Kenai River Heavy Metal Pollution Source Data Mining Exercise for the Kenai Watershed Forum: Main Kenai River System

Executive Summary

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Contents

List of Acronyms

1D – Point/line features

2D – Polygon features

AK - Alaska

AKDNR – Alaska Department of Natural Resources

AKDOT – Alaska Department of Transportation

BLM – Bureau of Land Management

DEM – Digital Elevation Model

DNR – Department of Natural Resources

DRG – Digital Raster Graphic

GIS – Geographic Information System

KWF - Kenai Watershed Forum

NHD – National Hydrography Dataset

SMUMN GSS – Saint Mary's University of Minnesota, GeoSpatial Services

USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey

Acknowledgment

Abstract

The Kenai Watershed Forum (KWF) is a non-profit organization that provides education, restoration, and research programs for the protection of watersheds within the Kenai Peninsula. The watersheds in the Kenai Peninsula are vital not only to sustaining ecological processes on the landscape and supporting local biodiversity, but to local, regional and world economic development and cultural significance. The Kenai Peninsula is a premier fishing destination and outdoor enthusiast's dream. It is important to protect and enhance the native fisheries and aquatic resources of the Kenai for both natural beauty and economic benefits. Studies have identified pollution as a threat to the aquatic resources within the Kenai watersheds, specifically heavy metal pollution.

The purpose of this data mining project was to develop a comprehensive geographic information systems (GIS) database of potential sources of pollution to the Kenai River main stem as well as to identify gaps in data that, if made available or created, would be beneficial to the understanding of heavy metal pollution. This data mining process is promising because of newly available, large-scale datasets available for the Kenai Peninsula through the mapping efforts of the Kenai Borough, The Alaska Department of Transportation (AKDOT), Alaska Department of Natural Resources (AKDNR), United States Geological Survey (USGS), Bureau of Land Management (BLM), and various other organizations.

Introduction

The Kenai Watershed Forum tasked Saint Mary's University of Minnesota GeoSpatial Services (SMUMN GSS) with the development of a comprehensive dataset comprising potential heavy metal pollution sources to the Kenai River main stem, as well as identifying any gaps or insufficient datasets that may be of value for the understanding of water quality. An initial literature review was performed to identify the top sources of pollution.
Potential pollution datasets identified included:

- Galvanized surfaces
- Tire and brake pad wear
- Fertilizer, pesticides, and fungicides
- Waste water discharge
- Boat hull coatings and anti-fouling paints
- Natural and environmental variables including flow rates, air and water temperature, water hardness, dissolved oxygen, and other water quality parameters
- Urbanization, anthropogenic development, impervious surfaces, deforestation

These datasets contribute valuable information regarding the source of a rapid increase of heavy metal pollution to the main stem Kenai River and will be a valuable contribution to the Kenai Watershed Forum, as well as its partners' efforts in planning for the mitigation of heavy metal pollution from the main Kenai River system.

Methodology

The following tasks were performed in order to develop a comprehensive GIS database of potential pollution sources to the Kenai River main stem. The order of tasks is outlined below.

1. Perform a literature review
2. Selection of a study area
3. Search for relevant digital data sources
4. Compile all acquired data
5. Identify and record gaps in data
6. Highlight results and gaps in a summary report

The first step was to perform a literature review. Multiple literature sources were reviewed to compile a list of the top potential heavy metal pollution sources. This review highlighted the most critical datasets for the understanding of the contribution of pollutants to the Kenai River.

After reviewing literary sources, an appropriate study area was identified and approved by the KWF (Figure 1). The study area chosen identifies the Kenai River main stem and also brings to light many of the tributaries that feed the main stem Kenai River.
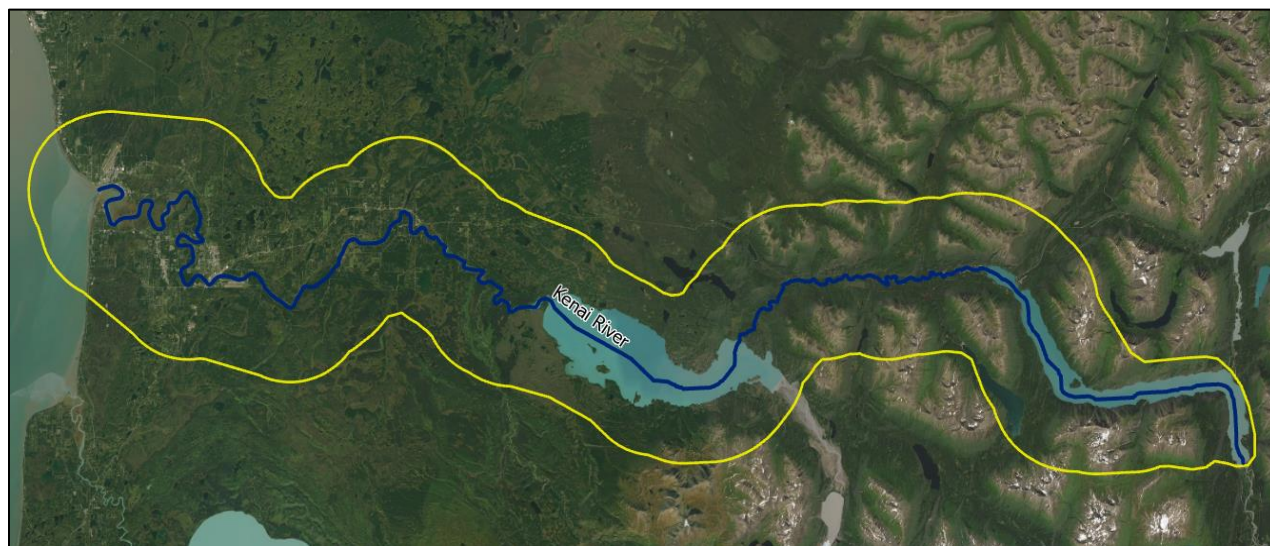

Figure 1. Study Area.

After defining an appropriate study area, the next step was to collect all available datasets related to the top pollution sources that were highlighted during the literature review. These datasets came from many internet sources, but two primary sources were the Kenai Peninsula Borough GIS Department and the AKDNR open data portal site. Data was not always available in traditional formats, such as shapefile and geodatabase, and therefore required a different process to get the data converted to a usable GIS layer. Data packages could be sourced and downloaded from various agencies' ArcGIS Online accounts, which were then downloaded and converted into useable feature classes through ArcGIS Pro feature conversion tools.

Once the applicable and available datasets had been located and downloaded, all 1D and 2D data were compiled into ArcGIS file geodatabases. Each source information was recorded in an Excel spreadsheet. Some datasets in the form of rasters, such as Digital Raster Graphics (DRG), were separated into standalone folders and not converted to file geodatabase rasters.

After compiling all available data sources and recording the metadata in the project spreadsheet, the next step was to identify any data gaps found. Comments on how these datasets could be potentially useful to locating potential heavy metal pollution sources to the main stem Kenai River were added to the spreadsheet. Recommendations on how to fill the data gaps are outlined in the recommendations section of this summary.

Finally, all the acquired datasets were compiled into deliverable file geodatabases.

Results

The results were a collection of 14 data sources ranging from the Alaska Department of Transportation Counts to wells and many more. Listed below are all relevant datasets acquired.

- Traffic Counts
- Bridges, Gates, Culverts
- Digital Raster Graphics
- Facilities
- Fire Locations
- Fire Perimeters
- Land Cover
- Material Sites
- Mining Claims
- Oil and Gas leases
- Parcel Boundaries
- Railroads
- Waterways
- Wells

All of these datasets contain pertinent information about heavy metal pollution and could be useful for analysis. These sources were compiled into ArcGIS file geodatabases. Each pollution source's data download metadata was recorded in an Excel spreadsheet table identifying a link, date of creation, type of pollution source, and if the source covers the entire study area. No manipulation of the data was conducted to match the data extent to the area displayed in Figure 1. Rather, entire datasets were maintained in their native extent in order to encompass those tributaries transporting water into the Kenai River main stem, even if this meant the data overlapped the entire state of Alaska. It was determined that the data would be better delivered in its entirety to the KWF.

After searching for all relevant and available datasets, data gaps were identified. These data gaps included GIS layers of all galvanized surfaces, impervious surfaces, natural mineral deposits, snow storage, and storm water systems.

Recommendations

Based on the data gaps identified in the results section, the following are recommendations on how to improve or create new datasets. These are not comprehensive, but are recommendations and are subject to funding.

A comprehensive database identifying galvanized metal surfaces on the Kenai Peninsula was not found, so it would need to be created. This dataset is valuable because as weather erodes the surfaces, heavy metals leach into the stream system and find their way to the main stem Kenai River through runoff.

A critical gap identified was an impervious surfaces data layer. There are roads and parcel data available, but these datasets do not tell the full story. They often include vegetated and forested areas in addition to impervious surfaces. This dataset would be valuable because it would show locations where water is not able to naturally re-enter the water table. This is an issue because as this water flows, it collects any debris or pollution along the way, which is then drained into the main stem Kenai River. Impervious surfaces data develops an understanding of the correlation between increased urbanization and the impacts on the natural environment.

Natural mineral deposits were another dataset that was not located. There were no readily available data found, so it would need to be created, most likely through fieldwork. A pdf file containing historic deposits for the peninsula was located, but would require conversion to a digital copy that could be geo-located and sites digitized from it. Although natural mineral deposits contain a low level of zinc, water sampling has indicated this source could have probable impacts on zinc levels in the Kenai River (Sires 2017).

Storm water transportation systems were another data gap identified. There was not a readily available collection of storm water systems for the Kenai Peninsula. Each town along the river should have a public utilities department and hard-copy maps with these systems locations. These hard copy maps would need to be converted to digital copy, geo-located and features digitized from them. Heavy metals are most commonly transported through storm water runoff. Once transport and runoff locations are identified, management practices could be implemented to capture heavy metals before they could enter the stream system.

The last gap identified was snow storage locations. Municipal snow storage facility locations would be on record with the Kenai Borough. This data is valuable because the snow contains emissions and pollution which, when melted, could runoff into the Kenai River.

Literature Review Sources

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