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## AK DOT Foothills Project Database Requirements and Design Document

This document describes the requirements and design of a geospatial database for storing information on lakes on the North Slope of Alaska.

### Background

PBS&J was contracted by the University of Alaska at Fairbanks to assist in database design for the Alaska DOT Foothills project. As part of this project, UAF has developed a methodology of using Synthetic Aperture Radar (SAR) to evaluate lake depth on North Slope lakes. To meet the project goal of dissemination, UAF is now developing a publically available web-based tool that will implement the methodology. The tool will use the database to 1) retrieve input data for analysis, and 2) store analysis results.

### Project Stakeholders

Name	e-mail	Phone	Role
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Stephen Bourne	<a href="mailto:sfbourne@pbsj.com">sfbourne@pbsj.com</a>	404.895.0753	PBS&J Project Manager
Leslie Gowdish	<a href="mailto:lsgowdish@pbsj.com">lsgowdish@pbsj.com</a>	239.221.8001	PBS&J Technical Manager

### Database Requirements

Through several discussions between PBS&J and UAF staff, the following requirements were developed for the database. The requirements are described in detail in the sections after the table. Please refer to the database ERD (appendix A) for more information.

R ID	Title	Change Request
R-GeneralInfo	General Information	N/A
R-IceGrounding	Ice Grounding	N/A
R-TimeSeries	Time Series	N/A
R-WaterExtractionPermits	Water Extraction Permits	N/A
R-Species	Species	N/A

## General Information

The database will have a main table that stores the following:

- Lake Shape
- Lake Name – NHD name
- Depth – best available estimate
- Elevation – best available estimate
- Lake Area – best available estimate
- General Description
- A unique ID specific to the Lake Database, called LakeID
- Lake IDs specific to UAF naming schemes
- Lake IDs specific to USGS naming schemes (e.g. NHD)
- Other Lake IDs as necessary
- Date of Information – date of last estimate
- Whether Lake is Permitted for Extraction – based on if lake has permits, updated when permits added
- Maximum Expected Ice Thickness – best available estimate
- Watershed Area – best available estimate
- Whether the Lake Contains Fish – based on if lake has species associated to it, updated when species added

## Ice Grounding

The main table will be linked to a table containing data on ice grounding. The two tables will be linked in a one-to-many relationship, which is linked by the LakeID. The relationship is one-to-many so that a single lake can have several ice grounding results from the SAR tool. This table will contain:

- IceGrounded – Boolean field to indicate if the lake is grounded in winter
- IceGroundedDate – date on which ice was grounded according to SAR data
- IceGroundedSource – analysis that results in IceGrounded and IceGroundedDate
- IceGroundedSourceLink – an URL that leads to a description of the analysis

## Time Series

The main table will be linked to a pair of tables containing data on time series, for storing information like lake levels, temperatures, etc. The pair of tables includes a time series catalog table and a time series data table. The time series catalog table holds one row per time series. Each row has a unique time series ID field called TSID. The catalog table is linked to a time series data table, which stores one row per time/value observation. The two tables are linked in a one-to-many relationship via the TSID.

The main table will be linked to the time series catalog table in a many-to-many relationship, where TSID and LakeID are used to link the time series and lakes. The relationship is many-to-many so that a multiple lakes can be described by one time series, and conversely one lake can have many time series. The former is possible when a regional climatic time series applies to all lakes.

The time series catalog table has the following fields:

- TSID
- Variable – name of variable
- Units – units of measure
- IsRegular – if time series values are regularly spaces in time
- TSInterval - e.g. hourly, daily, monthly
- StartTime
- EndTime

The time series data table has the following fields:

- TSID
- TSDateTime
- TSValue

### **Water Extraction Permits**

The main table is linked to a table dedicated to storing information on water extraction permits on the lake. The two tables will be linked in a one-to-many relationship, which is linked by the LakeID. The relationship is one-to-many so that a single lake can have several permits. This table will contain:

- LakeID
- PermitID – ID allocated by Permitting Agency
- PermitHolderOrganization – e.g. CPA, Exxon
- PermittingAgency – the primary agency issuing the oil exploration permit
- DateGranted
- PermitURL – link to permit document
- PermittedWithdrawal – volume of water permitted for withdrawal

### **Species**

The main table is linked to a table dedicated to storing information on species within the lake. The two tables will be linked in a many-to-many relationship, which is linked by the LakeID and SpeciesID. The relationship is many-to-many so that a single lake can have multiple species, and a single species can be present in many lakes. The species table will store the following information.

- SpeciesID
- SpeciesName

To store information on species population in specific lakes, the many-to-many relationship class will be attributed and will include the following fields:

- LakeID
- SpeciesID
- PopulationSizeWithinLake

- StudySourceLink – URL to open survey that estimated the population size

## **Database Design**

### **Initial Input Data**

The primary source for geospatial and indexing data for the lakes database will be the NHDPlus data produced by USGS (USEPA and USGS, 2005, National Hydrography Dataset Plus – NHDPlus, <http://nhd.usgs.gov>). Additional data (time series, species, and permits) will be added to the database as the data becomes available after the database is created. Addition of this data is outside the scope of this contract. Ice grounding data will be added by the SAR tool when it becomes operational.

### **Indexing System**

There are several indexing systems for lakes on the North Slope. These include a UAF naming scheme, USGS NHD naming scheme, and GNIS scheme. The database will store all of these IDs where they are available. To maintain integrity, a unique ID will be assigned to each lake, called LakeID, which will be a long integer and will be specific to the lakes database.

### **Database Technology and Web Services**

The database will be housed in an MS SQL Server 2008 instance, and will be served through ARC SDE 10.0. The database will be served as a map and feature service through ArcGIS Server 10.0.

### **Performance**

The database will require server-side tile caching for high performance. At a minimum, five levels of tiles should be created, with the minimum resolution being 1:1000. The number of lakes to be stored should be kept under 10,000 for the entire North Slope. To accomplish this, lakes below a certain size threshold should be removed from the database.

### **Data Publishing**

To publish Ice Grounding data produced by the SAR tool, a feature publishing service will be established on ArcGIS Server 10.0. The SAR tool will subscribe to this service and use it to publish data directly to the Ice Grounded Table.

### **Security**

The data service will be read-only with the exception of the publishing service for the Ice Grounded Table. The data will be consumable by the general public. Publishing will require authentication, which will be established as part of the ArcGIS Server service setup. The SAR tool will be the only valid user of the publishing service, and will provide the publishing service credentials on each use. Authentication of users of the SAR tool will be handled by the SAR tool developers at UAF.

## Appendixes:

Appendixes to this document include:

1. Database ERD
2. A Microsoft Access Personal Geodatabase Version of the Lakes Database, which includes:
  - Size-filtered NHD+ based lake data
  - NHD, GNIS IDs
  - Assigned LakeID
  - Pilot Data for the following fields (i.e. the data is not complete across all lakes)
    - Depth
    - Elevation
    - Lake Area
    - General Description
    - Lake IDs specific to UAF naming schemes
    - Watershed Area
    - Whether the Lake Contains Fish

# Lakes Database

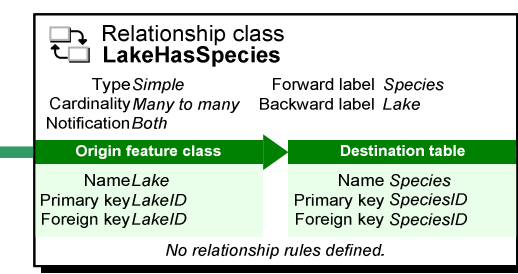
**Simple feature class Lake**

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID	No					
SHAPE	Geometry	Yes					
ComID	Long integer	No			0		
Permanent_ID	String	No			40		
FDate	Date	Yes			0	0	8
Resolution	Long integer	No			0		
GNIS_ID	String	No			10		
GNIS_Name	String	No			65		
AreaSqKm	Double	No			0	0	
Elevation	Double	No			0	0	
ReachCode	String	No			14		
FType	Long integer	No			0		
FCode	Long integer	No			0		
Description	String	No			254		
HydrographicCategory	String	No			32		
InundationControlStatus	String	No			32		
OperationalStatus	String	No			32		
PositionalAccuracy	String	No			32		
Stage	String	No			32		
Area_sqm	Double	No			0	0	
LakeID	Long integer	Yes			0		
LakeName	String	Yes			50		
UAFLakeID	String	Yes			30		
Permitted	Short integer	Yes			0		
PermittedWithdrawal	Double	Yes			0	0	
Depth	Double	Yes			0	0	
MaoiceThickness	Double	Yes			0	0	
WshedArea	Double	Yes			0	0	
WshedAreaSource	String	Yes			100		
ContainsFish	Short integer	Yes			0		
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	

Lake information for Alaska. Features from the National Hydrography Dataset (NHD).

NHD Common Identifier: 10-digit integer value that uniquely identifies the occurrence of each feature in NHD  
 NHD Permanent Identifier: 40-character GUID value that uniquely identifies the occurrence of each feature in The National Map  
 NHD Date of last feature modification  
 NHD Code for source resolution: 1 = Local resolution, 2 = High resolution, 3 = Medium resolution  
 NHD Unique identifier assigned to GNIS, length 10  
 NHD Proper name, specific term, or expression by which a particular geographic entity is known, length 65  
 Area of areal features, Always Equal Area, length 10  
 Elevation, in meters, of water surfaces where water pools are encoded for a few features  
 NHD Unique identifier composed subbasin code and randomly assigned sequential number unique within a Cataloging Unit, length 14  
 NHD Three-digit integer value, unique identifier of a feature type  
 NHD Five-digit integer value comprised of the feature type and combinations of characteristics and values  
 Detailed description of feature  
 NHD Portion of the year the feature contains water (Intermittent or Perennial)  
 NHD Existence of functional control structures (Controlled or Not Controlled)  
 NHD State or condition (Abandoned or Operational)  
 NHD The accuracy a feature can be confidently positioned (Approximate or Definite)  
 NHD: Height of water surface is the basis for elevation  
 Area of areal features, Always Equal Area Conic, Units = square meters

Name of lake  
 ID used by INE: Code for lakes that INE has investigated (WERCC Code)  
 Y/N - Lake permitted for withdrawal  
 Amount of water permitted for withdrawal (cubic meters)  
 Depth of lake (meters)  
 Maximum ice thickness (meters)  
 Watershed area (square meters)  
 Source reference for watershed area  
 Y/N - Lake contains fish

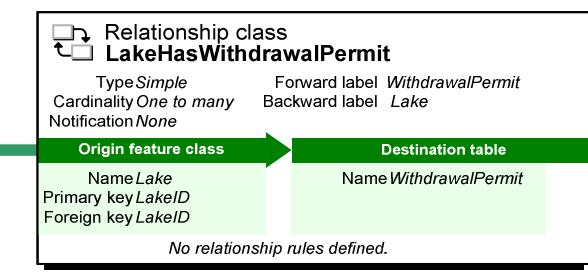


**Table Species**

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID	No					
LakeID	Long integer	Yes			0		
SpeciesID	Long integer	Yes			0		
SpeciesName	String	Yes			50		
PopulationSizeWithinLake	Double	Yes			0	0	
StudySourceLink	String	Yes			100		

Information about species within each lake.

Unique ID for each lake, Links to Lake feature class  
 Unique ID for each species  
 Name of species  
 Population size of species within lake  
 Link to lake species survey report

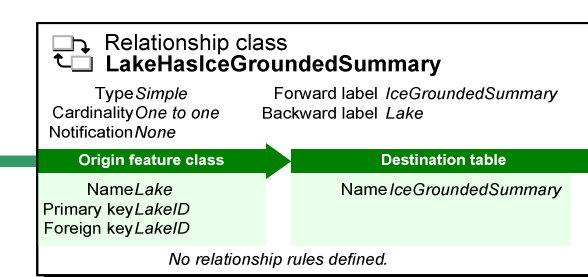


**Table WithdrawalPermit**

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID	No					
LakeID	Long integer	Yes			0		
PermitID	String	Yes			50		
PermitHolderOrganization	String	Yes			100		
PermittingAgency	String	Yes			50		
DateGranted	Date	Yes			0	0	8
PermitURL	String	Yes			100		
PermittedWithdrawal	Double	Yes			0	0	

Withdrawal permit information for lakes.

Unique ID for each lake, links to lake feature class  
 Unique ID for lake permits, permit number  
 Organizations holding the permit  
 Permitting agency  
 Date permit was granted  
 URL for linking to permit document  
 Permitted withdrawal (cubic meters)

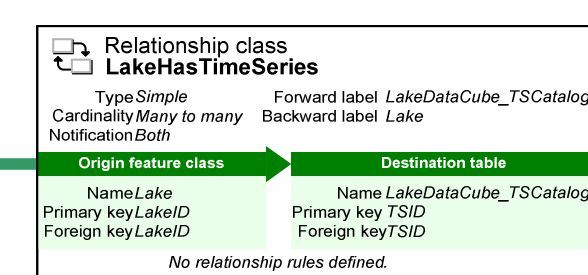


**Table IceGroundedSummary**

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID	No					
LakeID	Long integer	Yes			0		
IceGrounded	Short integer	Yes			0		
IceGroundedDate	Date	Yes			0	0	8
IceGroundedSource	String	Yes			50		
IceGroundedSourceLink	String	Yes			50		

Summary information on lake ice grounded based on data from SAR Tool. Information on whether the lake ice is grounded, date grounded and source.

Unique ID for each lake  
 Y/N - Lake ice grounded  
 Date lake ice determined to be grounded  
 Lake ice grounded source  
 Link to SAR image

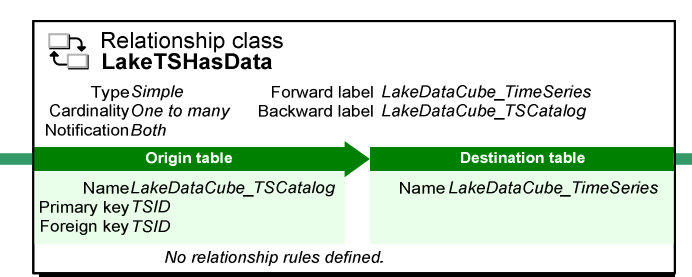


**Table LakeDataCube\_TSCatalog**

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID	No					
Variable	String	Yes			30		
Units	String	Yes			30		
IsRegular	Long integer	Yes			0		
TSSInterval	Long integer	Yes			0		
StartTime	Date	Yes			0	0	8
EndTime	Date	Yes			0	0	8
TSSID	String	Yes			50		

Catalog containing a summary of each time series (e.g. lake ice area grounded)

Time series variable name  
 Units of time series variable  
 Y/N - Regular time series interval  
 Time series interval (e.g. daily, hourly, etc.)  
 Start datetime of time series  
 End datetime of time series  
 ID for each time series



**Table LakeDataCube\_TimeSeries**

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID	No					
TSSDateTime	Date	Yes			0	0	8
TSValue	Double	Yes			0	0	
TSSID	String	Yes			50		

Table containing lake time series data.

Time series datetime  
 Time series value  
 Unique ID for time series