Quantifying the Availability of Tidewater Glacial Ice as Habitat for Harbor Seals in a Tidewater Glacial Fjord in Alaska Using Object-Based Image Analysis of Airborne Visible Imagery

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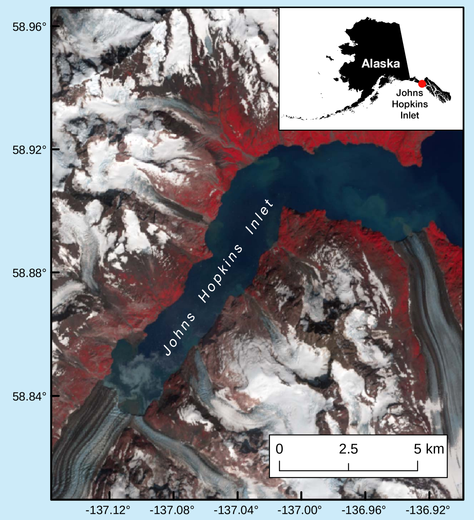
1. Background

- Tidewater glaciers are a prominent feature along the southeastern and southcentral coasts of Alaska and play an important role in landscape and ecosystem processes.
- Glacial ice serves as an important substrate for harbor seals for resting, pupping, nursing young, molting, and avoiding predators.
- Tidewater glaciers are naturally dynamic and many of the ice sheets that feed tidewater glaciers in Alaska are thinning and/or retreating.
- Changes in available ice may influence harbor seals; however, relationships between the availability of glacial ice and harbor seal spatial distribution are currently unknown.



2. Research Overview

- This research aims to assess the relationship between glacial ice availability and harbor seal spatial distribution in Johns Hopkins Inlet, Glacier Bay National Park through analysis of a time series of airborne visible imagery.
- The three main objectives of the work are:

  1) Map the distribution harbor seals.

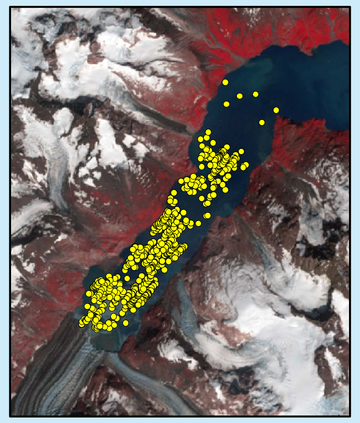
  2) Develop and apply automated methods for quantifying ice cover and properties from airborne imagery.

  3) Develop statistical models linking seal distributions to ice cover and properties.

3. Airborne Data Collection

- Since 2007 the National Park Service has carried out airborne surveys over Johns Hopkins Inlet to coincide with Harbor Seal pupping (June) and molting (August): ~6-8 surveys/year.
- Aerial surveys are conducted along a grid of 12 transects at an altitude of 1000 feet.
- Non-overlapping visible images acquired using a GPS-linked digital SLR camera (~4cm pixels).
- Using ArcGIS the images are georeferenced and then seals are manually counted including delineating adults from pups.

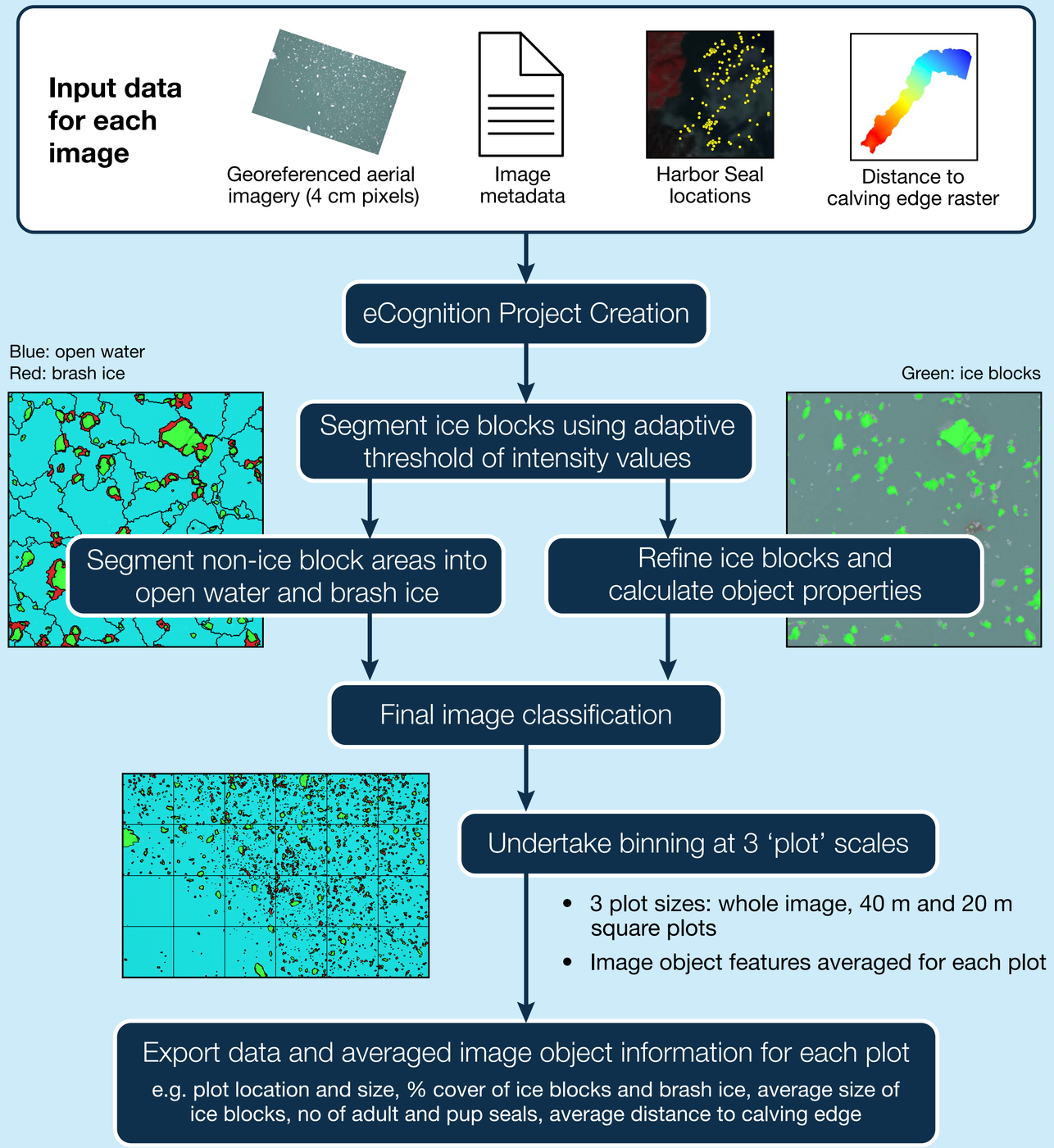
Examples of 4 cm optical images of Harbor Seals resting on glacial ice in Johns Hopkins Inlet: the images highlight the varied ice conditions and seal distributions



Seal locations mapped from 06/18/2007 survey

4. Object-Based Image Analysis (OBIA) Workflow

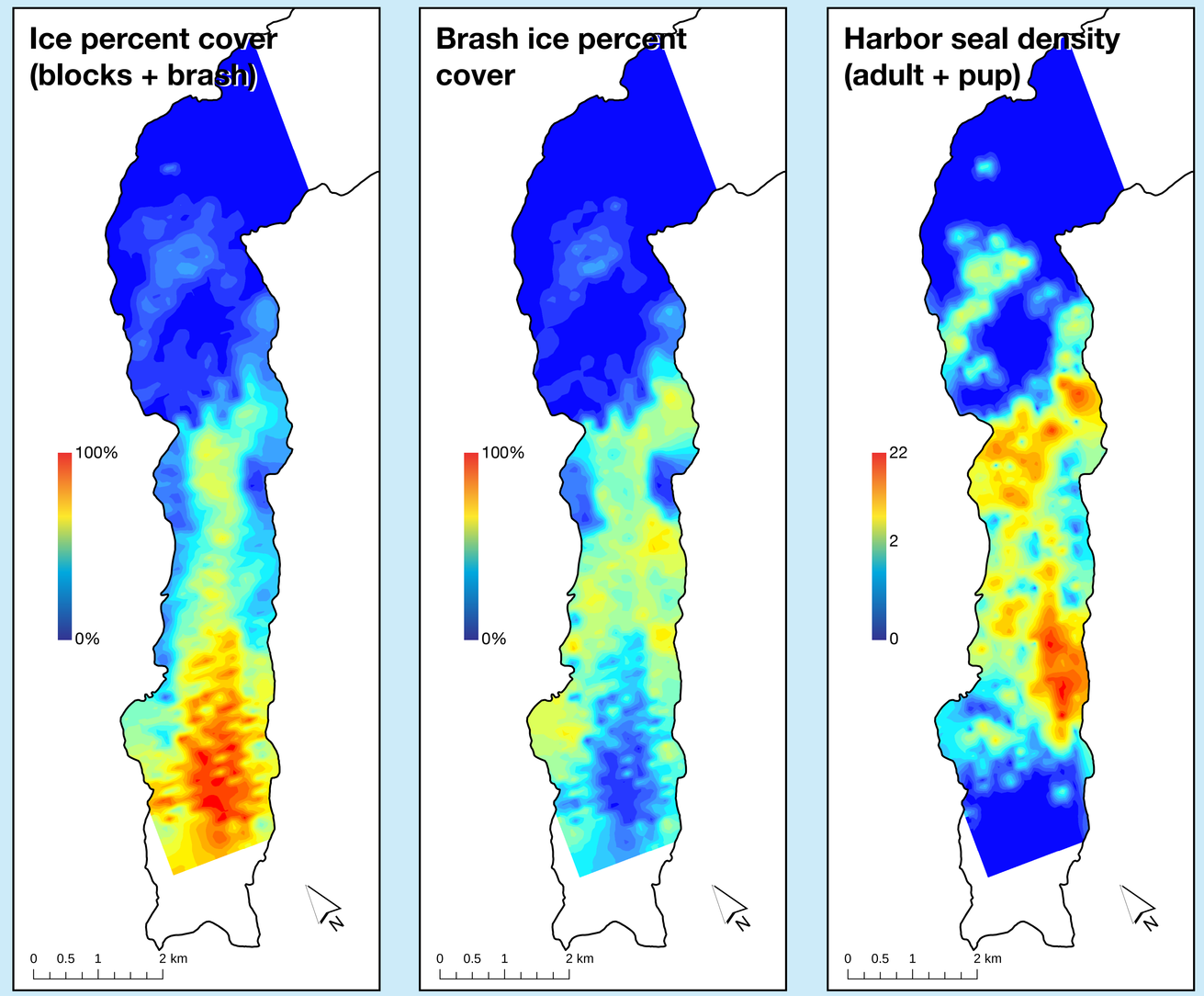
- OBIA workflow developed using Trimble eCognition to automate the classification of airborne visible imagery and quantification of glacial ice conditions.
- OBIA is based upon segmentation of imagery into coherent image features or objects that can be classified, merged or re-segmented based upon object properties (e.g. shape, size, color).
- Multiple step processing workflows enables contextual analysis and classification.
- eCognition rule-set also ingests existing vector/raster data and outputs summary results at three different 'plot' scales providing the inputs to statistical models.

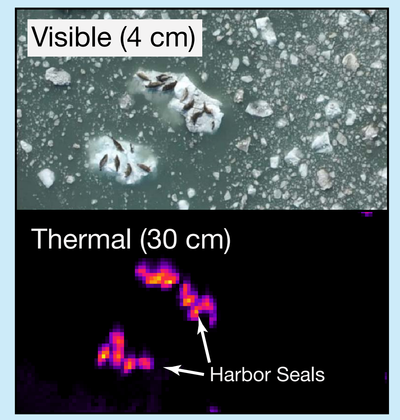


- Batch processing implemented using eCognition Server on high performance workstation.
- Time consuming: ~24 hours per survey (will be better with more server licenses).
- 42 surveys (2007-2012) x ~800 images/survey = ~33,000 images to process.

5. Example Results

- Version 1 of the OBIA workflow is currently being applied to the 2007-2012 survey data
- The OBIA results from 2007-2012 will provide input covariates for the development of statistical models linking seal distribution to ice properties.
- Examples of gridded products (data from image-scale plots interpolated using a radial basis function) from the 06/13/11 survey over Johns Hopkins Inlet are shown below:





6. Conclusions and Future Developments

- We have developed an automated workflow for quantifying ice conditions from large volumes of airborne visible imagery that will be used to investigate the relationship between Harbor Seal distribution and tidewater glacial ice availability in Johns Hopkins Inlet.
- Future work will include further development of the OBIA workflow and addition of new sensor types (e.g. thermal): see example FLIR image from Johns Hopkins Inlet (8/14/2013).

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