1=on)
  - • must be defined before calling this procedure
- ▪ pgconn - database connection handle
  - • must be defined before calling this procedure
- • UpdTable {new_rtbl}
  - o Inputs:
    - ▪ new_rtbl = previously defined array with the same elements as RTBL (see Attachment B).
  - o Return value:
    - ▪ number of rows updated (0 means nothing updated - error)
  - o Global variables:
    - ▪ IBUG - controls debugging (0=off, 1=on)
      - • must be defined before calling this procedure
    - ▪ pgconn - database connection handle
      - • must be defined before calling this procedure

4.0 Troubleshooting Information

If the program cannot retrieve the requested rating curve information for a site, check to make sure it has corresponding entries in the rating and ratingshift tables of the archive database.

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Attachment A
SHTBL array elements

SHTBL (corresponds to database table ratingshift)

Array element	Database column	Definition
id	*lid	location id
pe1	*pe1	first character of physical element code
pe2	*pe2	second character of physical element code
bdate	*begin_date	begin date of shift (from database entry)
edate		end date of shift (-1 if none; determined from next ratingshift entry begin date)
tbl	*tbl_ver	number of corresponding rating table
src	*src	source of corresponding rating table
val0	val_a	stage value for first shift
val1	val_b	stage value for second shift
val2	val_c	stage value for third shift
val3	val_d	stage value for fourth shift
sh0	sh_a	first shift
sh1	sh_b	second shift
sh2	sh_c	third shift
sh3	sh_d	fourth shift
dadj	datum_adj	data adjustment
nval		number of defined shift pairs

To insert or update a shift table, all of the elements that have an associated database column must be defined (so edate and nval are not needed). All unused stage-shift pairs should be defined as 0-0. The starred database columns constitute the Prime Key.

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Attachment B
RTBL array elements

RTBL (corresponds to database table rating)

Array element	Database column	Definition
id	*lid	location id
pe1	*pe1	first character of physical element code
pe2	*pe2	second character of physical element code
bdate	*valid_date	valid date of rating
tbl	*tbl	number of rating table
src	*src	source of rating table
gs	othagid	source agency id for lid
ofs	rfs_input	whether used in nwsrfs
h0, h1…	stgflow	stage values
q0, q1…	stgflow	flow values
npair		number of defined stage-flow pairs
	units	
	interpolate	
	offsets	
	allowstg	

To insert or update a rating table, all of the elements that have an associated database column must be defined (so npair is not needed). Note the database table rating contains columns that are not part of the RTBL array. The stage-flow pairs are stored in the database as an array so there is no limit on the number and no need to signify the end of the table with a 0-0 pair. The starred database columns constitute the Prime Key.