Representative Polygon Generation for Cycle-Averaged Lake Products

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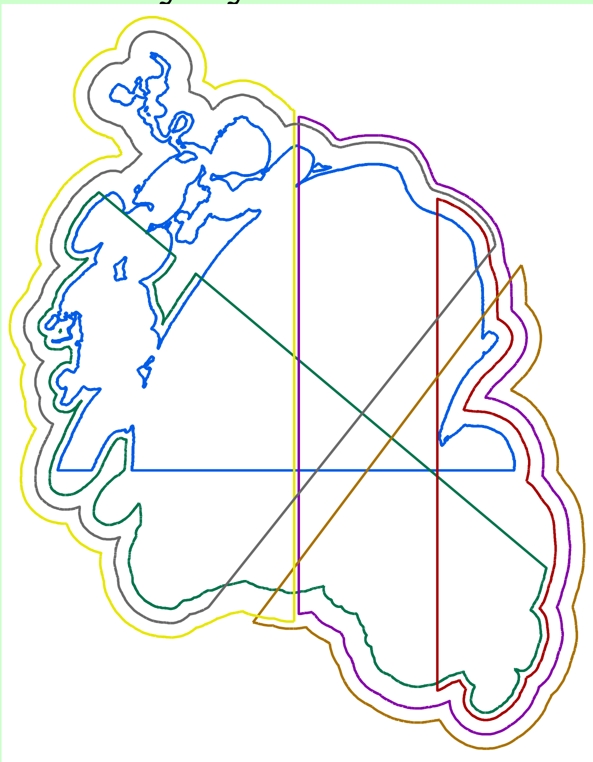
Background

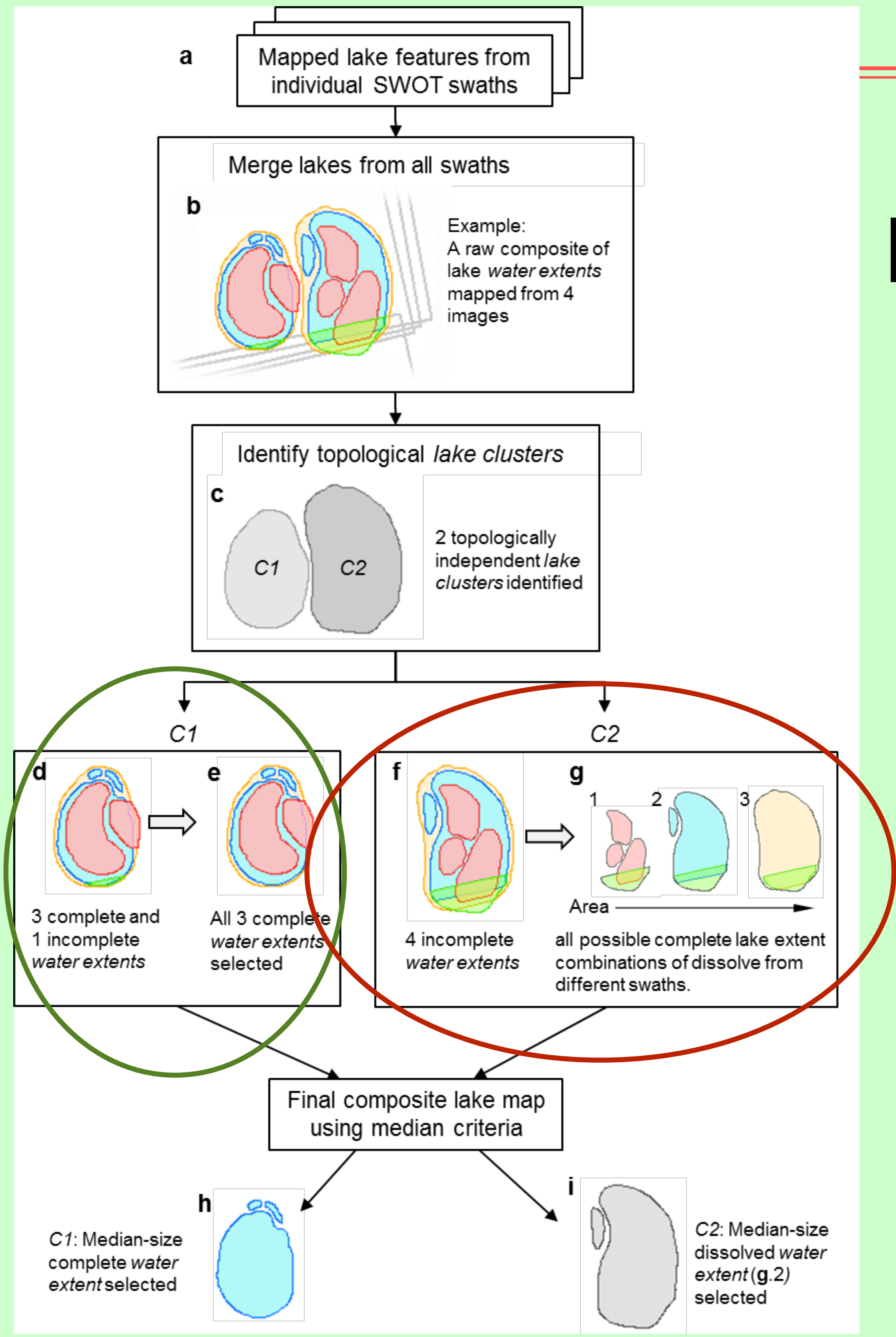
- Multiple lake observations (completely or partially) in 21-day cycle:
  - 2-4 times at low latitudes;
  - >10 times at high latitudes.
- Cycle-averaged lake products:
  - Averaging lake attributes;
  - How about the lake shape?
    - There is no such an "average" shape.
    - Currently, maximum lake extent is being considered.
      - Pro:
        - Easy implementation.
      - Con:
        - Not so "averaging" or representative;
        - Vulnerable to over-estimation of lake mapping;
        - No plan handling half lakes.



- Objectives:
  - To produce more representative lake shape for the cycle period;
- Challenges:
  - Lake dynamics in the cycle period;
  - Half lakes;
  - Lake mapping error;
  - Imperfect image georeferencing.

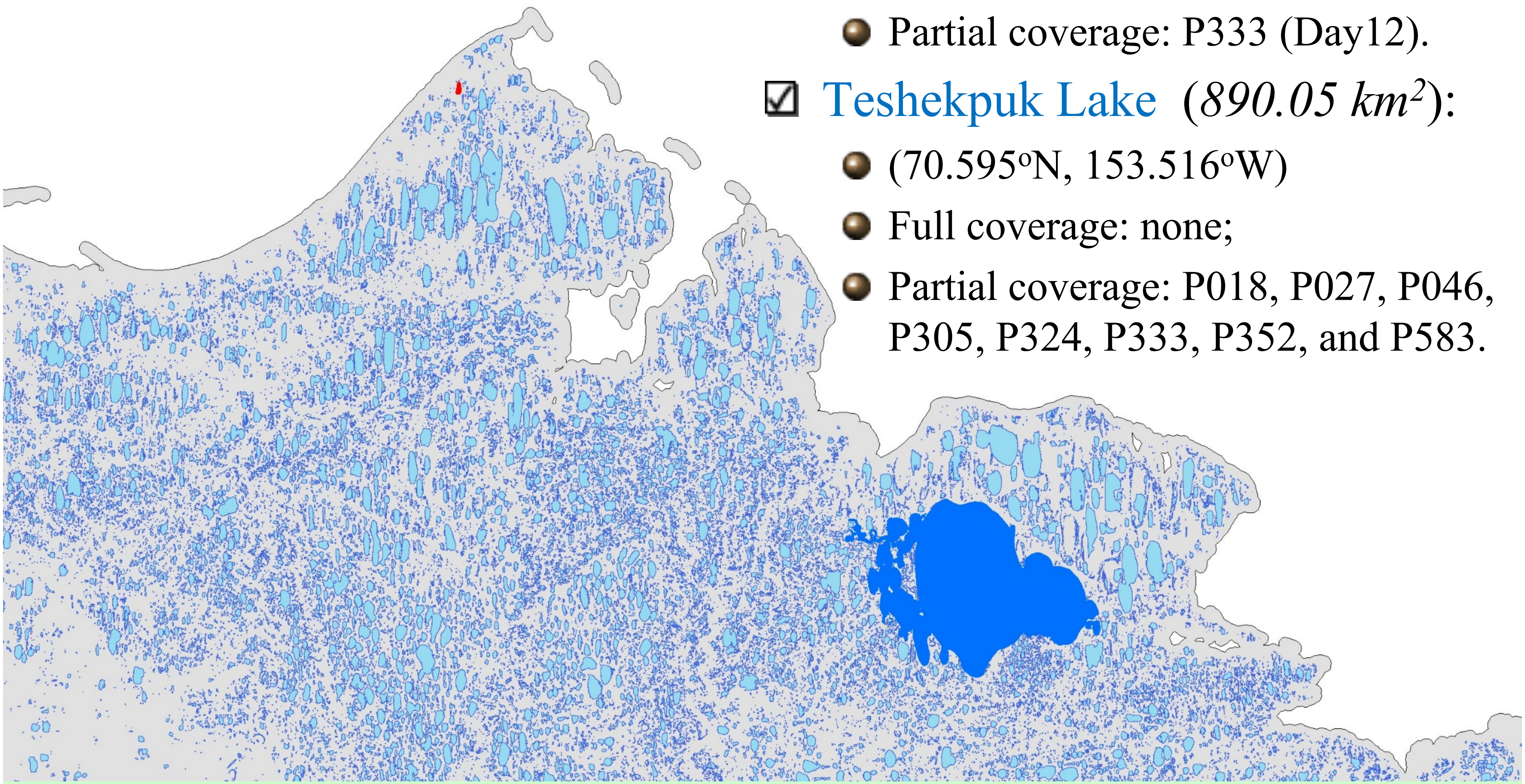
Median-sized Lake Compositing

(Sheng et al, 2016)



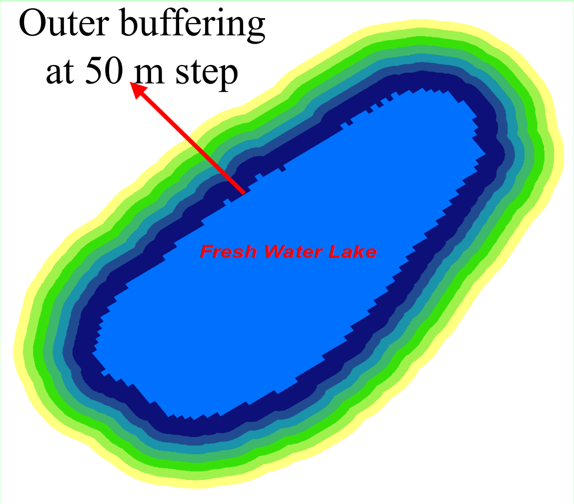
Testing Cases

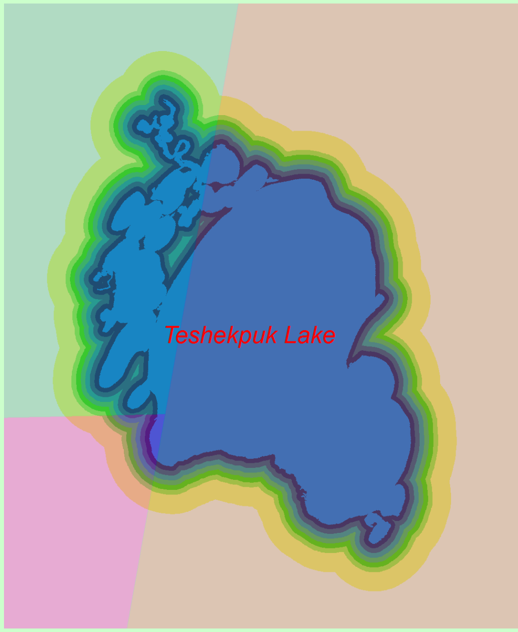
- ☑ Fresh Water Lake (*1.89 km²*):
  - (71.241°N, 156.773°W)
  - Full coverage: P027, P055, P074, P102, P305, P380, and P408;
  - Partial coverage: P333 (Day12).
- ☑ Teshekpuk Lake (*890.05 km²*):
  - (70.595°N, 153.516°W)
  - Full coverage: none;
  - Partial coverage: P018, P027, P046, P305, P324, P333, P352, and P583.



Testing dataset preparation

- ☑ Processing procedures:
  - Lake polygons from Circa-2015 lake database;
  - Lake dynamics using buffers (or raising lake level using DEM);
  - Observed lake polygons clipped by SWOT passes.
- ☑ Freshwater Lake: creating buffer polygons of the original lake using a 50-m buffer distance.
- ☑ Teshekpuk Lake: distance set to 500-m (2000-m for last one).

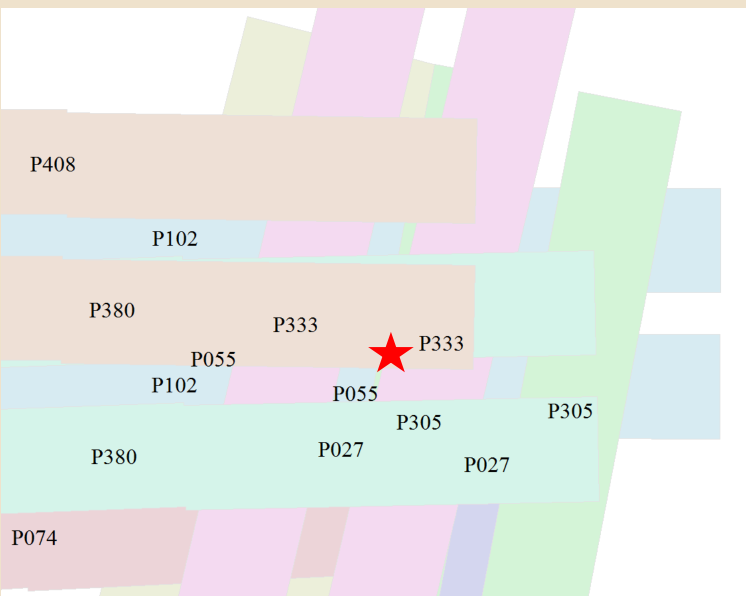


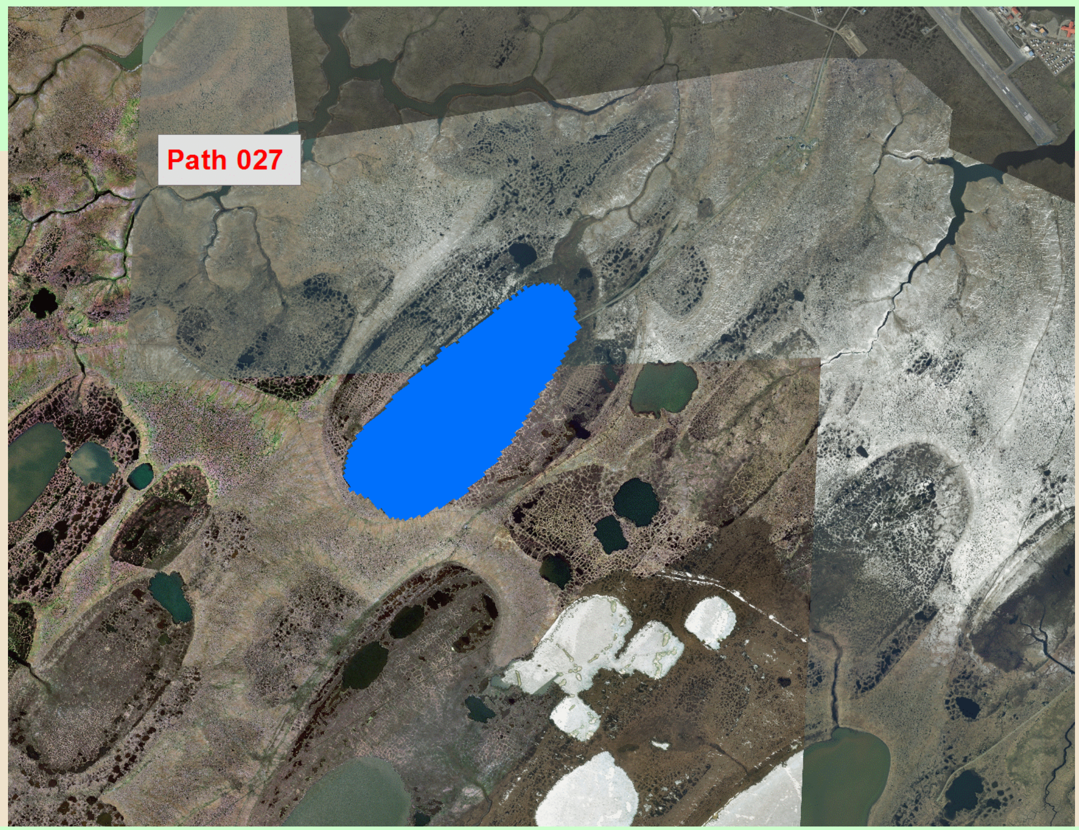


P018: 850 (km2)
P027: 980
P046: 1078
P305: 1242
P324: 1401
P333: 1321
P352: 1162
P583: 1726 Over-mapping?

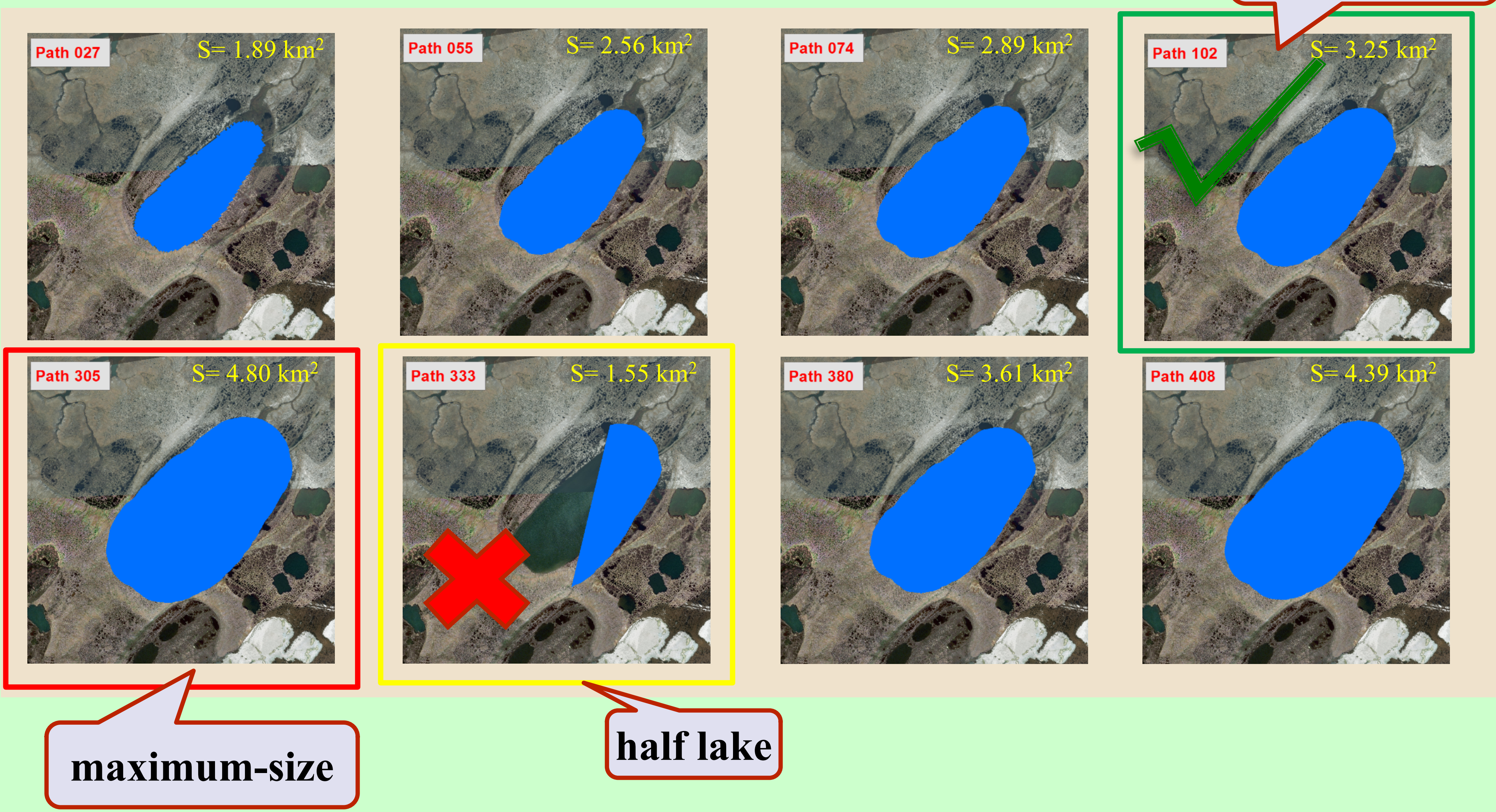
Case 1: Freshwater Lake

Seven-time full-coverage observations and one-time partial-covered observation within 21-day cycle





Results: Case1 Freshwater Lake

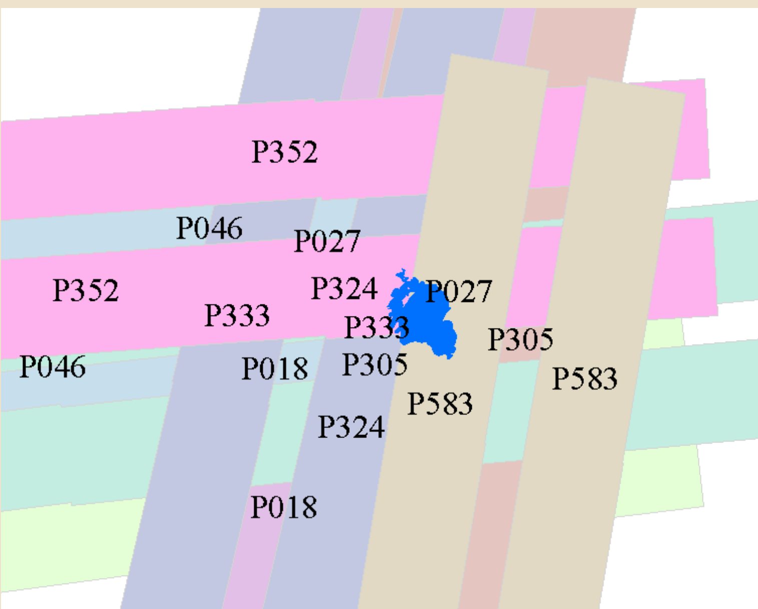


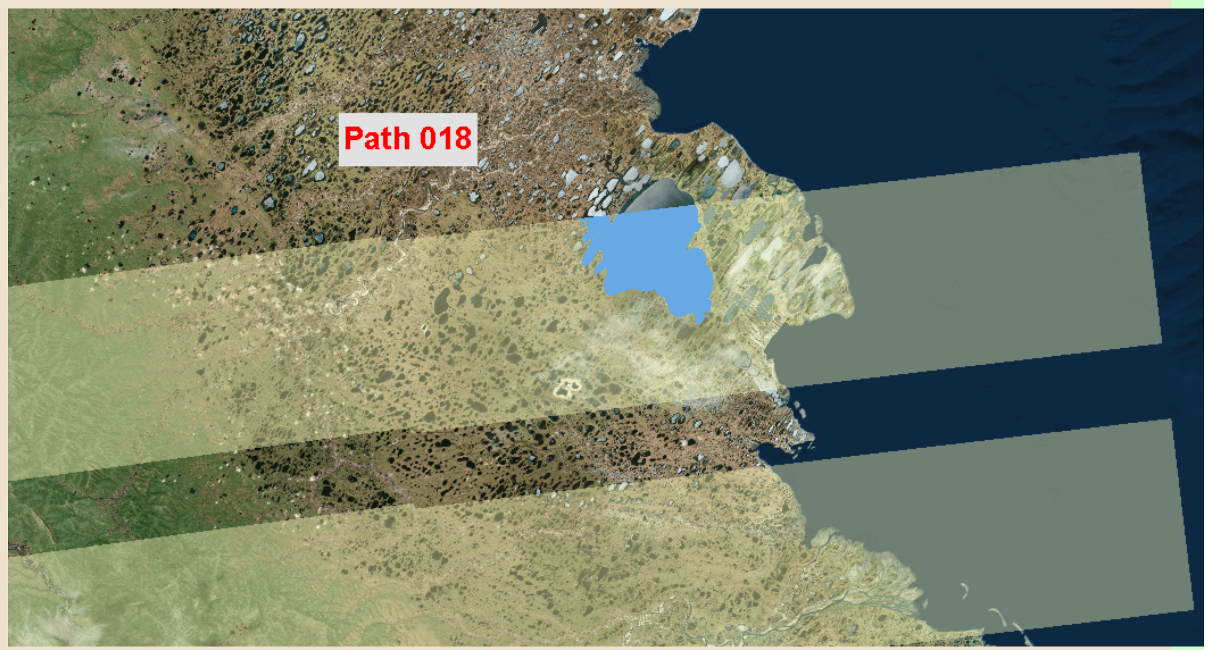
Multi-temporal, median-size composite scheme applied:

max area: 4.80 km^2, min area: 1.89 km^2, stdev. area: 0.94 km^2, med area: 3.25 km^2.

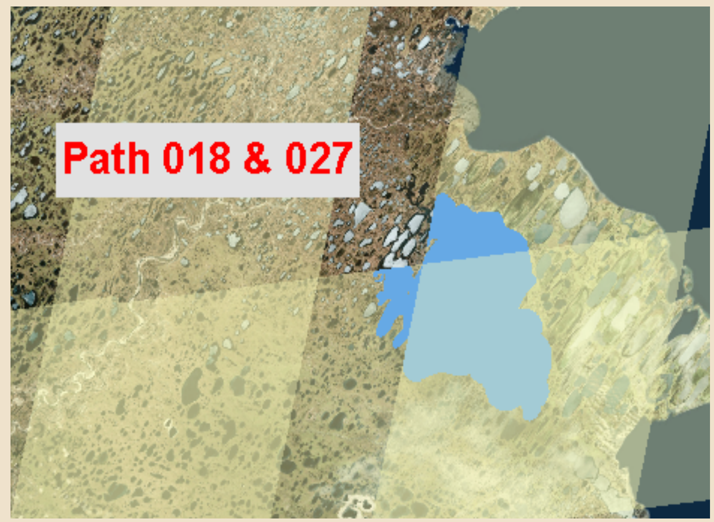
Case 2: Teshekpuk Lake

Eight-time but partial observations within one 21-day cycle (half lakes)





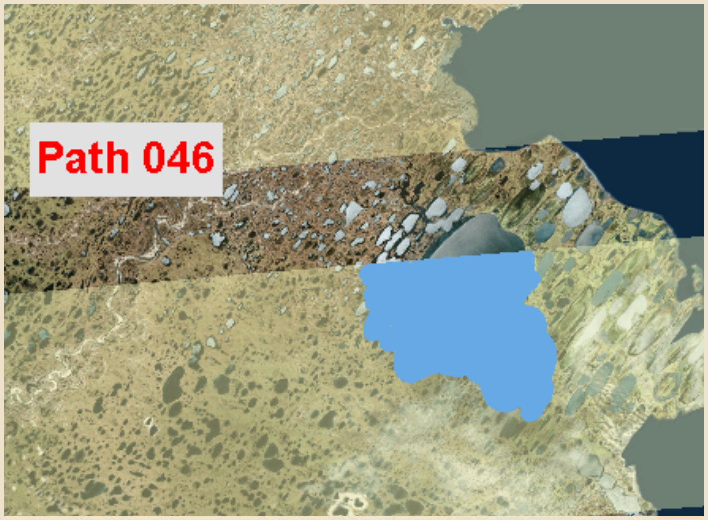
Half-lakes → Half-lake

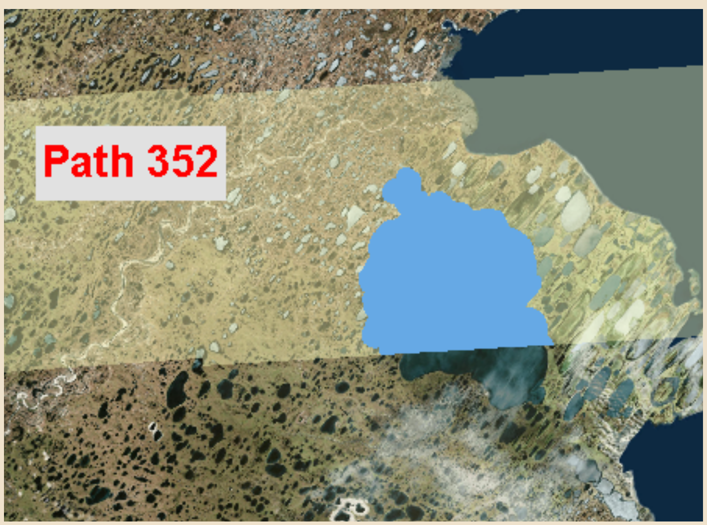


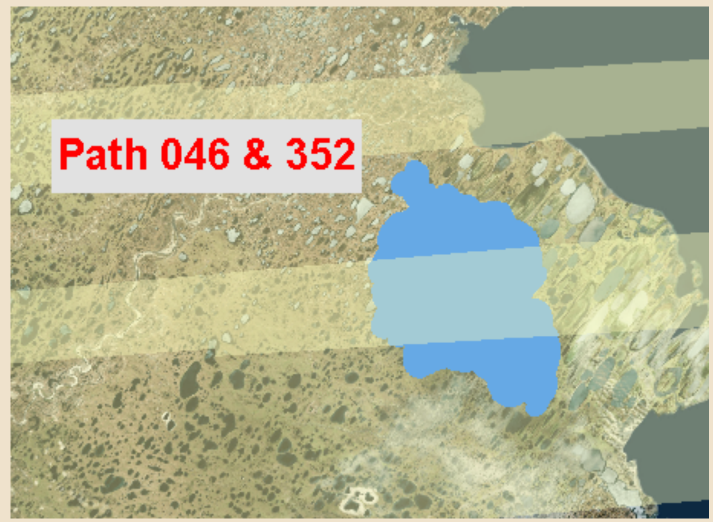
Multi-temporal, half-lake composite scheme applied:

sectional combinations

Half-lakes → Full lake







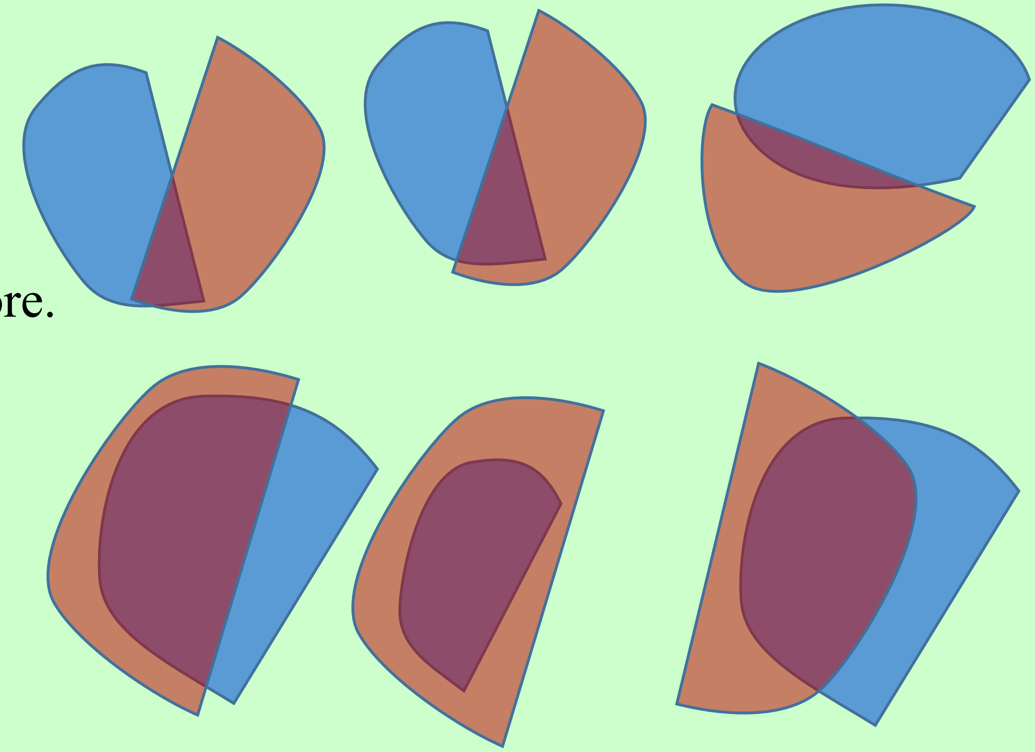
Multi-temporal, half-lake composite scheme applied:

acceptable combination

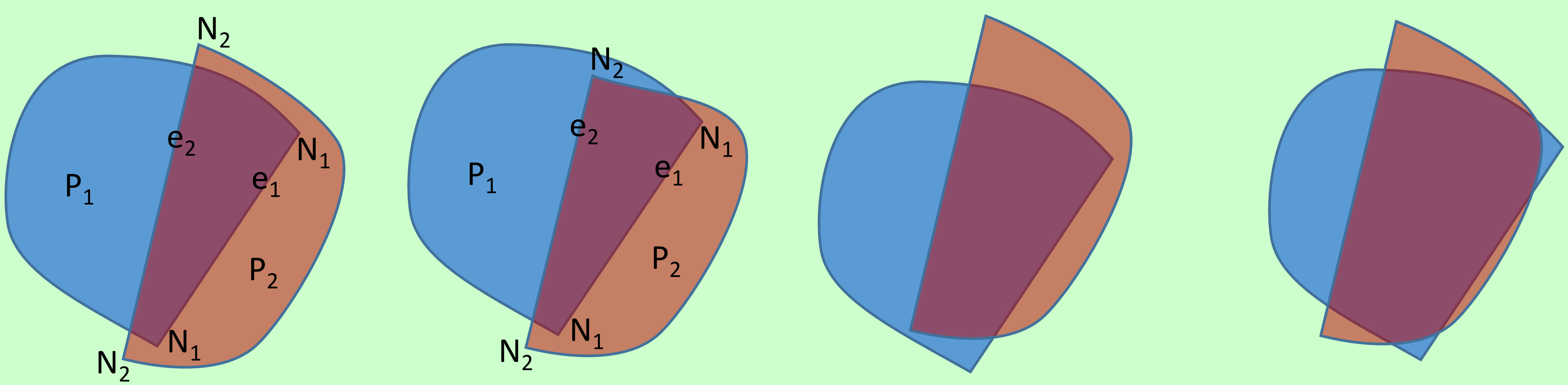
Two half pieces: n=2

- ☑ Judge half lake:
  - If they form any edge corner.
  - If all edges intersects the other lake shore.

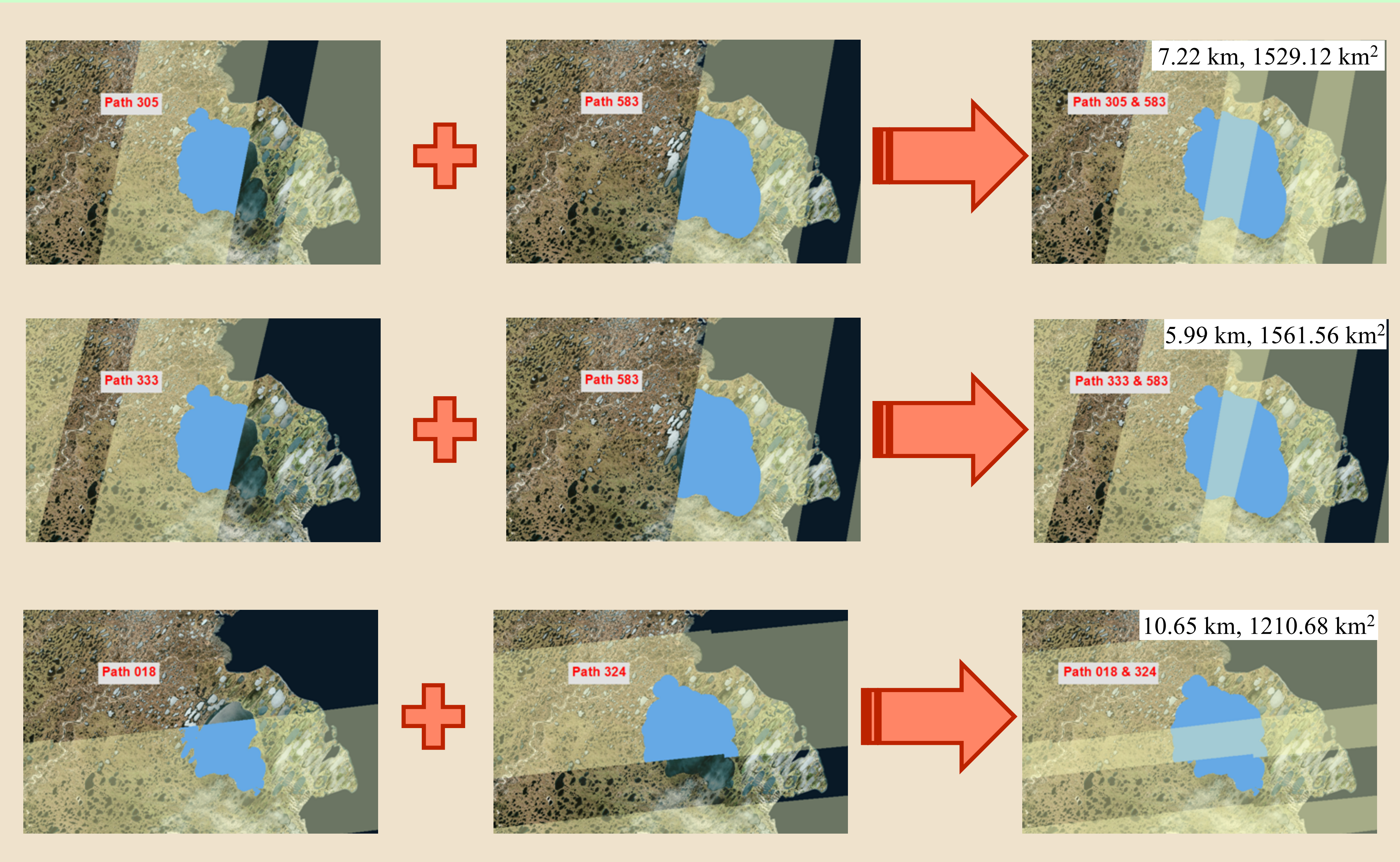
Half lake cases

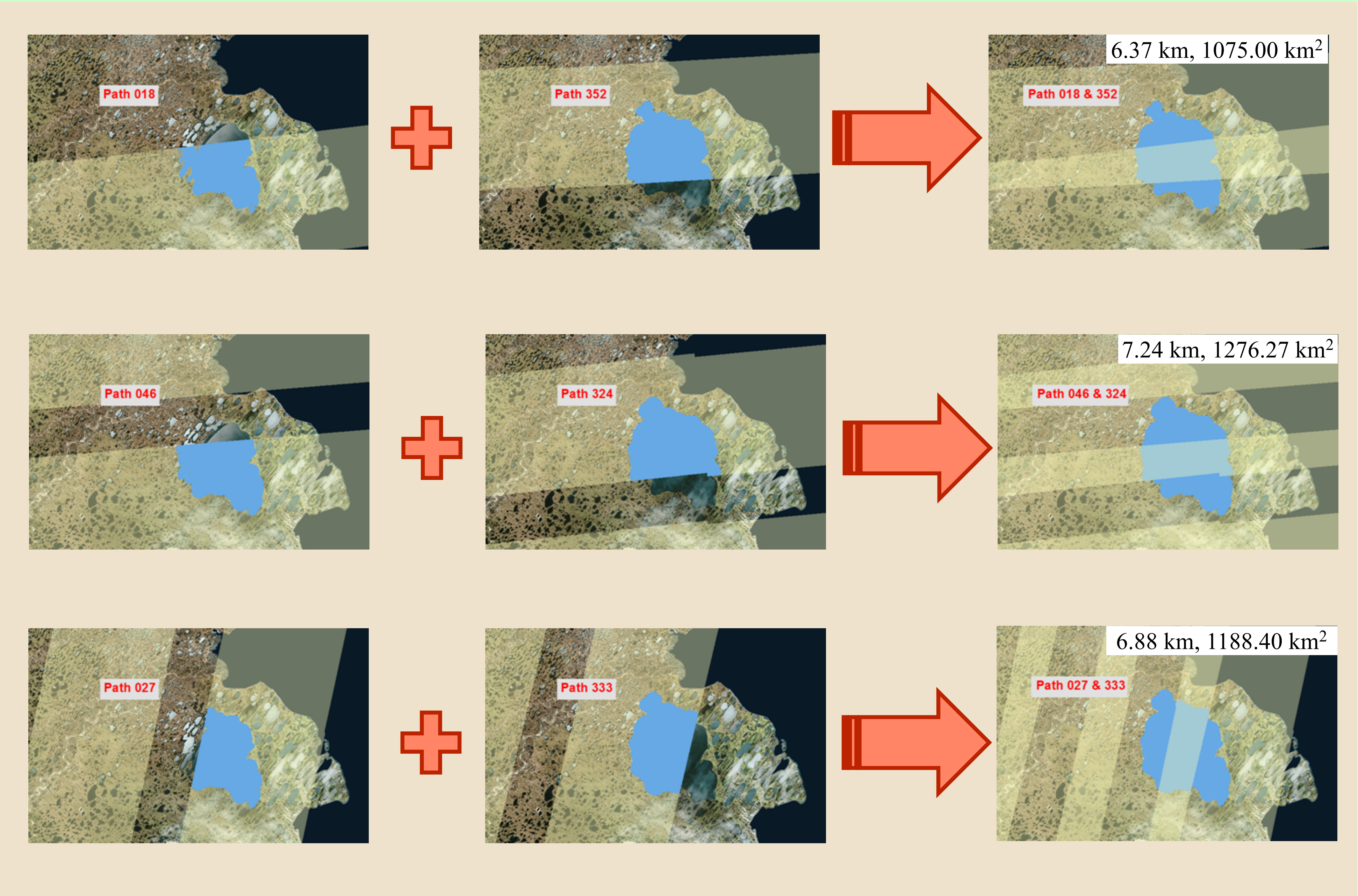


Full lake cases



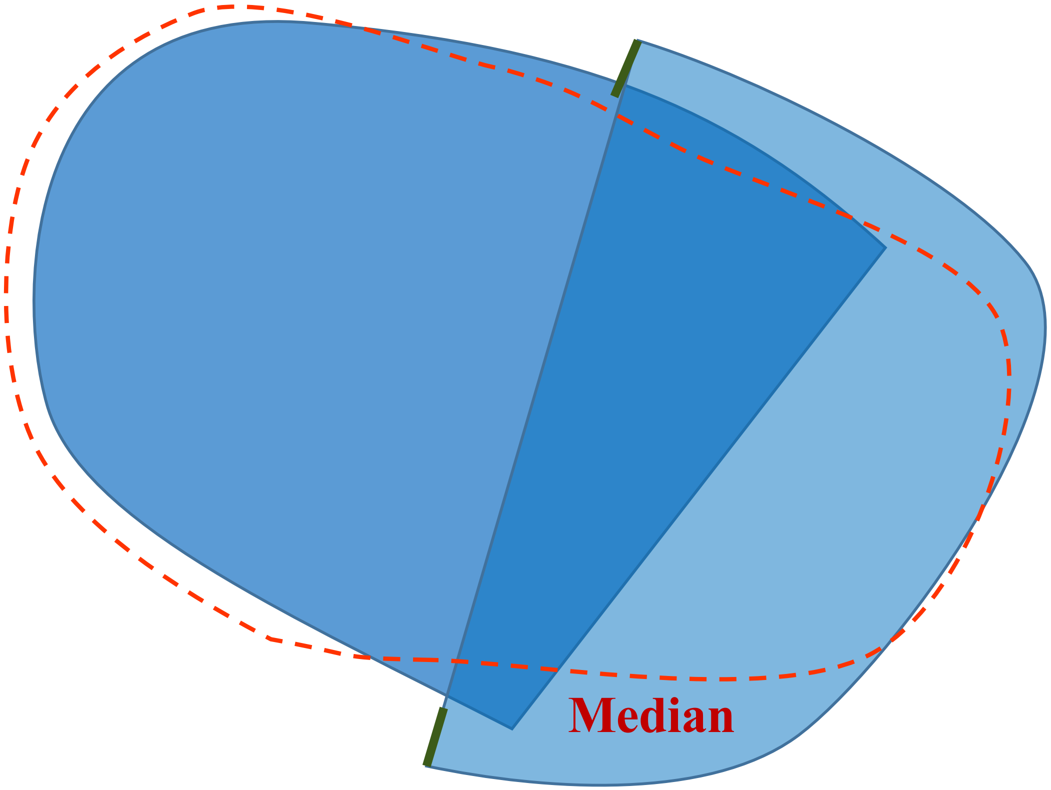
8 Combined Full Lakes

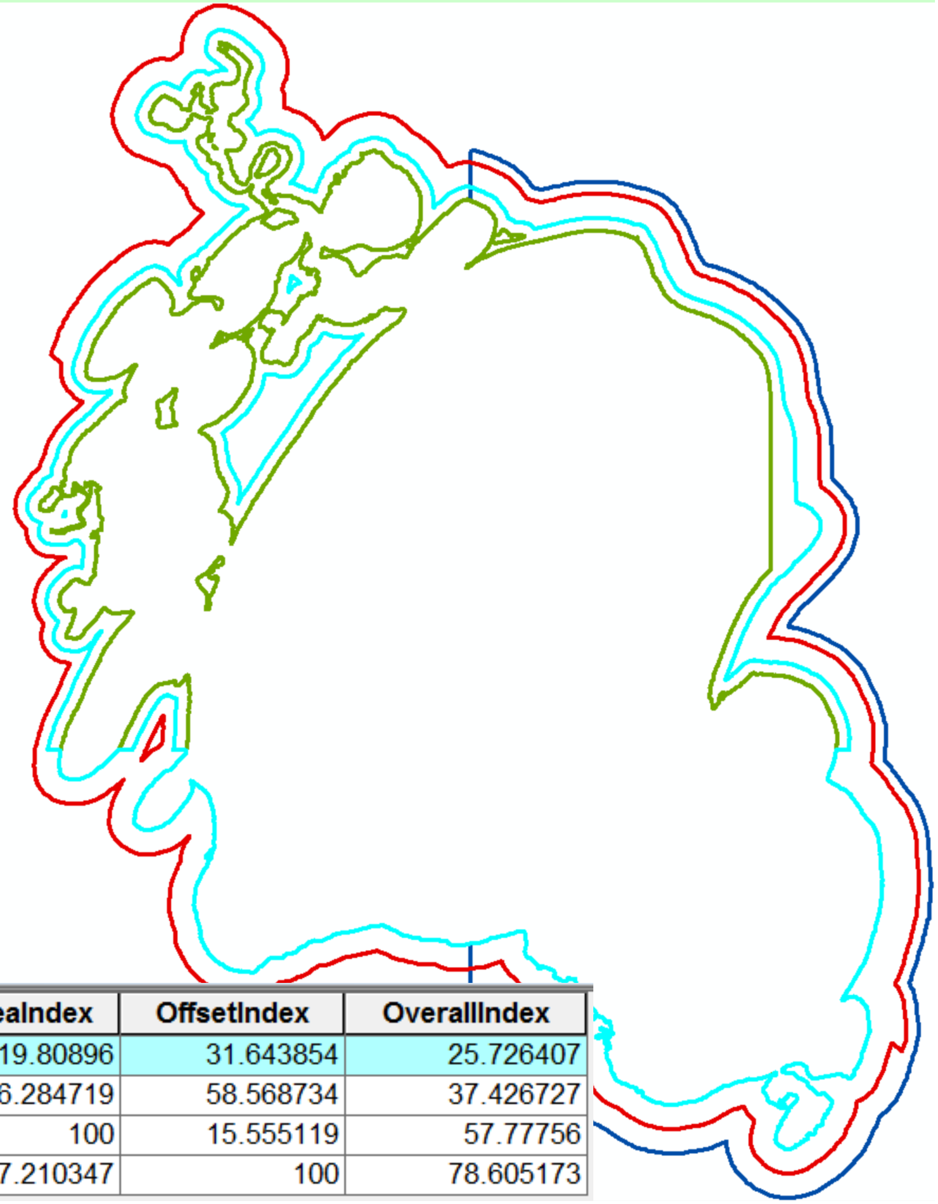



Path 018
Path 352
6.37 km, 1075.00 km^2
Path 018 & 352
Path 046
Path 324
7.24 km, 1276.27 km^2
Path 046 & 324
Path 027
Path 333
6.88 km, 1188.40 km^2
Path 027 & 333

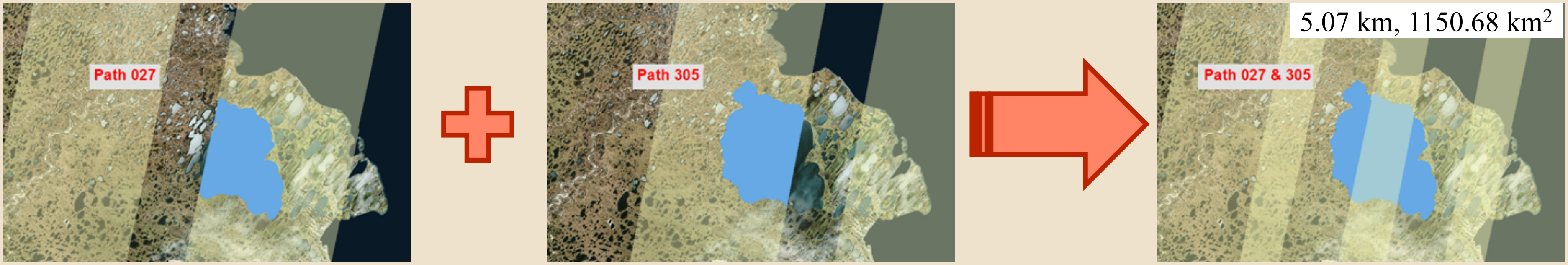
Optimal Polygon Selection

- ☑ Piece margin offset;
- ☑ Area deviation from median.



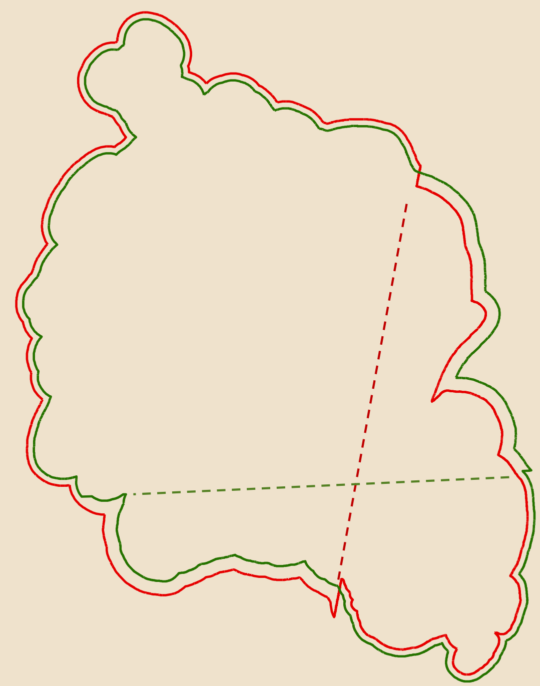


OBJECTID *	pass_merg	Offset	Area_Difference_with_Median	AreaIndex	OffsetIndex	OverallIndex
1	012_052	2249.8067	34551668.877982	19.80896	31.643854	25.726407
2	073_032	4164.105	34551668.877982	16.284719	58.568734	37.426727
4	022_062	1105.933928	149505963.075772	100	15.555119	57.77756
3	073_052	7109.7746	129309458.938493	57.210347	100	78.605173

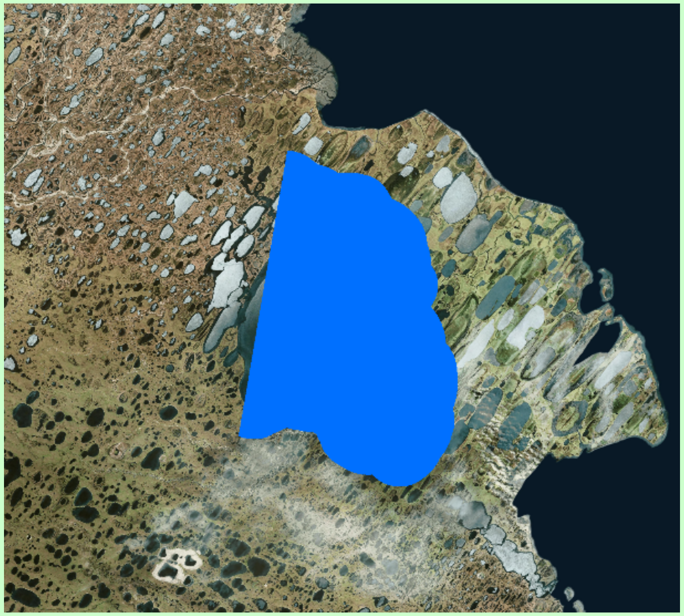


max area: 1561.56 km^2
min area: 1075.00 km^2
stdev. area: 170.72 km^2
med area: 1210.68 km^2
Selected: 1130.30 km^2

P018: 850 (km^2)
P027: 980
P046: 1078
P352: 1162
P305: 1242
P333: 1321
P324: 1401
P583: 1726

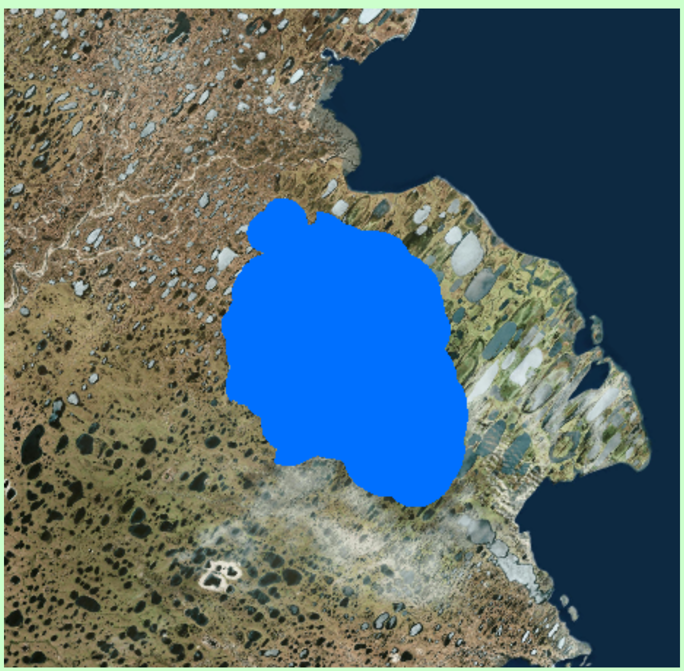


Comparison with Maximum Compositing



Maximum composite scheme:

the observation by Path583 is selected, with the area of 1174.78 km^2

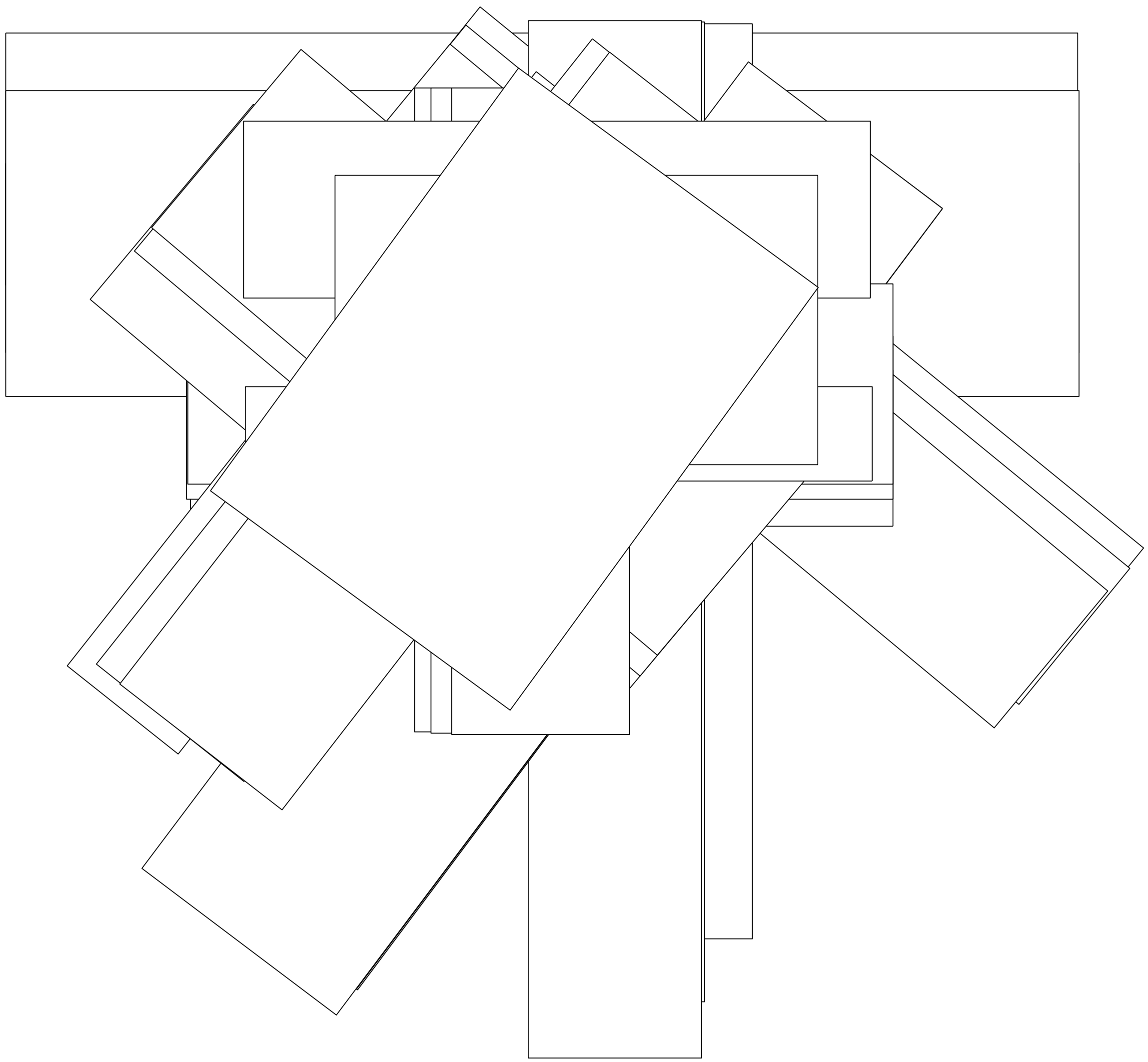


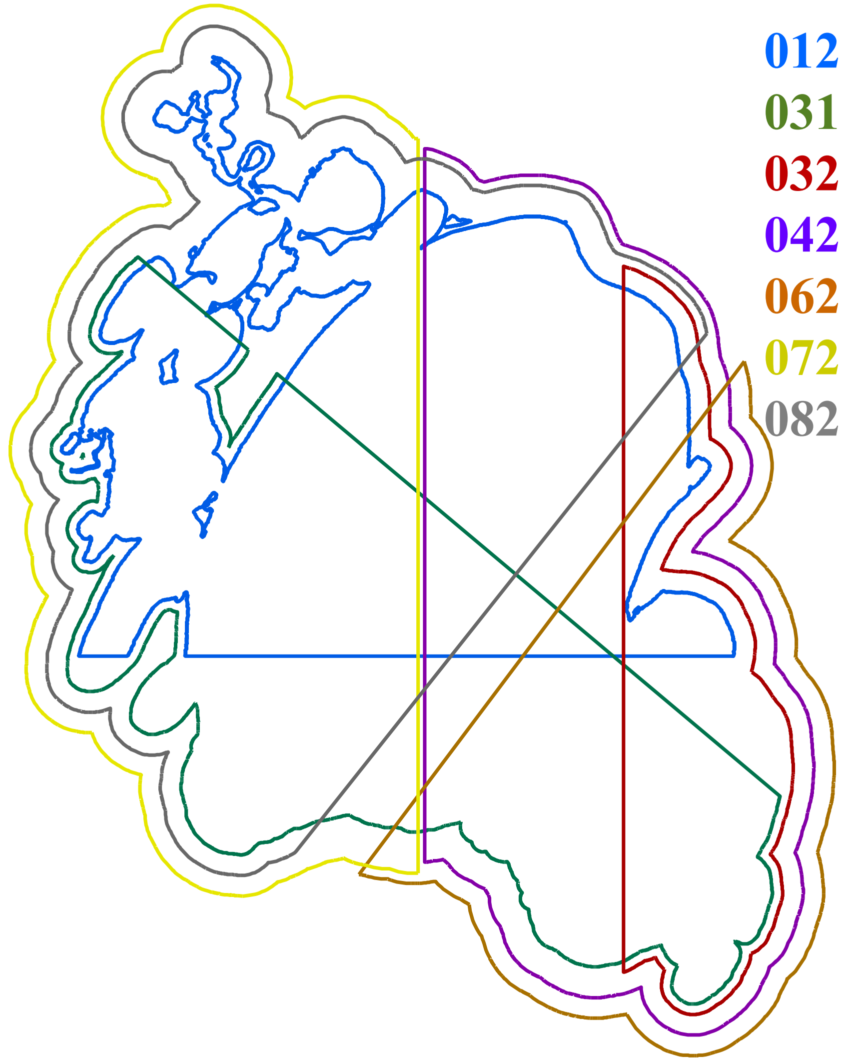
Union composite scheme:

all half-lake observations are dissolved to form a union water body area, with the area of 1587.90 km^2

What if two pieces are not enough?

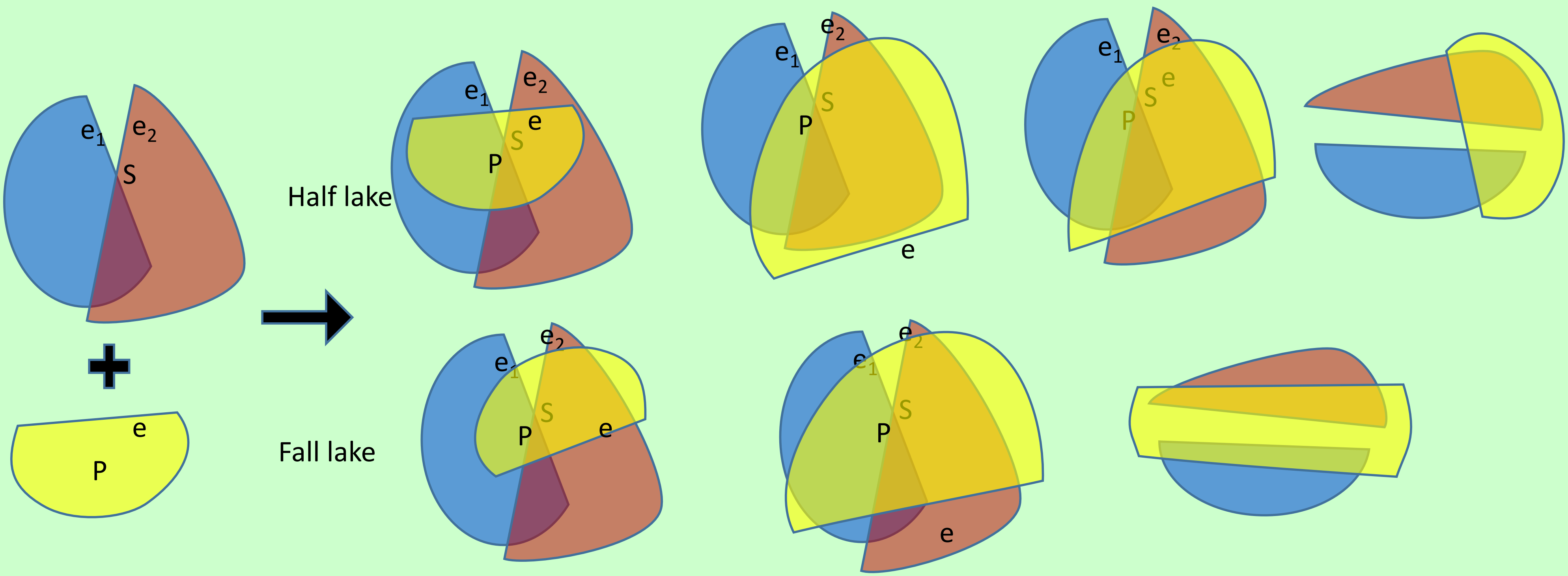
☑ 27 passes & 8 lake pieces.



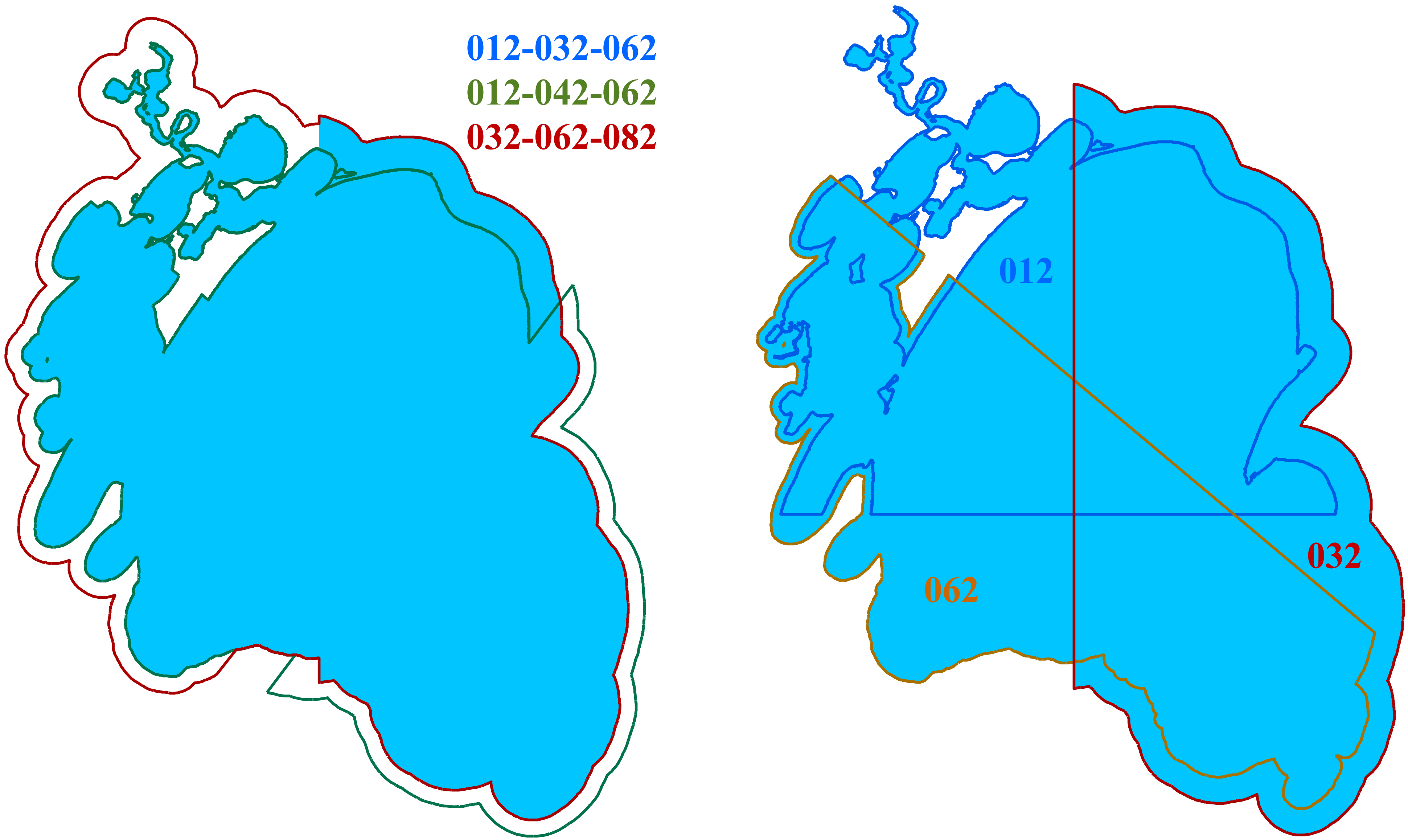


Multiple half pieces: n>= 2

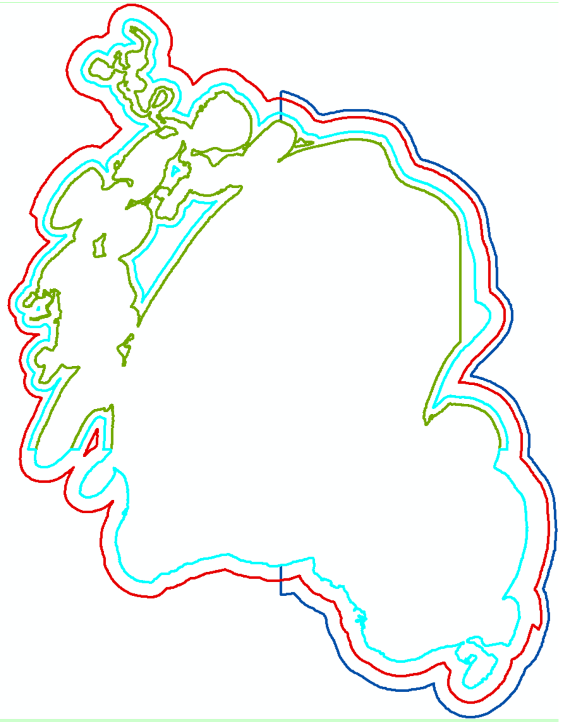
- Judge half lake:
  - If they form any edge corner.
  - If all edges intersects the other lake shores;

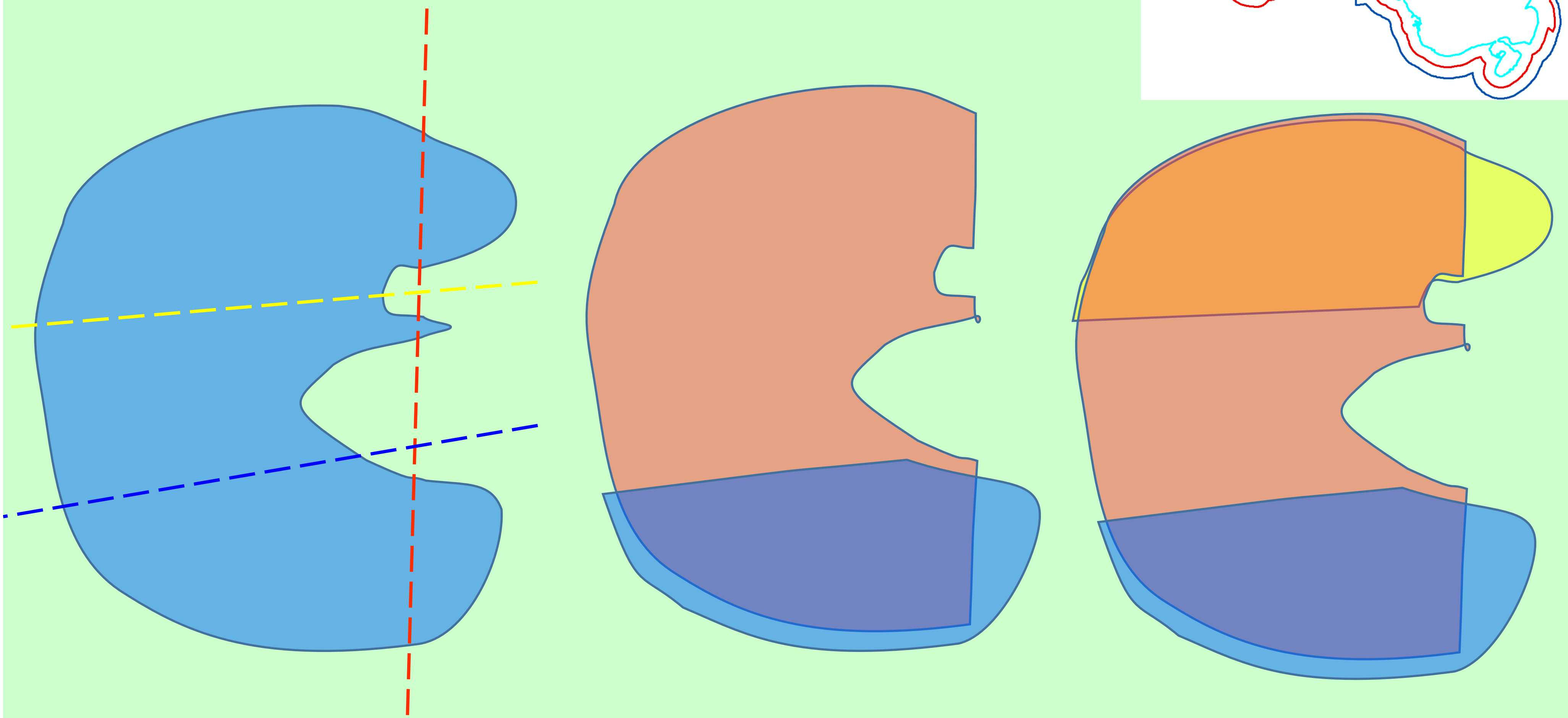


Full Lakes from 3-pieces

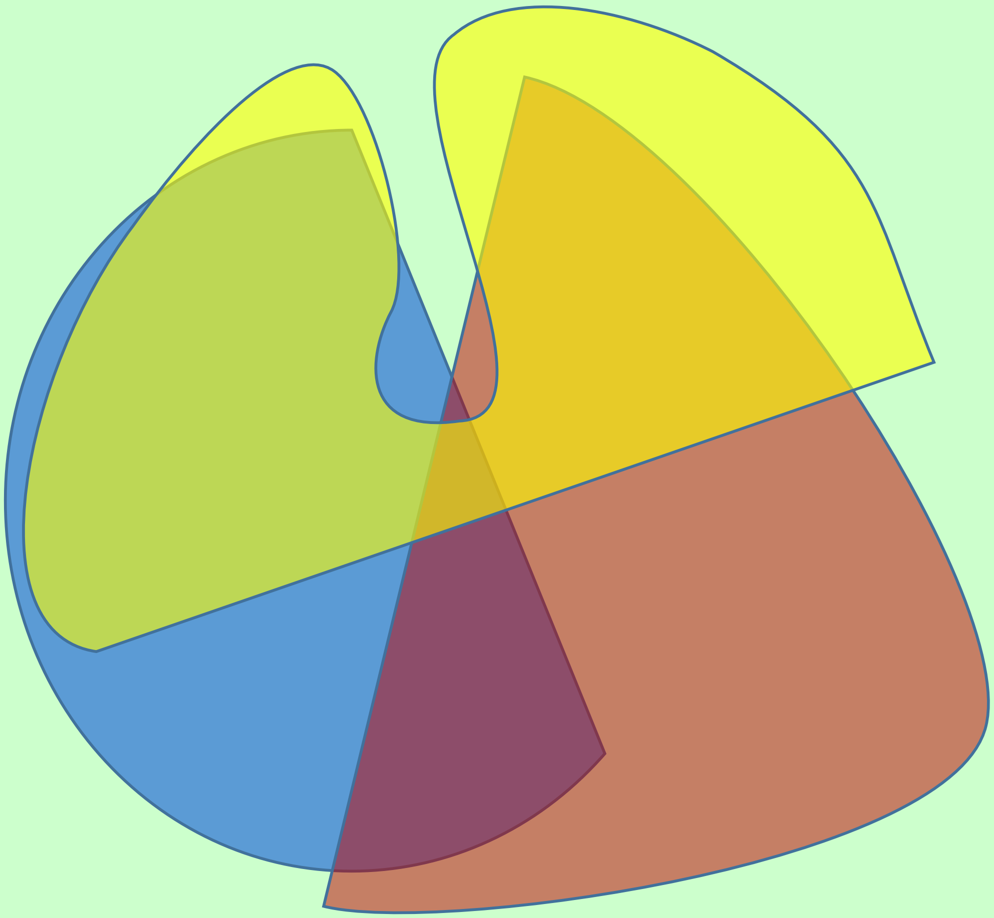


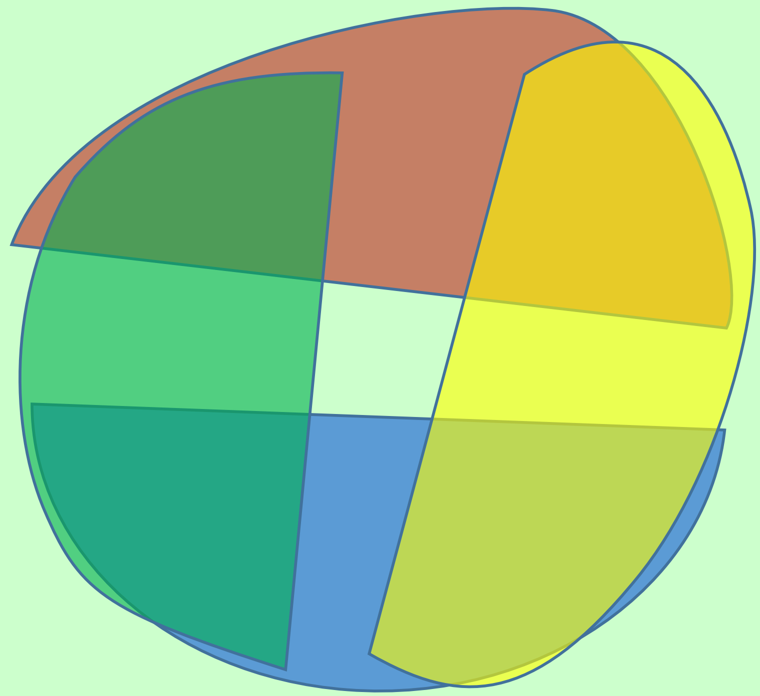
More to consider





More challenging cases ……





Summary

- ☑ Median-sized polygons are more presentative to the "averaging" lake shape in a cycle.
- ☑ The scheme is less vulnerable to lake mapping error.
- ☑ This scheme is potentially applicable to future season-averaged and annual-averaged lake product generation.
- ☑ More complicated cases deserve further investigation.