Mapping the gaps in Alaska’s seafloor: Procedures, products, and prospects for completion

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Talk organization

• Introduction—why work on bathymetry?
• Procedures—“smooth sheet” methods
• Products – data, web page, tech memos, papers
• Prospects for funding
• Future directions
  • Finish & maintain Alaska bathymetry
  • International collaborations (GEBCO)
Chartered bottom trawling fishing vessels

(Photos by Adam Poquette, NEFSC)
Alaska Fisheries Science Center
Trawl surveys of fish populations

- Gulf of Alaska
  - 825 stations
  - Odd years
  - 75 days

- Aleutian Islands
  - 420 stations
  - Even years
  - 70 days

- Bering Sea
  - 376 stations
  - Every year
  - 65 days

- Bering Sea slope
  - 200 stations
  - Even years
  - 60 days

- Gulf of Alaska
  - 825 stations
  - Odd years
  - 75 days
Importance of bathymetry

- Predictor of fish abundance & distribution
- Trawl survey stations & strata
- Trawl survey biomass estimates
- ***NEW Modeling approach for population estimates NEW***
- But our bathymetry maps are terrible!
2. Procedures

- Old hydrographic surveys (NOS)
- “Smooth sheets” & unproofed data available online
- GIS proofing and editing
  - Latitude/Longitude positioning
  - Tide information
  - Depth errors
Kiliuda Bay, Kodiak island

Navigation chart 16592, 1:80,728, 1990 Edition

Smooth sheet H05152, 1:20,000, 1931
17x substrates, 30x soundings
"The initial NOS data retrieval project, referred to as the Asheville Project, transferred data into electronic format by manually digitizing the smooth sheets of ~3200 selected surveys conducted in the 1930’s through 1973."

Wong et al. Assessing 155 years of hydrographic survey data for high resolution bathymetry grids
Proofing smooth sheets
Reading the smooth sheet

lots of critical information especially lat./long. and tides
Geographic reference system

- Horizontal Datums
  - WGS84 – GPS units
  - NAD83 - modern charts
  - Historical smooth sheets: Valdez, Port Hobron, Unalaska,

- Triangulation stations shape file.

http://www.ngs.noaa.gov/cgi-bin/sf_archive.prl
Reynolds, 1930. First-order triangulation in southeast Alaska.
△Left, 1928, Lat: 57° 15' 28.406" -878.7 m
Long: 152° 56' 46.997" -787.9 m

DESIGNATION – LEFT
57 15 36.14415(N)
152 56 29.49216(W)
NAD83

Horizontal Control:
Latitudes & Longitudes

Δ Left, 1928:
Lat: 57°15'28.406" N, 152°56'46.997" W
NAD83

DESIGNATION – LEFT
57 15 36.14415(N)
152 56 29.49216(W)
NAD83

17.50484 seconds
or 293.529 meters

7.73815 seconds
or 239.380 meters

Longitude = -152.80000
Latitude = 57.23333
Alignment with triangulation stations
Tidal reference:
High and low tides

KODIAK ISLAND, AK  StationId: 9457292

Weekly Tide Prediction in Feet
Time Zone: LST/LDT
Datum: MLLW

http://tidesandcurrents.noaa.gov/tide_predictions.shtml
MHW = -7.9 Feet = -1.3 Fathoms

Horizontal Control: Triangulation stations
Bathymetry example: Shearwater Bay
Digitize the shoreline (MHW)
Create a complete bathymetry surface
Connect to land, river, and watersheds

Streams and rivers: ftp://ftp.dnr.state.ak.us/asgdc/adnr/hydro_63360.zip
Align with orthographic photos
3. Products

- Regional bathymetry compilations
- NOAA Tech. memos
- Web page
- NOAA priorities
  - Essential Fish Habitat (EFH)
  - NOAA’s Deep Sea Coral Research and Technology Program (DSCRTP)
  - NPRB's Gulf of Alaska - Integrated Ecosystem Research Program (GOA-IERP)
- GEBCO priorities
## Progress - tabular

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<th>Features</th>
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<td>In progress</td>
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<td>Yes</td>
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<td>Inside waters</td>
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Progress - geographical

Bathymetry Progress
Completed (Year)

Arctic (funded 2018)

Eastern Bering Sea Slope (2018)

Norton Sound (2015)

Cook Inlet (2014)

Central Gulf of Alaska (2015)

Western Gulf of Alaska (finalizing)

Eastern Gulf of Alaska (finalizing)

Aleutian Islands (2013, revision 2017-19)

Imagery - Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
NOAA Tech. memos

Smooth Sheets: How to Work with Them in a GIS to Derive Bathymetry, Features and Substrates

- NOAA Technical Memorandum NMFS-AFSC-249
- NOAA Technical Memorandum NMFS-AFSC-250
- NOAA Technical Memorandum NMFS-AFSC-275
- NOAA Technical Memorandum NMFS-AFSC-287
- NOAA Technical Memorandum NMFS-AFSC-298
doi:10.7289/v5v69gj5

Smooth Sheet Bathymetry of the Aleutian Islands
Smooth Sheet Bathymetry of Cook Inlet, Alaska
Smooth Sheet Bathymetry of the Central Gulf of Alaska
Smooth Sheet Bathymetry of Norton Sound
Shortraker rockfish (*Sebastes borealis*)

Model-based Essential Fish Habitat Definitions for Bering Sea Groundfish Species

Predictive models of coral and sponge distribution, abundance and diversity in bottom trawl surveys of the Aleutian Islands, Alaska

Christopher N. Rooper, Mark Zimmermann, Megan M. Prescott, Albert J. Hermann

Validation and improvement of species distribution models for structure-forming invertebrates in the eastern Bering Sea with an independent survey

Christopher N. Rooper, Michael F. Sigler, Pam Goddard, Pat Malecha, Rick Towler, Kresimir Williams, Rachel Wilborn, Mark Zimmermann

Using species distribution models to describe essential fish habitat in Alaska

Edward A. Laman, Christopher N. Rooper, Kali Turner, Sean Rooney, Dan W. Cooper, and Mark Zimmermann

Influence of environmental factors on capelin distributions in the Gulf of Alaska

David W. McGowan, John K. Horne, James T. Thorson, Mark Zimmermann
Walleye pollock (Gadus chalcogrammus)
Pacific cod (Gadus macrocephalus)
Pacific Ocean perch (Sebastes alutus)
Arrowtooth flounder (Atheresthes stomias)
Sablefish (Anoplopoma fimbria)
Comparison of the physical attributes of the central and eastern Gulf of Alaska Integrated Ecosystem Research Program inshore study sites

Mark Zimmerman

https://doi.org/10.1016/j.dsr2.2018.05.011
Verification of historical smooth sheet bathymetry for the Gulf of Alaska - Integrated Ecosystem Research Program (in review)
Mark Zimmermann, Alex De Robertis, and Olav Ormseth

Box plot shows 10%, 25%, Median, 75%, and 90%.
((Smooth sheet – Echosounder)/Echosounder)*100
Volcanic ash deposition, eelgrass beds, and inshore habitat loss from the 1920s to the 1990s at Chignik, Alaska

Mark Zimmermann a, *, Gregory T. Ruggerone b, Jeffrey T. Freymueller c, Nicole Kinsman d, David H. Ward e, Kyle R. Hogrefe e

Article

Bathymetry and Canyons of the Eastern Bering Sea Slope

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thalweg [tahl-veg] or canyon centerline or line of lowest elevations
Detail of NOS navigational chart 16006 (Edition 37, 2015, Scale 1:1,534,076), showing reported pinnacles in the Zhemchug Canyon area.
GEBCO bathymetry

Our bathymetry
4. Prospects for funding

- Complete all Alaska regions?
- Create and maintain bathymetry database?
- Research grant history
- Salary grant history
Research grants

- PI - International Science Fellowship 2017 (FY18), NMFS S&T (Arctic).
- Co-PI for HAIP funds for 2013-2014, predicting trawlability.
- Co-PI for NPRB, 2008-2011, Gulf of Alaska trawlability work.
- PI for NPRB, 2004-2006, Aleutian Islands trawlability work.
Salary grants

- Lead PI for NPRB funds for 2017-2019 for Aleutians bathymetry revision.
- Lead PI for AKR EFH funds for 2016-2017 for SE AK bathymetry compilation.
- Lead PI for AKR EFH funds for 2015-2016 for EBS Slope bathymetry compilation.
- Lead PI for AKR EFH funds for 2013-2014 for Cook Inlet bathymetry compilation.
5. Future directions

- Regions to map?
  - Prince William Sound? Kotzebue Sound? Chukchi?

- Tailor products for what uses?
  - Resolutions? Vertical datums (MLLW vs. MSL)?
  - Shift toward derived products – thalwegs, bay metrics, pass cross-sections

- Permanent funding source
  - Need plan to finish Alaska, create database

- GEBCO collaboration
  - seafloor feature naming
  - global bathymetry compilation