Realities and Challenges of Airborne Operations along the Coastal Zone

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Introduction

The purpose of the this presentation is to provide feedback and analysis of airborne remote sensing mapping operations in the Coastal Zone.

We will present statistics showing

- Estimated flight time requirements vs. actuals
- Challenges and restrictions in the coastal zone, including
  - Tide requirements
  - Weather
  - Low clouds and fog
  - Military operations
  - Coordinating multi- agency participation, including Map Once, Use Many Times

Background

- As NOAA and similar agencies world wide focus their attention on coastal zone issues, airborne mapping activity has expanded into areas that present multiple challenges to field operations and geospatial data production.

- Recent projects have been designed to support research and policy decisions on a variety of needs, including CMSP, sea-level rise baseline, LULC analysis, coastal erosion and the Digital Coast.

- High resolution LIDAR data and digital imaging systems have been actively deployed via fixed-wing aircraft to collect precise information through thousands of miles of flight lines along the west coast of the United States.

Project Review – NCMP

National Coastal Mapping Program (NCMP): California, Oregon, and Washington

Purpose

- Collection of topographic, bathymetric, and imagery data along the US west coast shoreline to provide a seamless dataset representing the coastal condition, in support of the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) NCMP.

Area of interest

- From shoreline inland 500 meters along the entire coast, including federally authorized projects.

Project Review - NCMP

National Coastal Mapping Program (NCMP): California, Oregon, and Washington

Concurrency Requirements

- In areas where valid bathymetry data are obtained, topographic data is being collected so that the resulting bathymetric and topographic lidar data may be merged later with no discontinuity.

- Hyperspectral data is being collected concurrent with the lidar data so that the resulting elevations and imagery depict the same ground condition.

Tidal Requirements

- Bathymetric (Airborne LIDAR) data – High tide
- Topographic data – MLLW / MLW
- RGB Imagery – None
- Hyperspectral Imagery – MLLW / MLW

Project Review - NCMP

National Coastal Mapping Program (NCMP):
California, Oregon, and Washington

Additional Requirements

- Cloud and fog free
- Air traffic restrictions coordination, including multiple military bases along California coast

Products

- Topographic data, 1m nominal, 15cm vertical (RMSE), .5m horizontal (RMSE)
- Bathymetric data, 5m nominal, 15cm vertical (RMSE), 1.5m horizontal (RMSE)
- RGB Imagery, 35cm GSD, geo-referenced to LiDAR within 3m (RMSE)
- Hyperspectral imagery, 1m GSD, geo-referenced to LiDAR within 3m (RMSE)

Washington Weather News

The Seattle Times August 11, 2010

From Manhattan to Moscow, summer has been a sweltering affair for much of the globe. But from **Seattle to San Diego**, the West Coast has been trapped in a twilight zone of drizzle, fog and temperatures more conducive to fleece than bikinis. Blame an unusually strong high-pressure system sprawled across more than a million square miles of the Pacific, shoving cool marine air and clouds toward the coast.

Monday, August 16, 2010 - Seattle, WA

KOMOnews.com

Why has it been so foggy this summer?

In Seattle proper, since July there have been 19 days with fog at some point, of which 7 have had dense fog with visibility of 1/4 mile or less. Over on the coast, it's been worse with **Forks reporting 32 days of fog (out of 38)** with 14 days experiencing dense fog. **Forks averages 13 days** from July 1-August 31

SEATTLE WEEKLY

The Gloomiest Summer in the History of Seattle

Tue., Aug. 10 2010

According to a University of Washington researcher (Jim Johnstone) who studies such things, this is the gloomiest, most cloud-covered summer since we started keeping these sorts of depressing measurements in 1951….. Seattle has experienced three times the average amount of low clouds and fog.

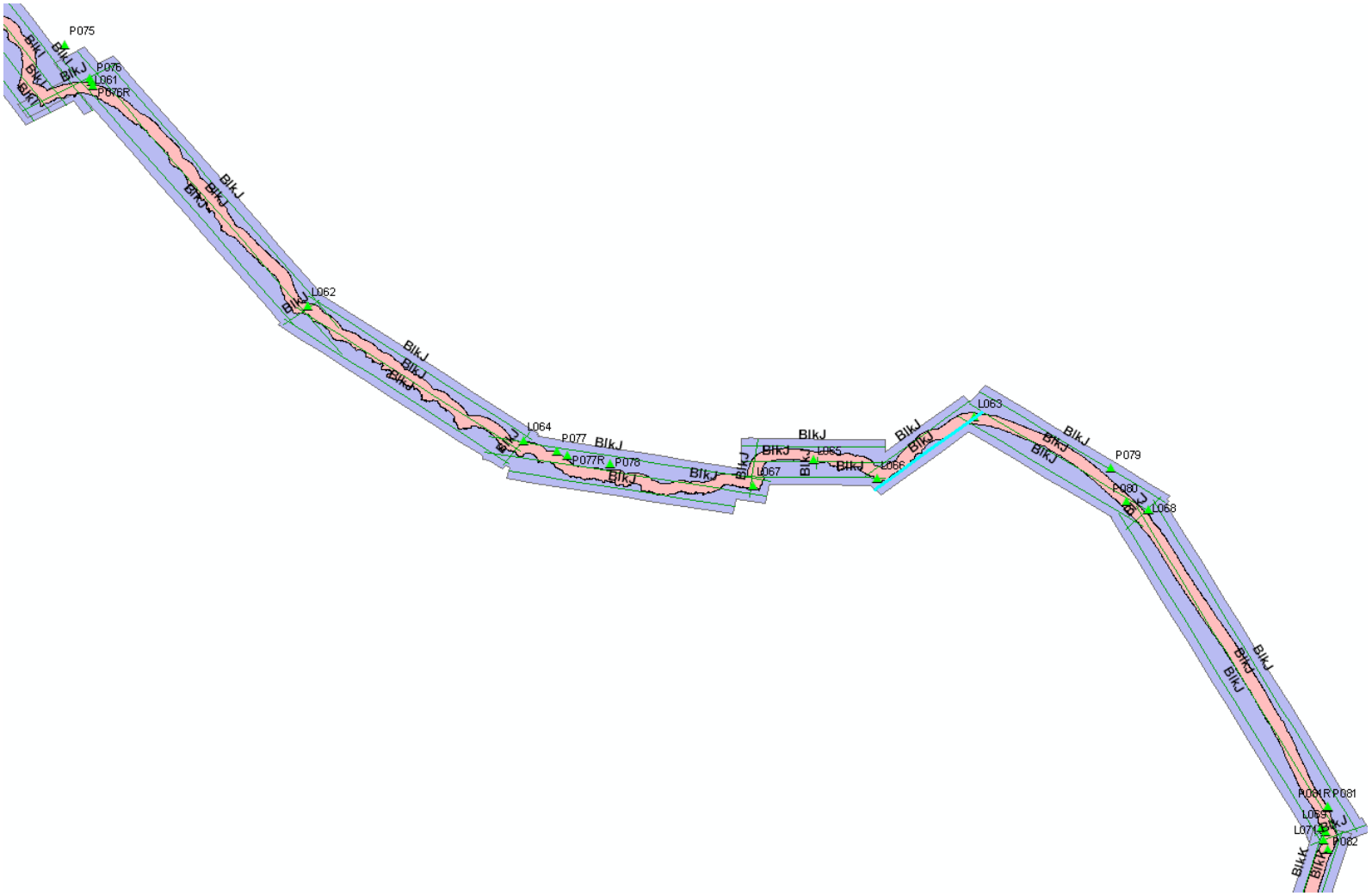
"Along the coast it's been abysmal," he says. "Foggy low clouds every day. It's amazingly bad." Rejoice! Someone else is suffering more!

Oregon Weather News

The coast is clear? Hardly. Oregon's beaches have been extra cool and cloudy this summer August 11, 2010

NEWPORT – You may not be able to prove it as a scientific fact, but ask anyone anywhere on the Oregon coast and they will tell you, this seems like the coolest, grayest summer in memory. Ever.

Project Area – NCMP



A portion of block J (one of 40 Topographic LiDAR acquisition blocks)

Tidal Window Chart – October 2010 - NCMP

Date	Tidal Window	CASI Window	Total Acq. Window	Comment
10/1/2010				No tides
10/2/2010				No tides
10/3/2010				No tides
10/4/2010	20:36-22:24	17:50-24:00	1h 48m	No tides
10/5/2010	20:36-23:54	17:55-24:00	3h 18m	Data Acquired
10/6/2010	20:54-23:54	17:55-24:00	3h 00m	Weather / fog
10/7/2010	21:30-23:48	17:55-23:55	2h 18m	Weather / fog
10/8/2010	22:06-23:48	18:00-23:50	1h 42m	Data Acquired
10/9/2010	22:54-23:48	18:00-23:50	0h 54m	Weather
10/10/2010	23:42-23:42	18:00-23:50	1h 00m	Data Acquired
10/11/2010				No tides
10/12/2010				No tides
10/13/2010				No tides
10/14/2010				No tides
10/15/2010				No tides
10/16/2010				No tides
10/17/2010				No tides
10/18/2010	21:06-22:36	18:15-23:30	1h 30m	Data Acquired
10/19/2010	20:54-23:30	18:15-23:30	2h 36m	Weather / fog
10/20/2010	21:00-23:30	18:20-23:25	2h 30m	Weather / fog
10/21/2010	21:18-23:24	18:15-23:30	2h 06m	Weather / fog
10/22/2010	21:36-23:24	18:15-23:30	1h 48m	Weather / fog
10/23/2010	22:06-23:24	18:15-23:30	1h 18m	Weather / fog
10/24/2010	22:36-23:24	18:15-23:30	0h 48m	Weather / fog
10/25/2010	23:12-23:18	18:15-23:30	0h 06m	Weather / fog
10/26/2010				No tides
10/27/2010				No tides
10/28/2010				No tides
10/29/2010				No tides
10/30/2010				No tides
10/31/2010				No tides

A Month in the Life of Coastal Acquisition

Out of 31 calendar days in October …

- Original MLLW window allowed a maximum of 9 possible acquisition days, with up to 3 collection hours each day (+/- 1.5 hrs from MLLW);
- JALBTCX approves a change to MLW to increase the acquisition window; this provides an additional 6 possible acquisition days in October, a total of 15;
- CASI sensor requires sun angle greater than 30º. This sun angle requirement reduces possible days from 15 to 14, and reduces the flight window from a 3 hour maximum to an average window of 2 hours;
- Weather, fog, and marine layer conditions decrease the available acquisition days even further.
- At month's end, based on the above constraints, there were only 4 suitable acquisition days, resulting in a standby ratio of 8:1 for the month.

Project Review – Coastal CA – CSC/OPC

Purpose

- As part of a partnership between the NOAA Coastal Services Center (CSC) and the California State Coastal Conservancy (SCC) working for the Ocean Protection Council (OPC), this project involves the collection and delivery of topographic LiDAR and digital imagery for areas of coastal California. Data are intended for use in coastal management decision making, including applications such as sea level rise.

Area of interest

- From ocean edge up to the designated areas within the 10m contour. (The data along the 500m corridor will be developed from the JALBTCX NCMP dataset.)
- Total LiDAR area is 2139 square miles; Imagery area is 3774 square miles
- Map Once Use Many Times concept was embraced by all Agencies to ensure that no data collects were duplicated and data boundaries could be merged/integrated

Concurrency Requirements - None

Project Review – Coastal CA – CSC/OPC

Tidal Requirements

- LiDAR – MLLW
- Imagery – MLLW for 7 areas / estuaries; no restrictions for remaining project area

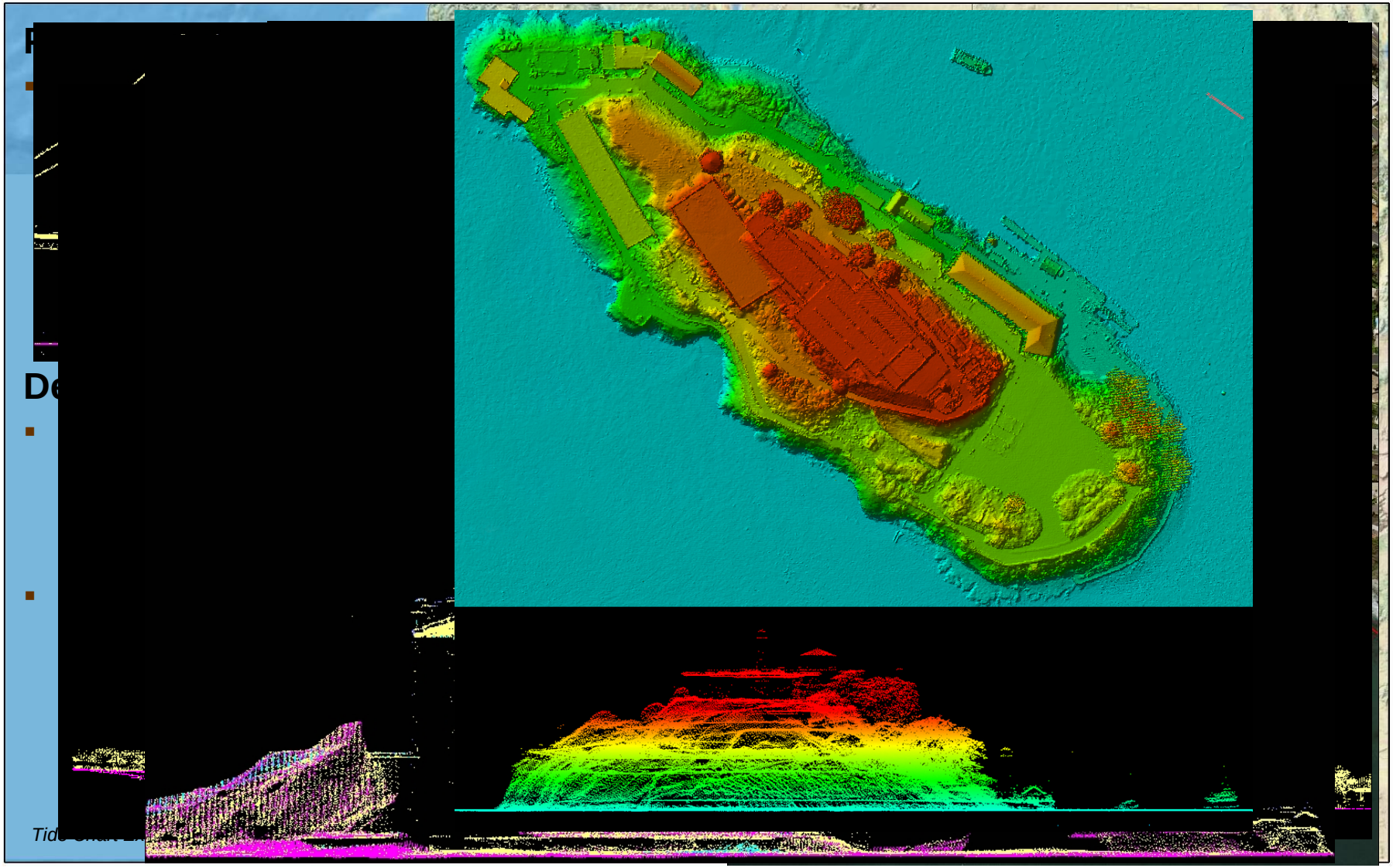
Other Requirements

- Streams and rivers are within their normal banks
- Data will not be collected during strong onshore winds, high waves or other anomalous weather conditions.
- The project area must be cloud-free below the design altitude for the mission
- Air traffic restrictions coordination

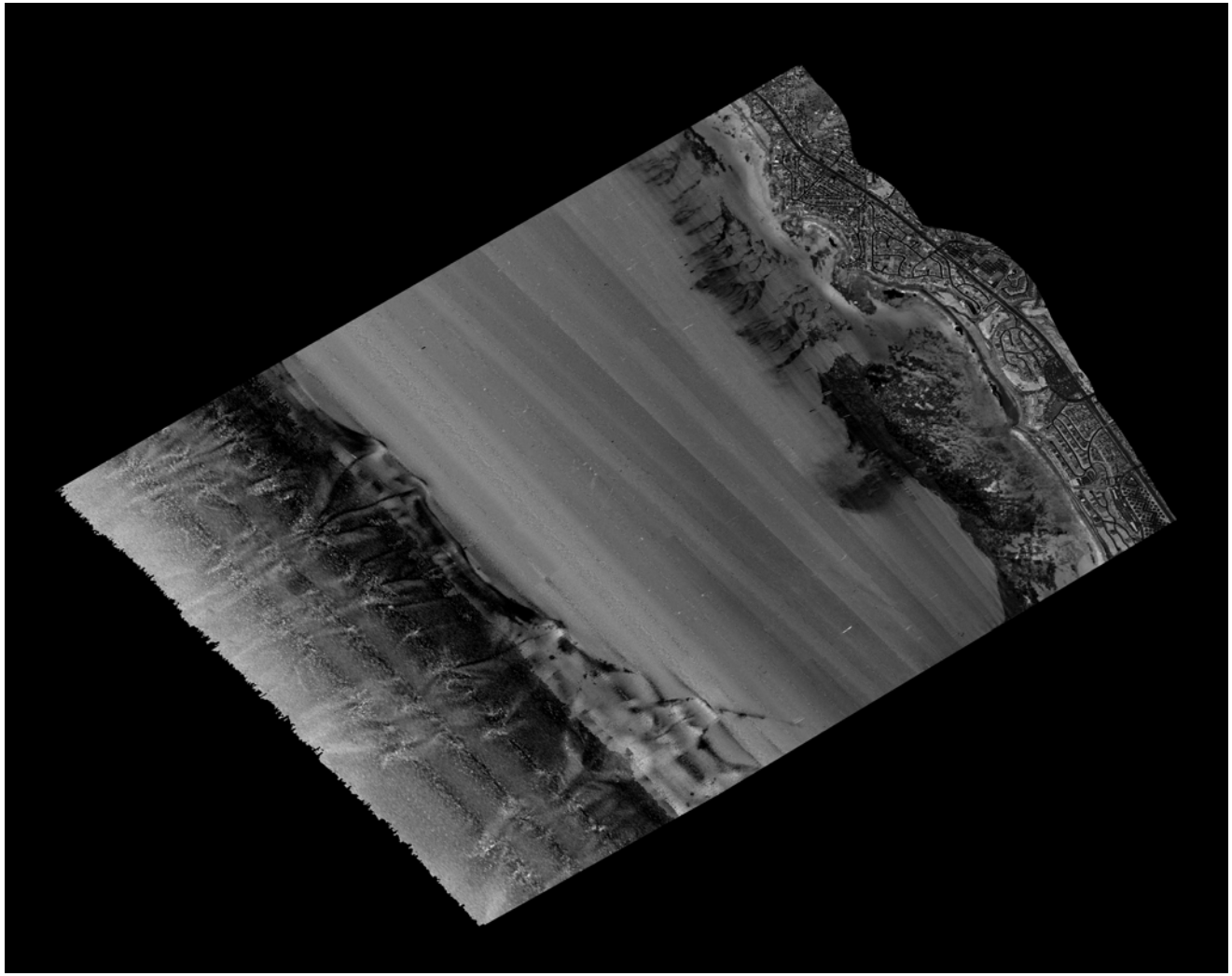
Products

- LiDAR - 1m nominal, 9 cm vertical (RMSE), .5m horizontal (RMSE)
- Imagery - 4 band orthophotos, 8 bit and 16 bit, horizontal accuracy is 2m or better at the 95% confidence level (NSSDA)

Coastal CA LiDAR and Imagery



Merged Data Example



Projects: Planned vs. Actual

PROJECT DAYS			
Project	Proposed	Contracted	Total Days
NCMP – CA Imagery	42	40	26
NCMP – CA LiDAR	185	135	Currently – 190 days
NCMP – WA/OR Imagery	34	32	54
NCMP WA/OR LiDAR	61	50	Currently – 77 days
SF Bay LiDAR	36	36	52
CSC/OPC 10m Imagery	62	48	95
CSC/OPC 10m LiDAR	87	68	94

Projects: Standing By

ACQUISITION BREAKDOWN			
Project	Total Days	Acquisition Days	Standby: Acquisition
NCMP – CA Imagery	26	12	2:1
NCMP – CA LiDAR	190	Currently – 41 days	5:1
NCMP – WA/OR Imagery	54	6	9:1
NCMP WA/OR LiDAR	77	Currently – 14 days	6:1
SF Bay LiDAR	52	10	5:1
CSC/OPC 10m Imagery	95	24	4:1
CSC/OPC 10m LiDAR	94	28	3:1

Conclusions

- Mapping along a coast line, with multiple environmental constraints- including tides, weather, geography-, human restrictions and unique technical requirements…is not an easy task.
- Trust the professional Contractors to know what they are talking about and integrate their recommendations

- Special thanks to the California State Coastal Conservancy and Ocean Protection Council, NOAA CSC, and the USACE National Coastal Mapping Program. All of these Agencies have had the foresight to understand the importance and support programs focused on coastal mapping

Thank You