High-Frequency Ammonium Measurements in the San Francisco Estuary

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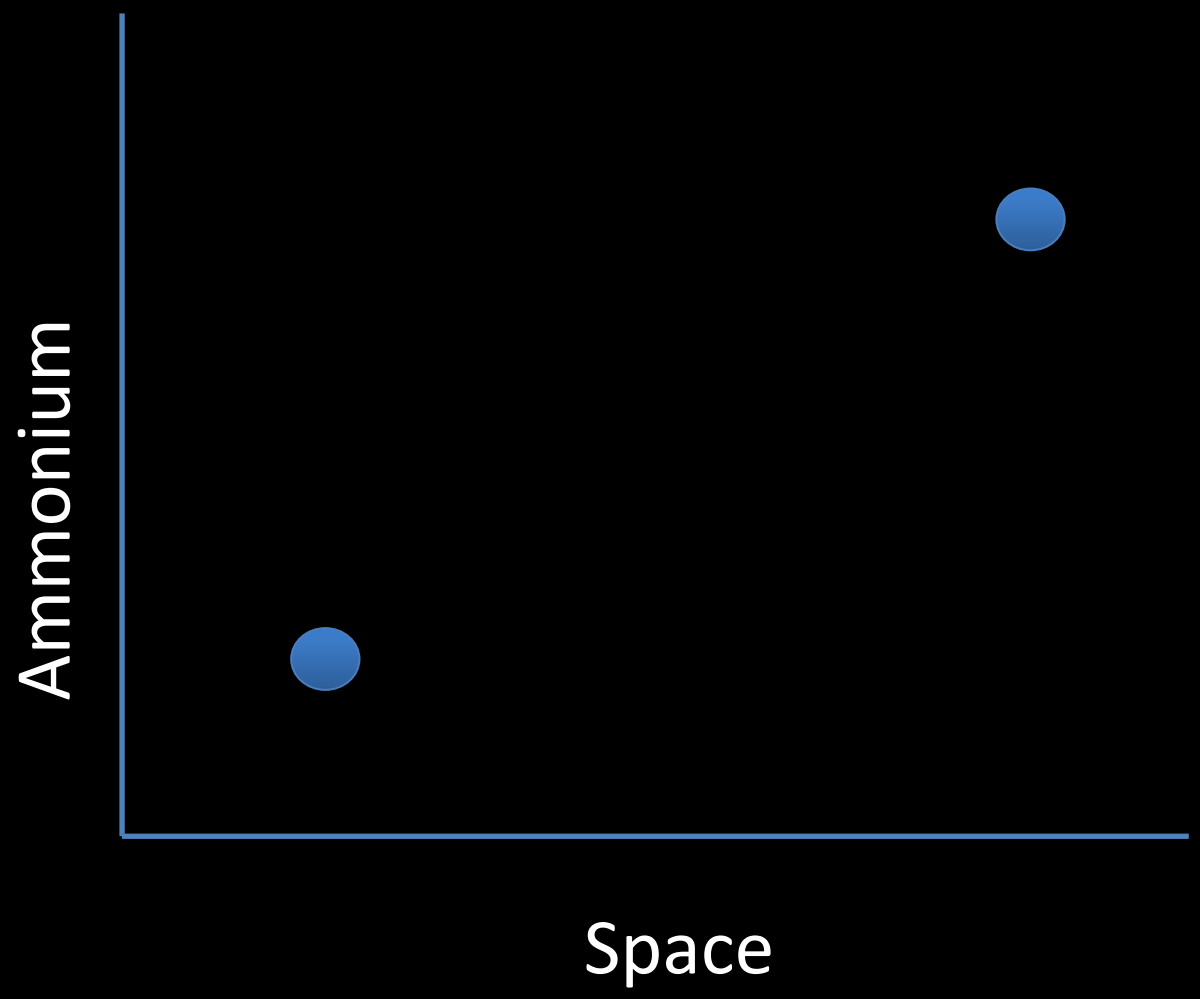
Stanford University

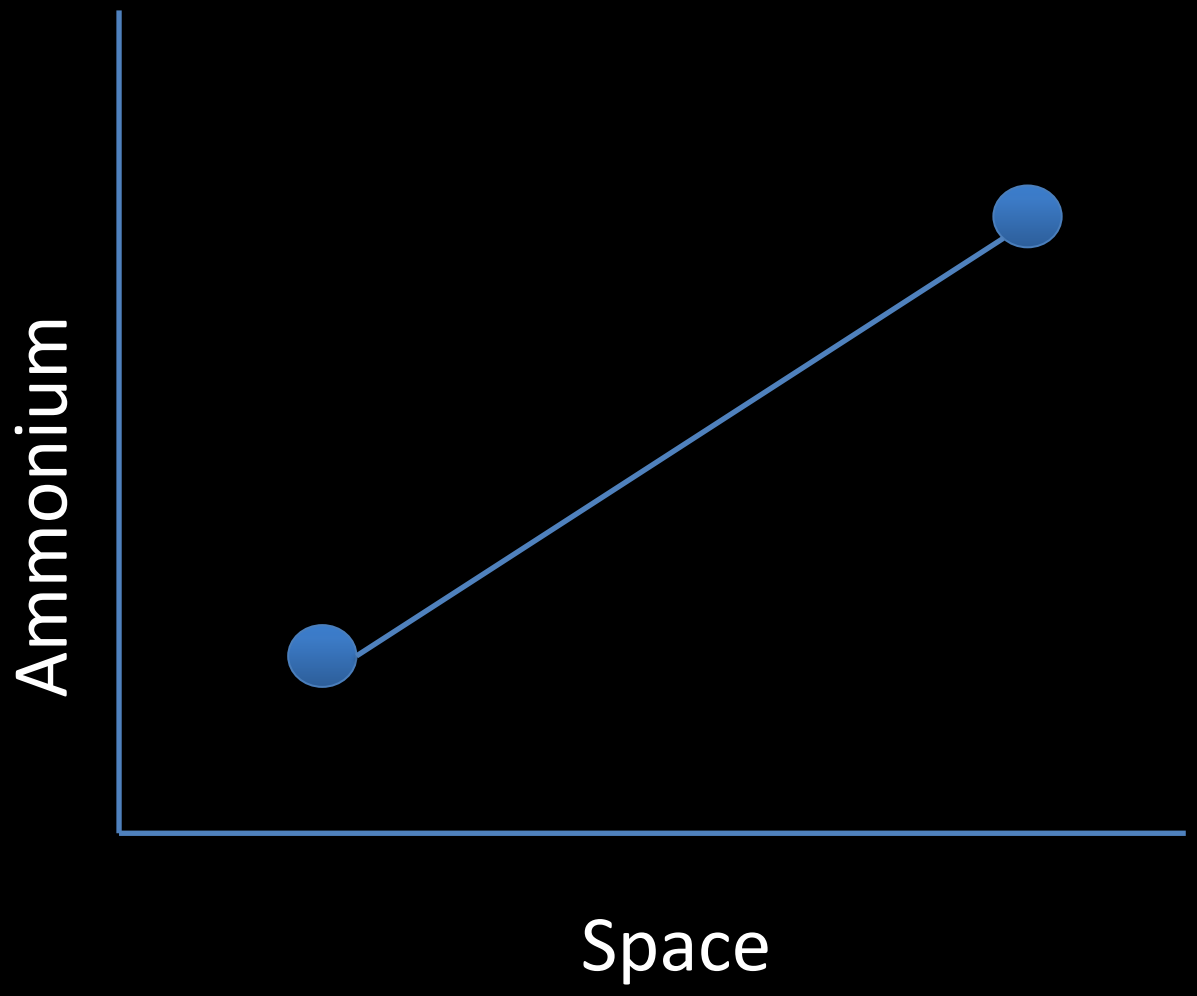
October 29, 2014
Bay-Delta Science Conference
Sacramento, California

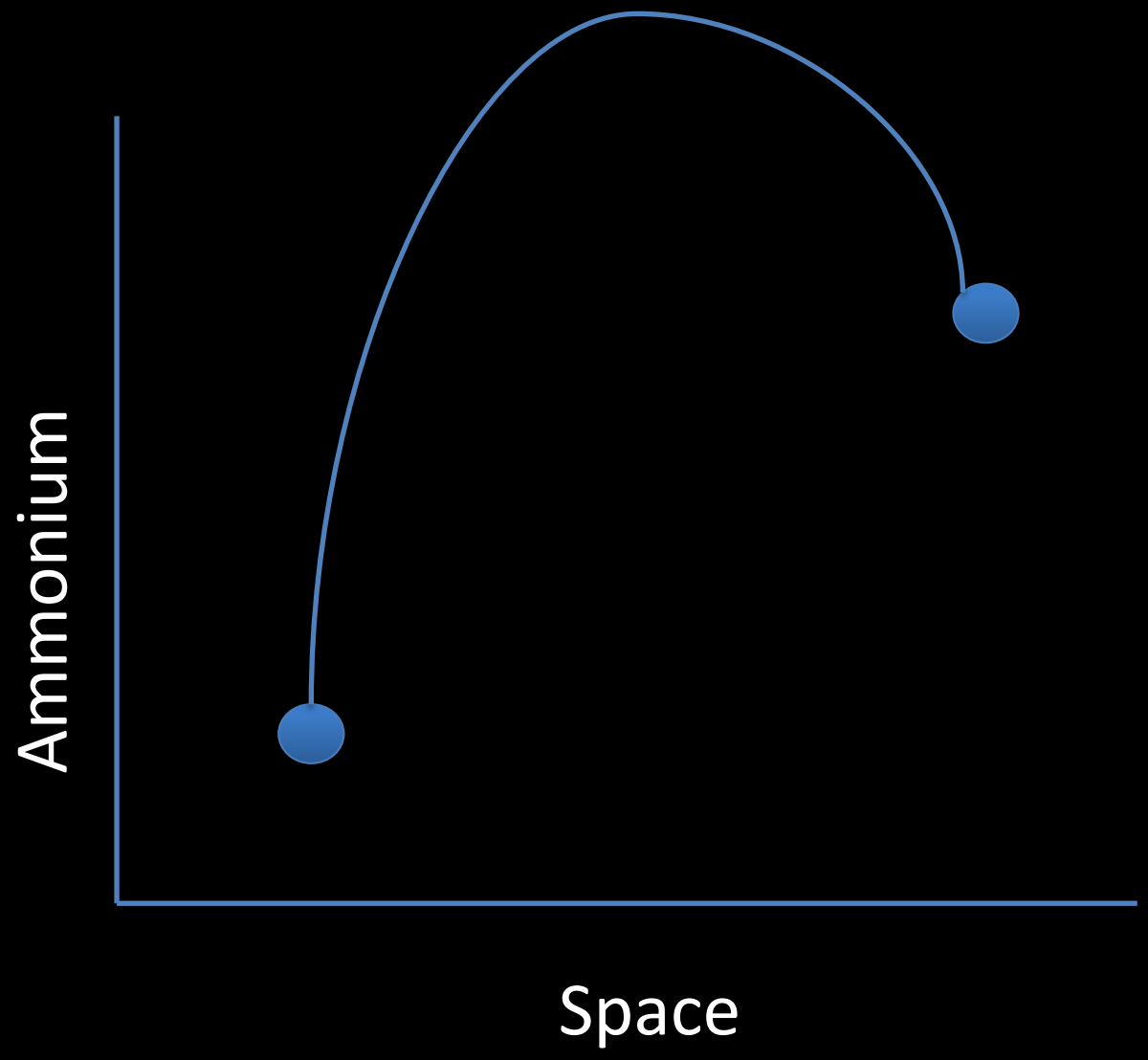
Talk Outline

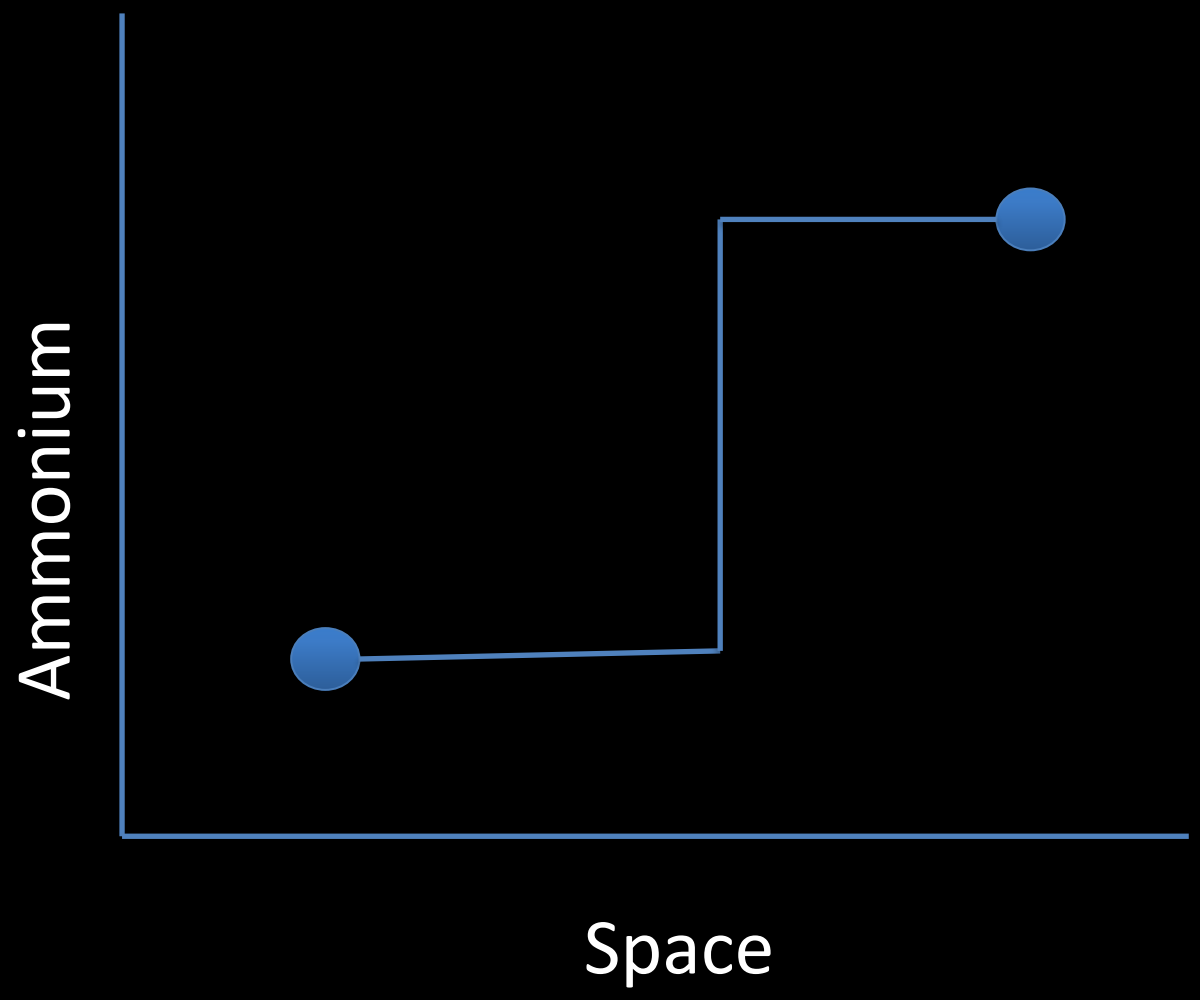
- Why more ammonium (NH_4^+) measurements?
- How and when more ammonium (NH_4^+) measurements?
- A look at data from 2014
- What lies ahead

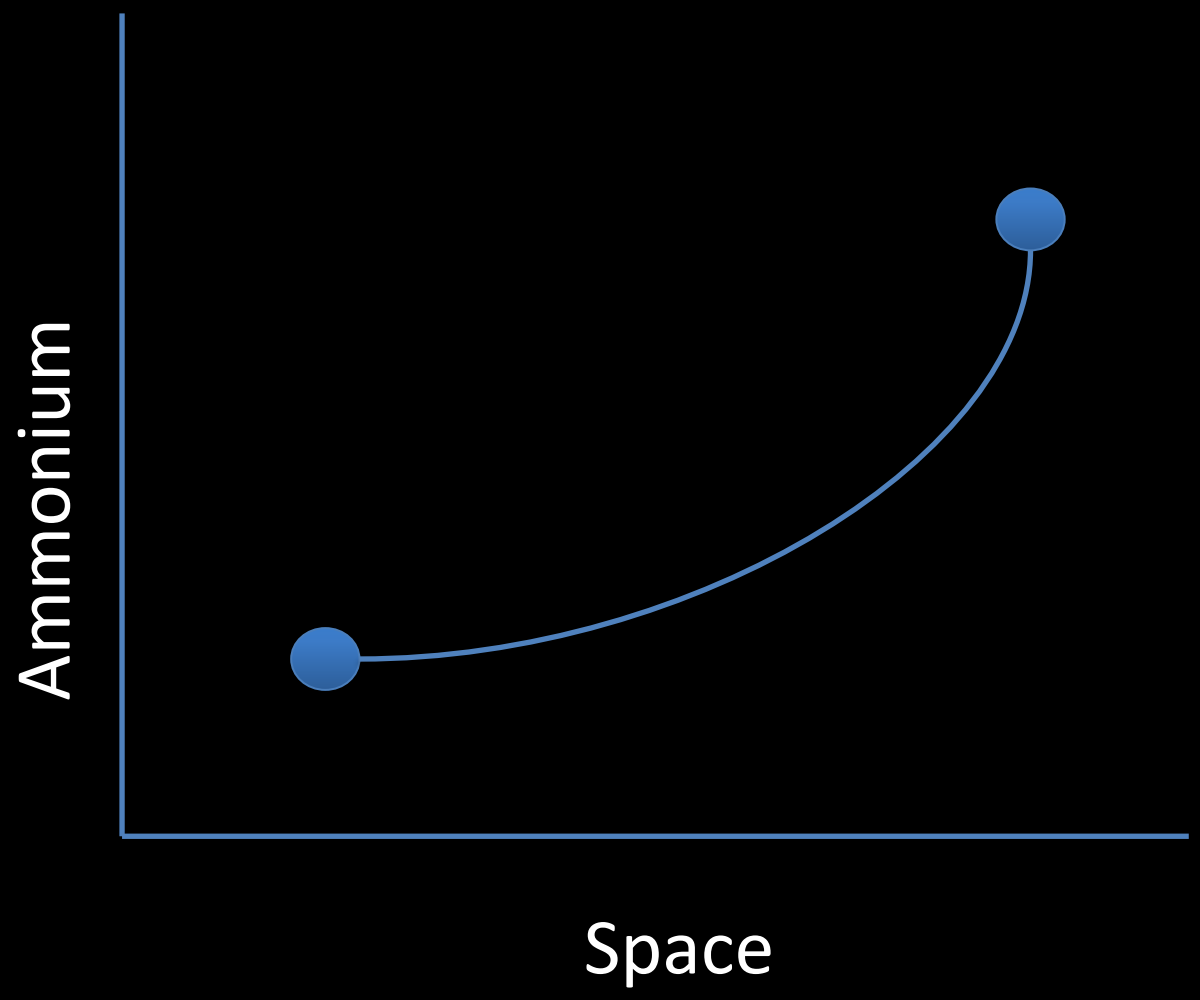
Why more ammonium measurements?


Ammonium
Space

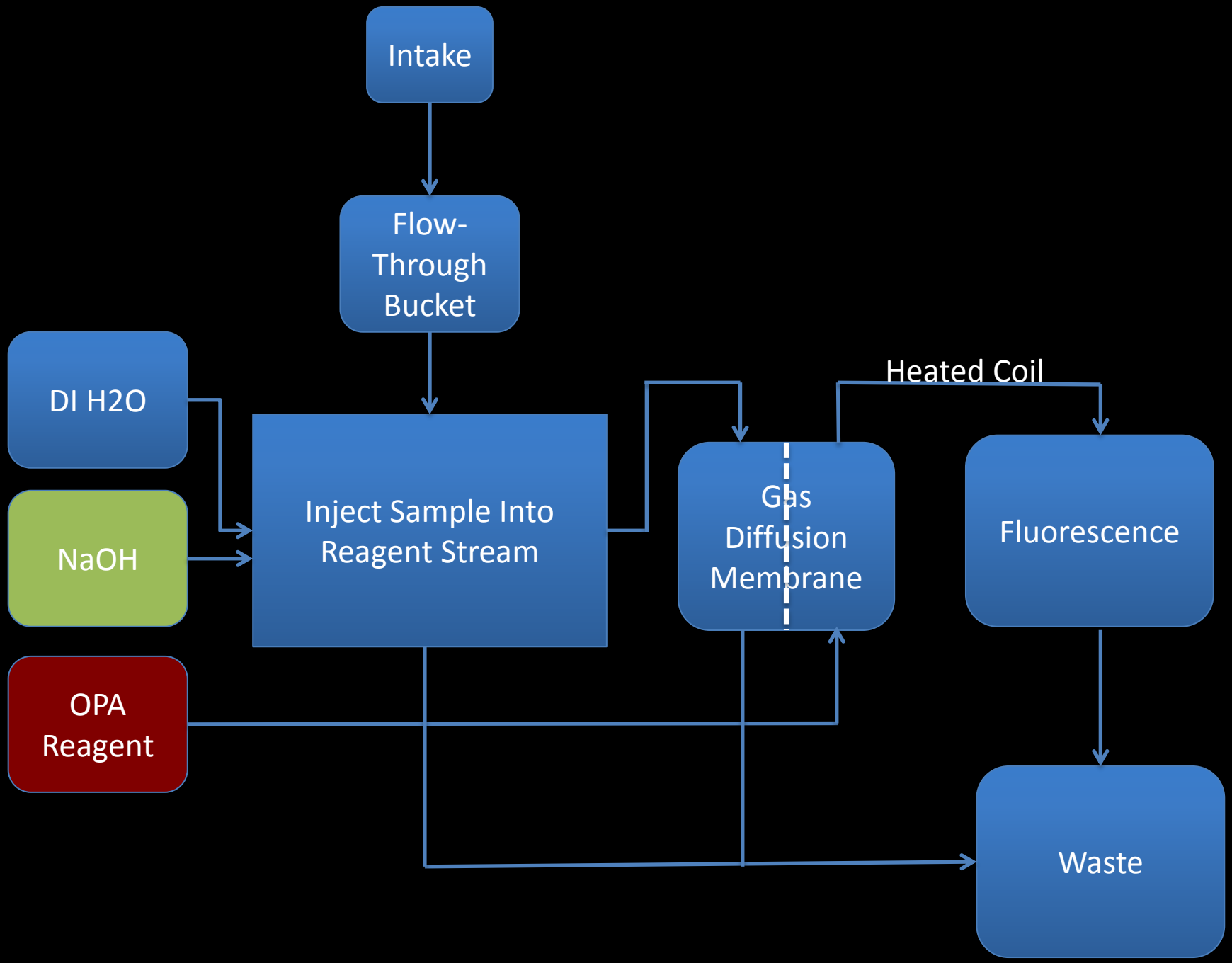

Ammonium
Space


Ammonium
Space


Ammonium
Space


Ammonium
Space

How and When More Ammonium Measurements?

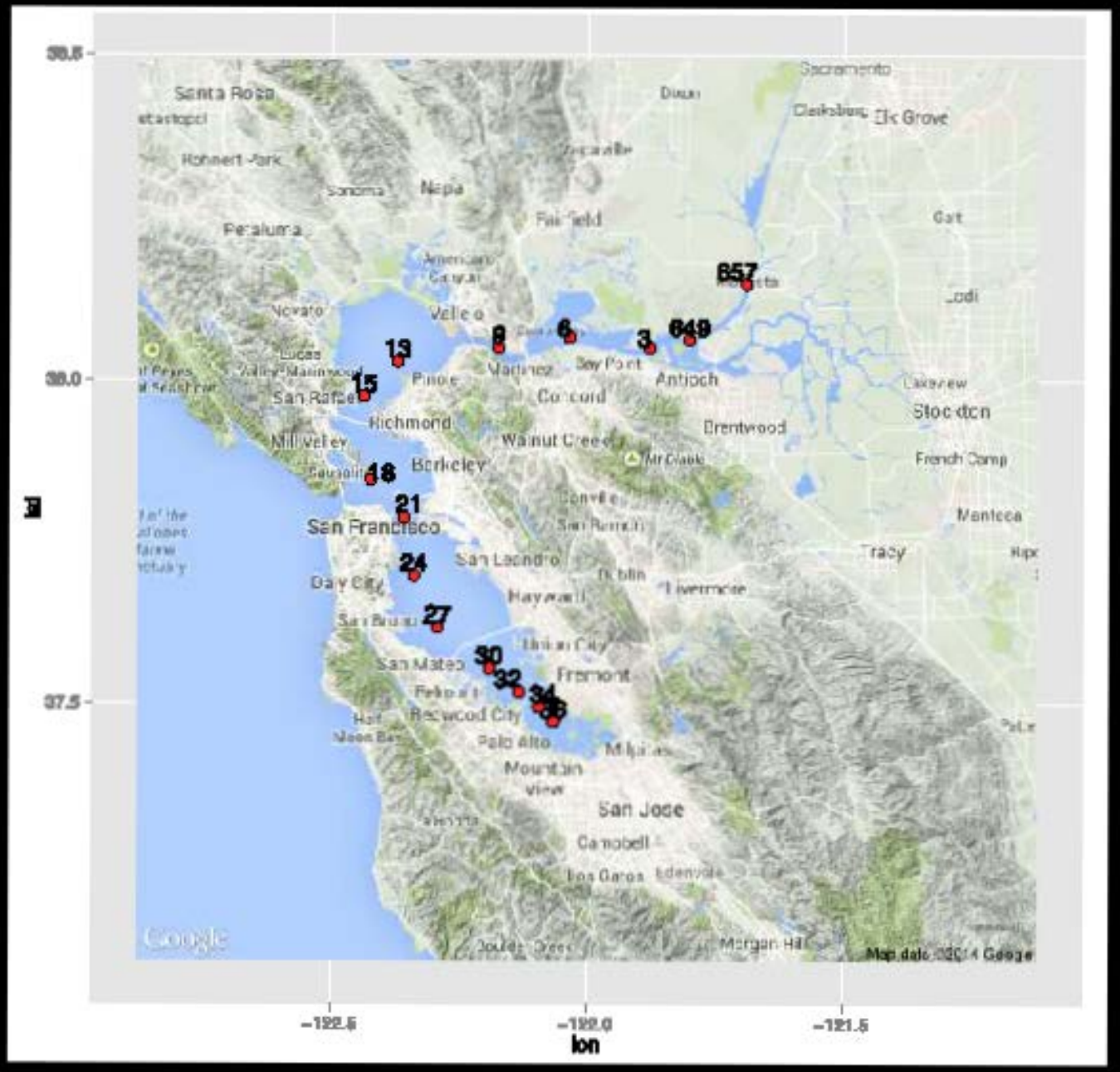

Intake
Flow-Through Bucket
DI H2O
NaOH
OPA Reagent
Inject Sample Into Reagent Stream
Heated Coil
Gas Diffusion Membrane
Fluorescence
Waste

How and When More Ammonium Measurements?

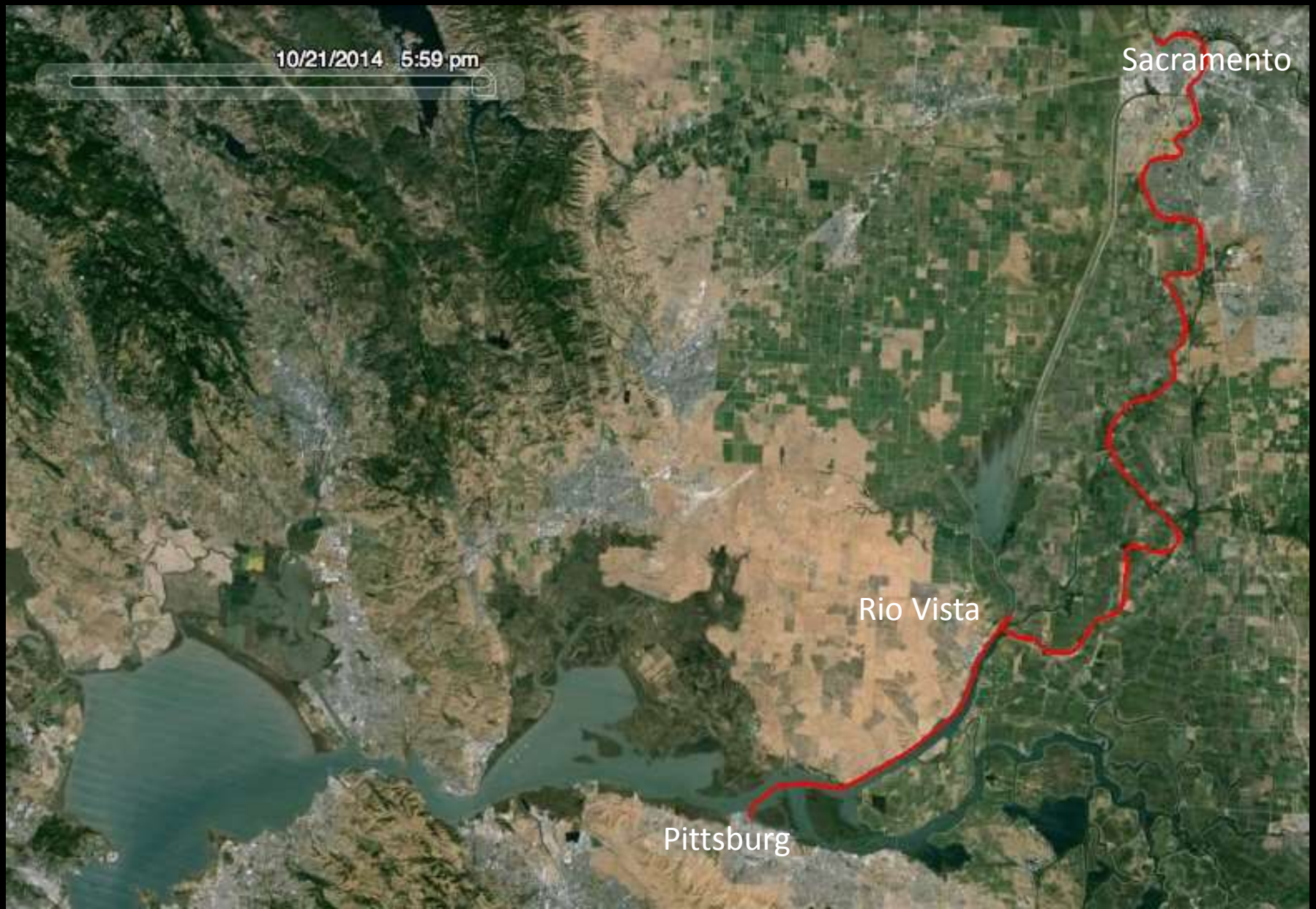
- **R/V Polaris –**
- **USGS Monthly**
- South Bay to Rio Vista
  - May to October 2014

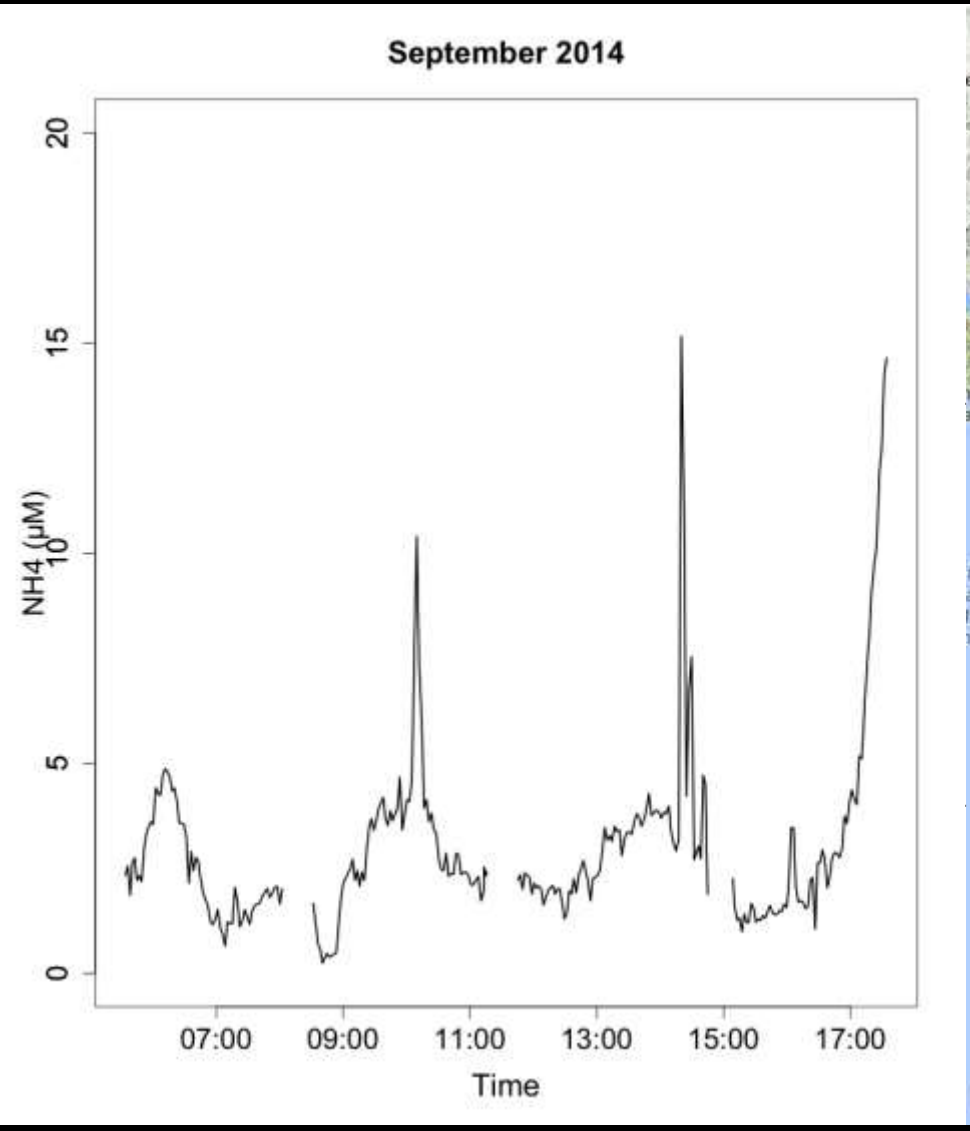
- **R/V Questuary –**
- **Sacramento to Suisun Bay**
  - January 27-29, 2014
  - April 30-May 1, 2014
  - August 27-28, 2014
  - October 21-22, 2014

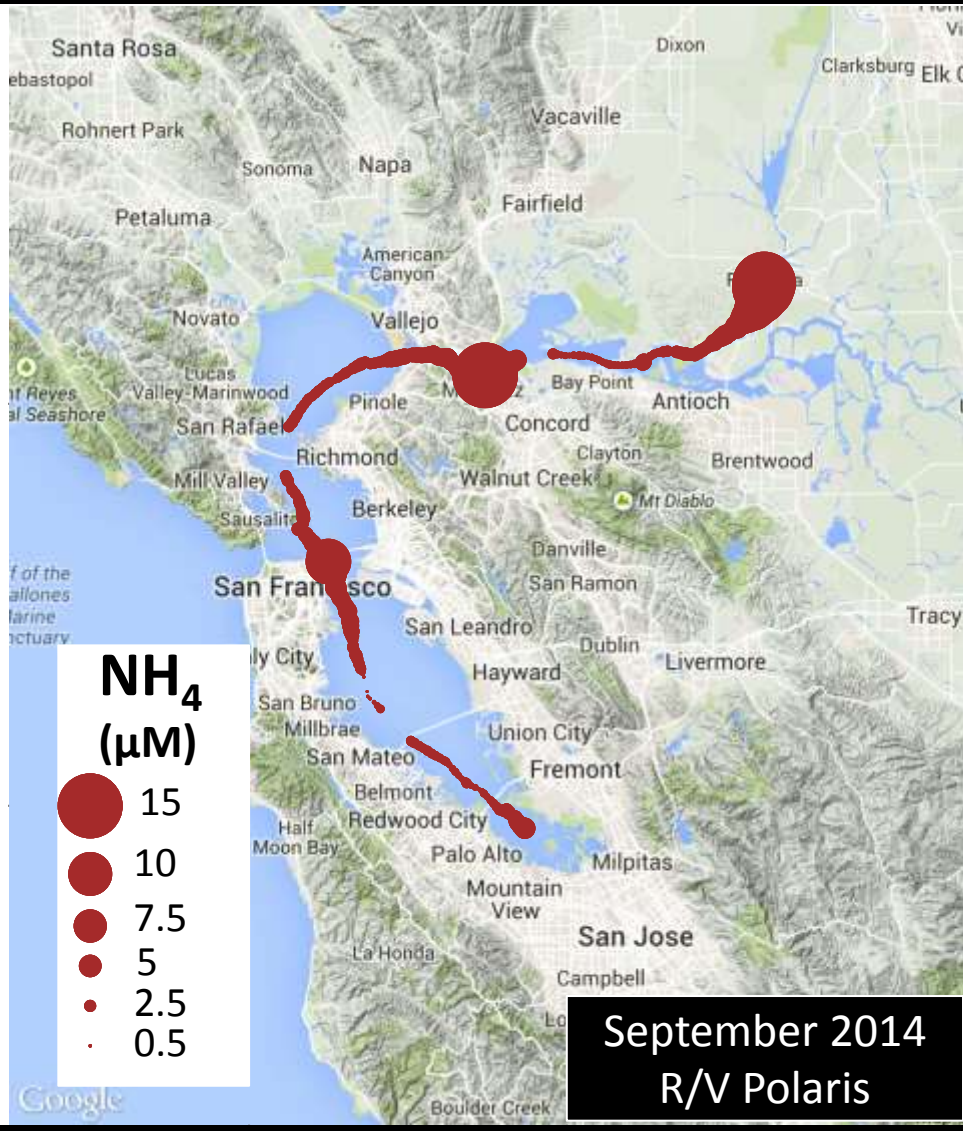
R/V Polaris

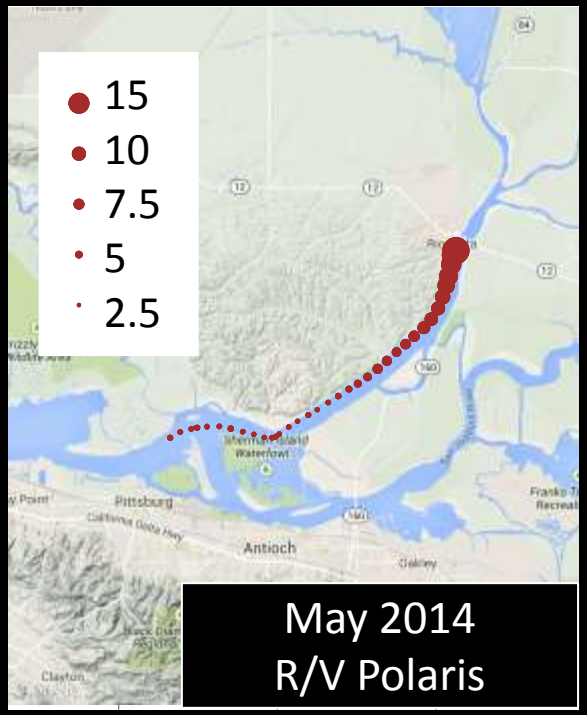

38.5
38.0
37.5
lat
−122.5
−122.0
−121.5
lon
Santa Rosa
Rohnert Park
Sonoma
Napa
Petaluma
Novato
Vallejo
Fairfield
Dixon
Sacramento
Elk Grove
Galt
Lodi
Stockton
Lakeview
French Camp
Manteca
Tracy
Antioch
Brentwood
Martinez
Bay Point
Concord
Pinole
San Rafael
Richmond
Mill Valley
Walnut Creek
Berkeley
San Francisco
San Leandro
Daly City
Hayward
Fremont
San Mateo
Redwood City
Palo Alto
Mountain View
San Jose
Campbell
Los Gatos
Morgan Hill
Google
Map data ©2014 Google
657
8
6
3
649
13
15
18
21
24
27
30
32
34

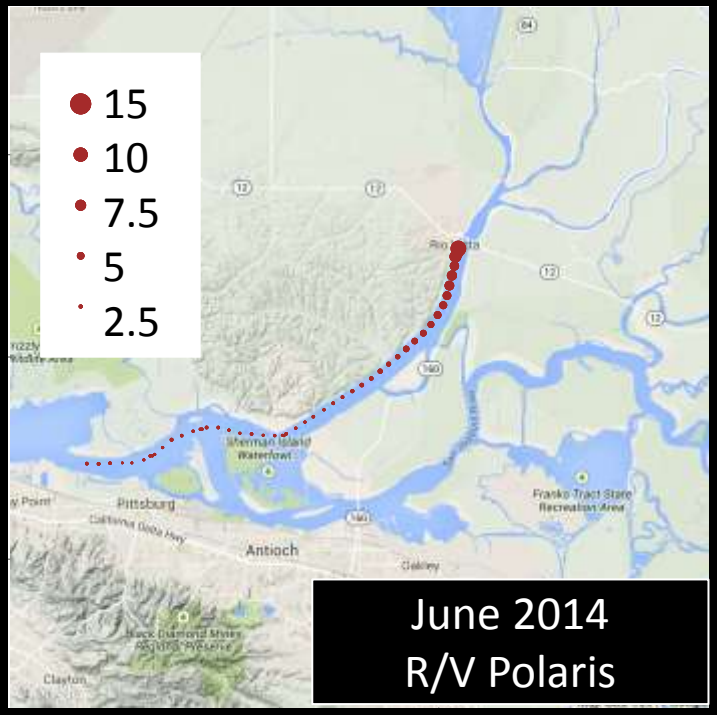
R/V Questuary

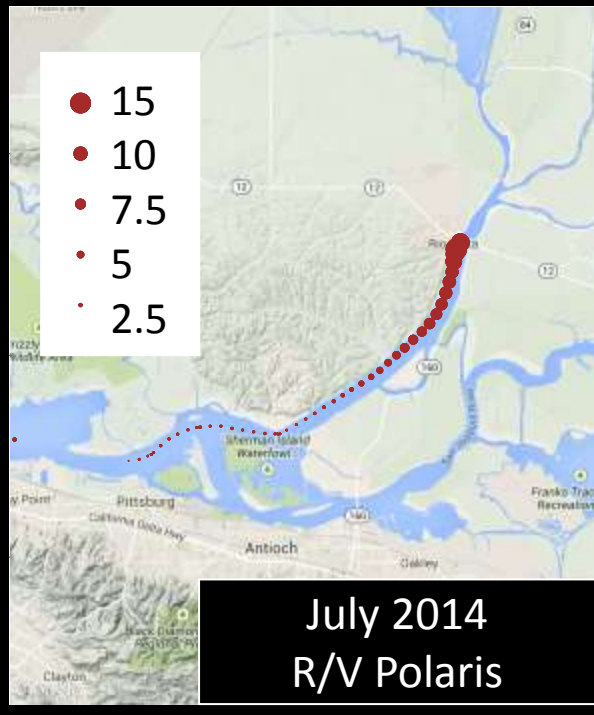


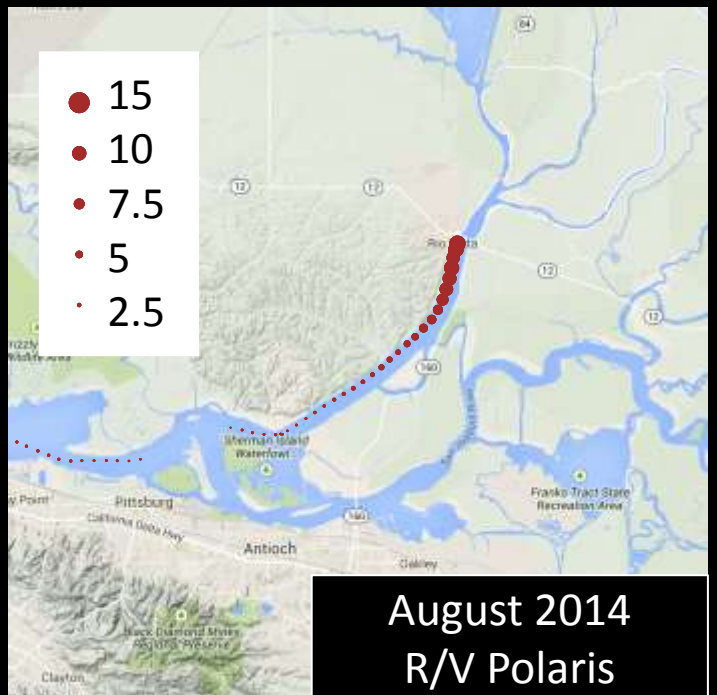

September 2014
NH4 (µM)
0
5
10
15
20
07:00
09:00
11:00
13:00
15:00
17:00
Time

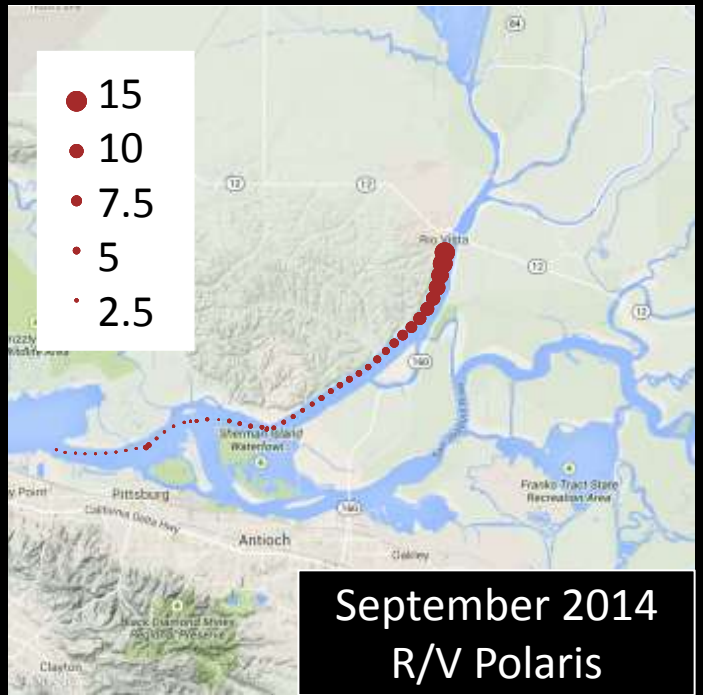

Santa Rosa
Dixon
Clarksburg
Vacaville
Rohnert Park
Sonoma
Napa
Fairfield
Petaluma
American Canyon
Novato
Vallejo
Lucas Valley-Marinwood
Pinole
Bay Point
Antioch
San Rafael
Concord
Richmond
Clayton
Brentwood
Mill Valley
Walnut Creek
Mt Diablo
Sausalito
Berkeley
Danville
San Ramon
San Leandro
Tracy
Dublin
Livermore
Hayward
San Bruno
Millbrae
Union City
San Mateo
Fremont
Belmont
Redwood City
Half Moon Bay
Palo Alto
Milpitas
Mountain View
San Jose
La Honda
Campbell
Boulder Creek
Google
NH_4 (µM)
15
10
7.5
5
2.5
0.5
September 2014
R/V Polaris


15
10
7.5
5
2.5
Pittsburg
Antioch
May 2014
R/V Polaris

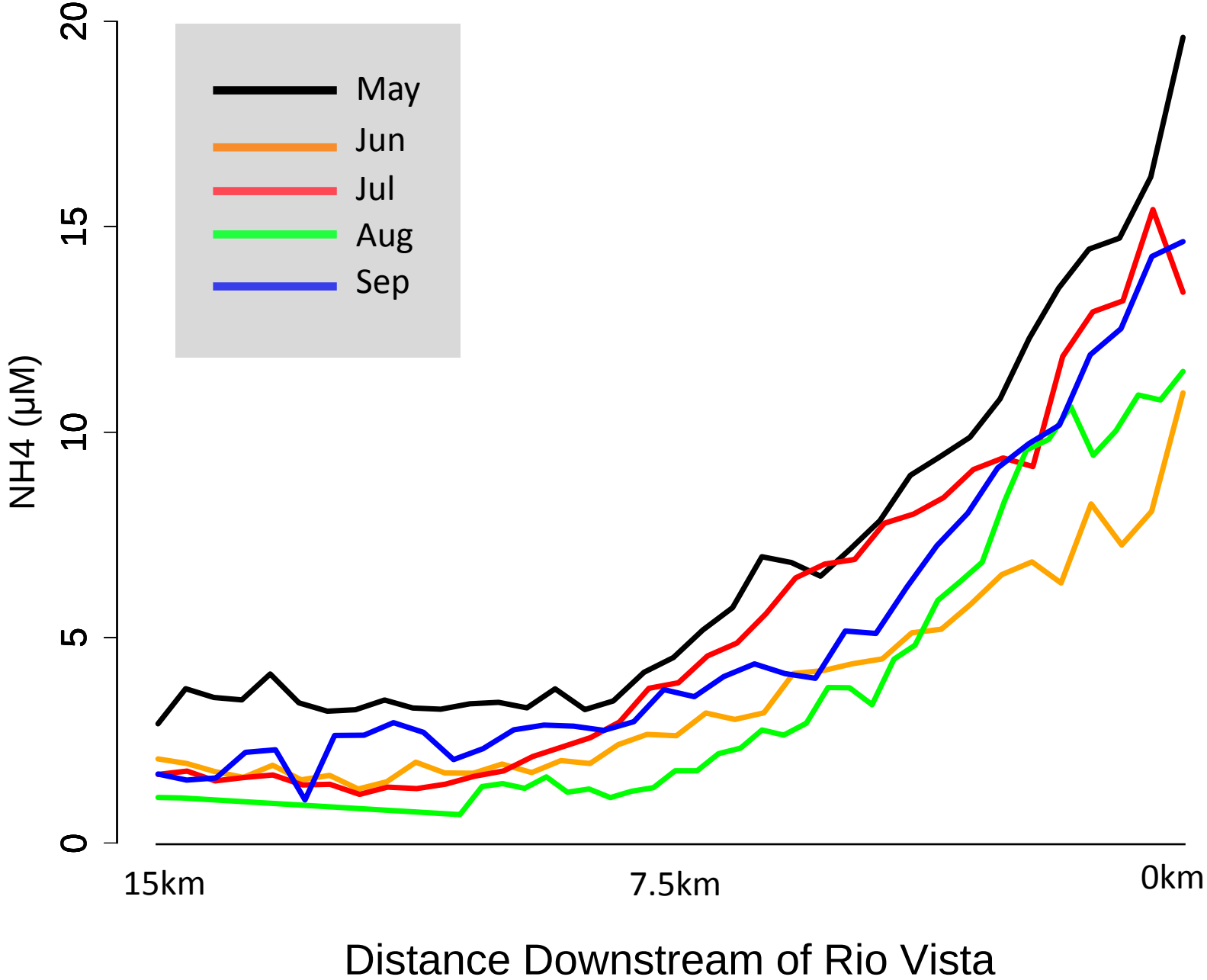

15
10
7.5
5
2.5
Pittsburg
Antioch
June 2014
R/V Polaris

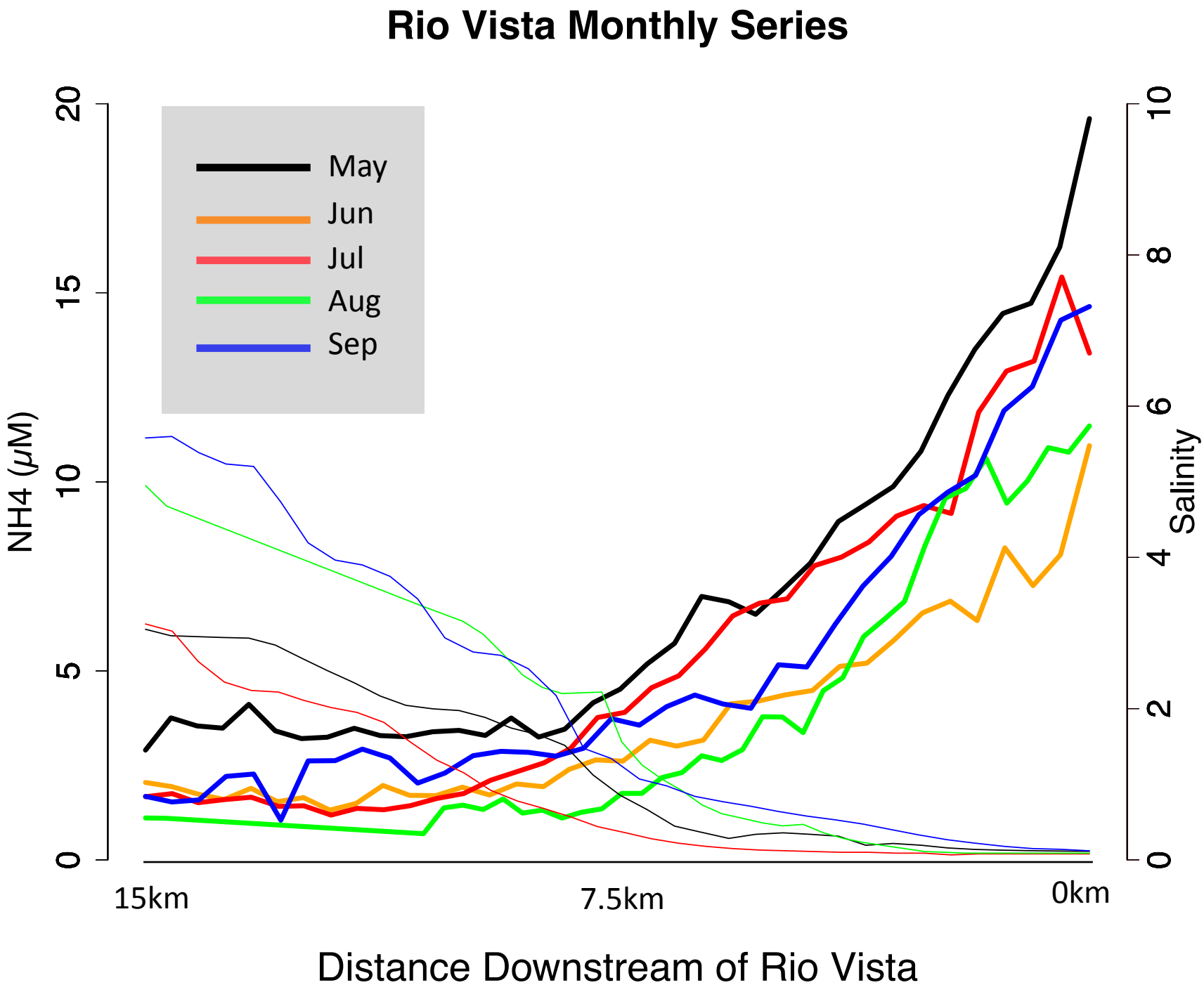

15
10
7.5
5
2.5
Pittsburg
Antioch
July 2014
R/V Polaris


15
10
7.5
5
2.5
Pittsburg
Antioch
August 2014
R/V Polaris

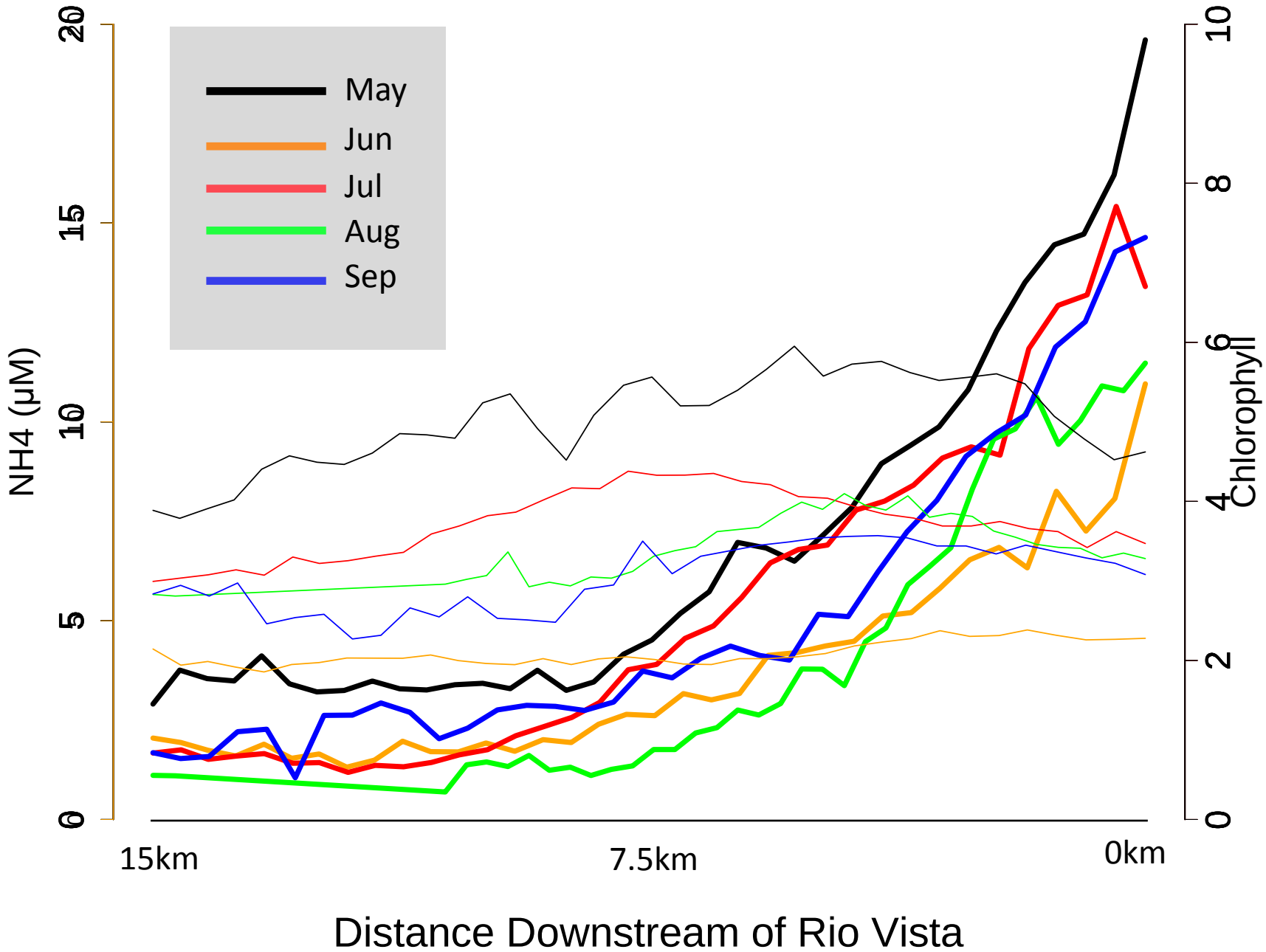

15
10
7.5
5
2.5
Pittsburg
Antioch
September 2014
R/V Polaris

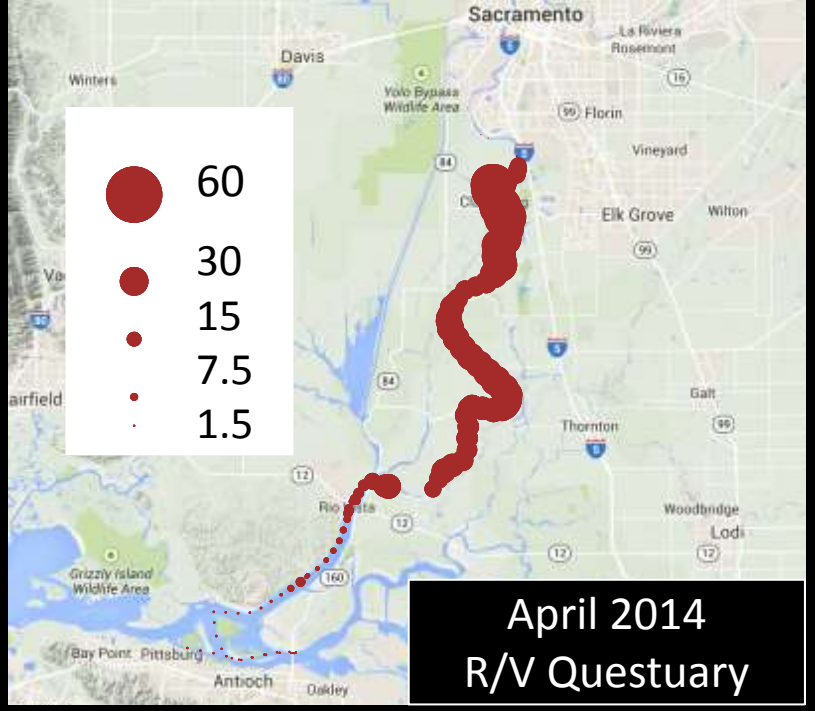
Rio Vista Monthly Series



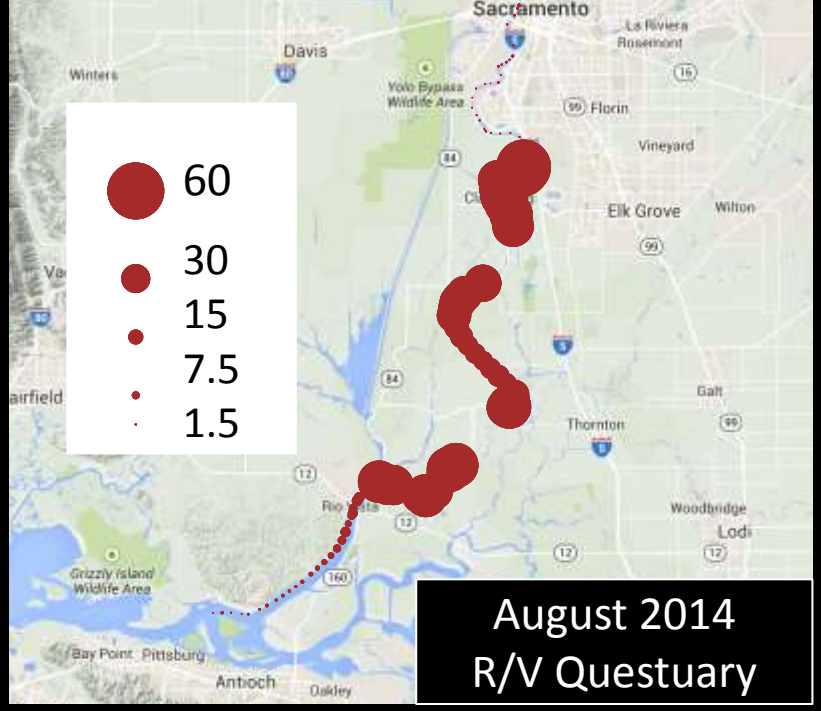

Rio Vista Monthly Series
May
Jun
Jul
Aug
Sep
NH4 (μM)
0
5
10
15
20
Salinity
0
2
4
6
8
10
15km
7.5km
0km
Distance Downstream of Rio Vista

Rio Vista Monthly Series

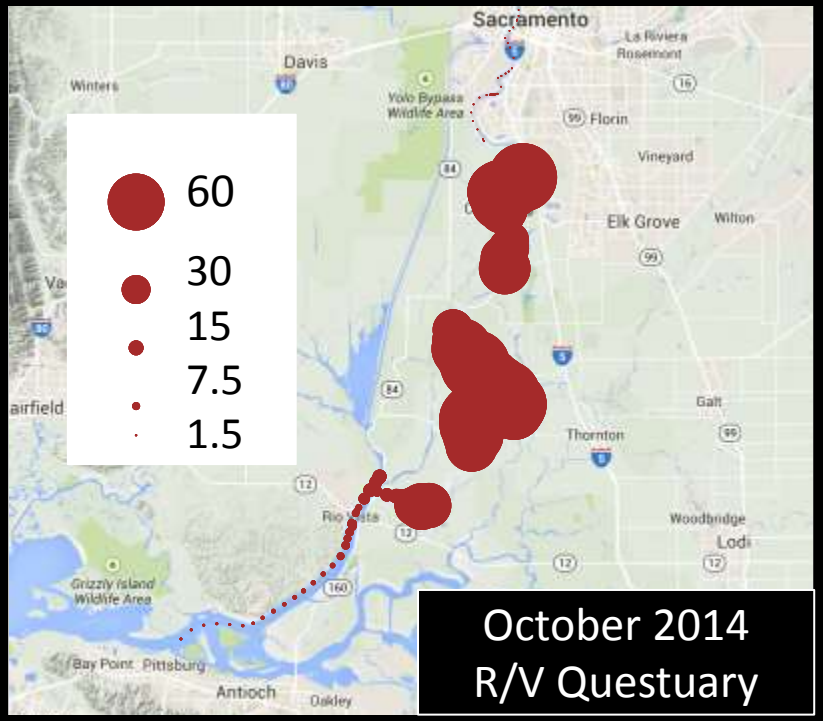




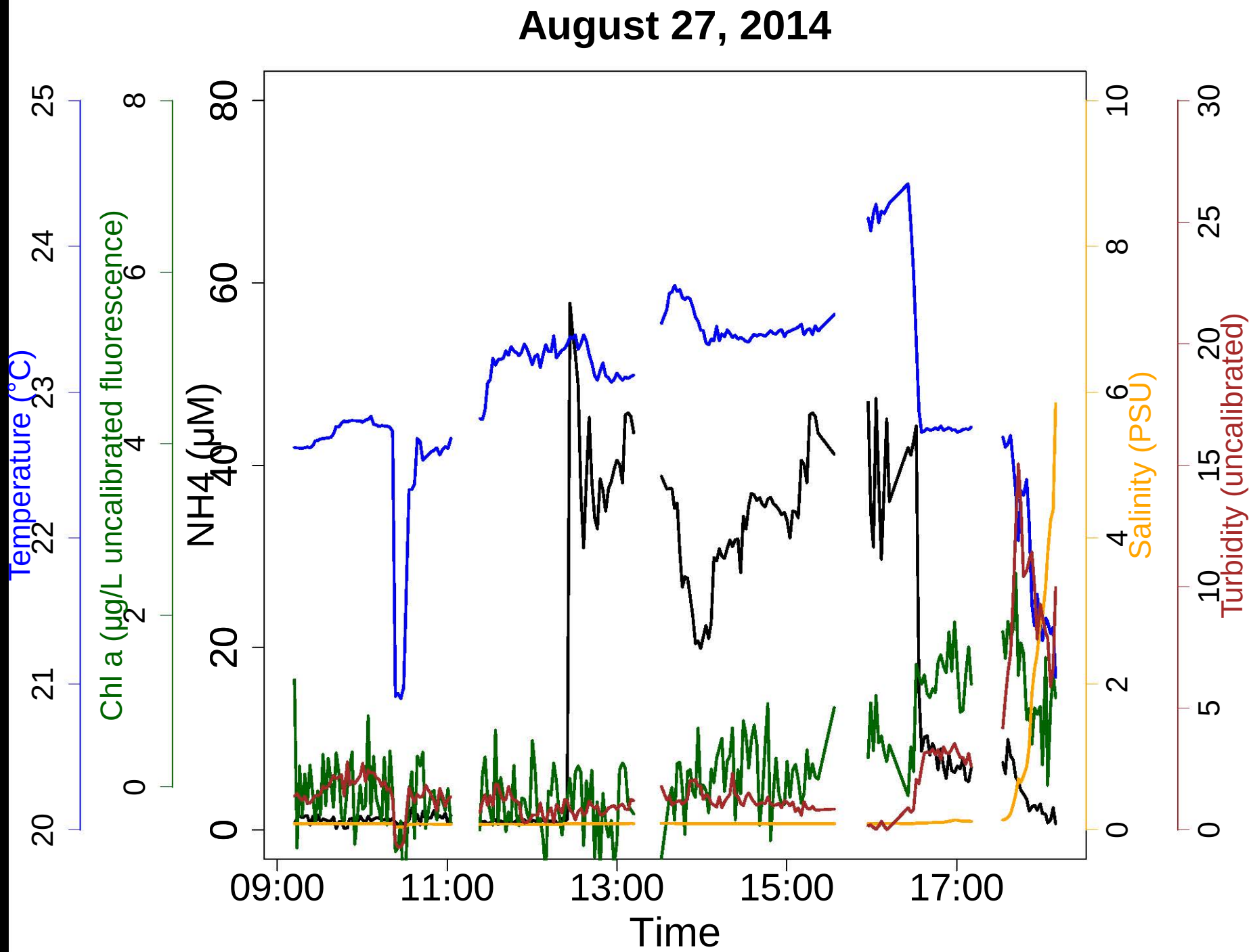
April 2014
R/V Questuary

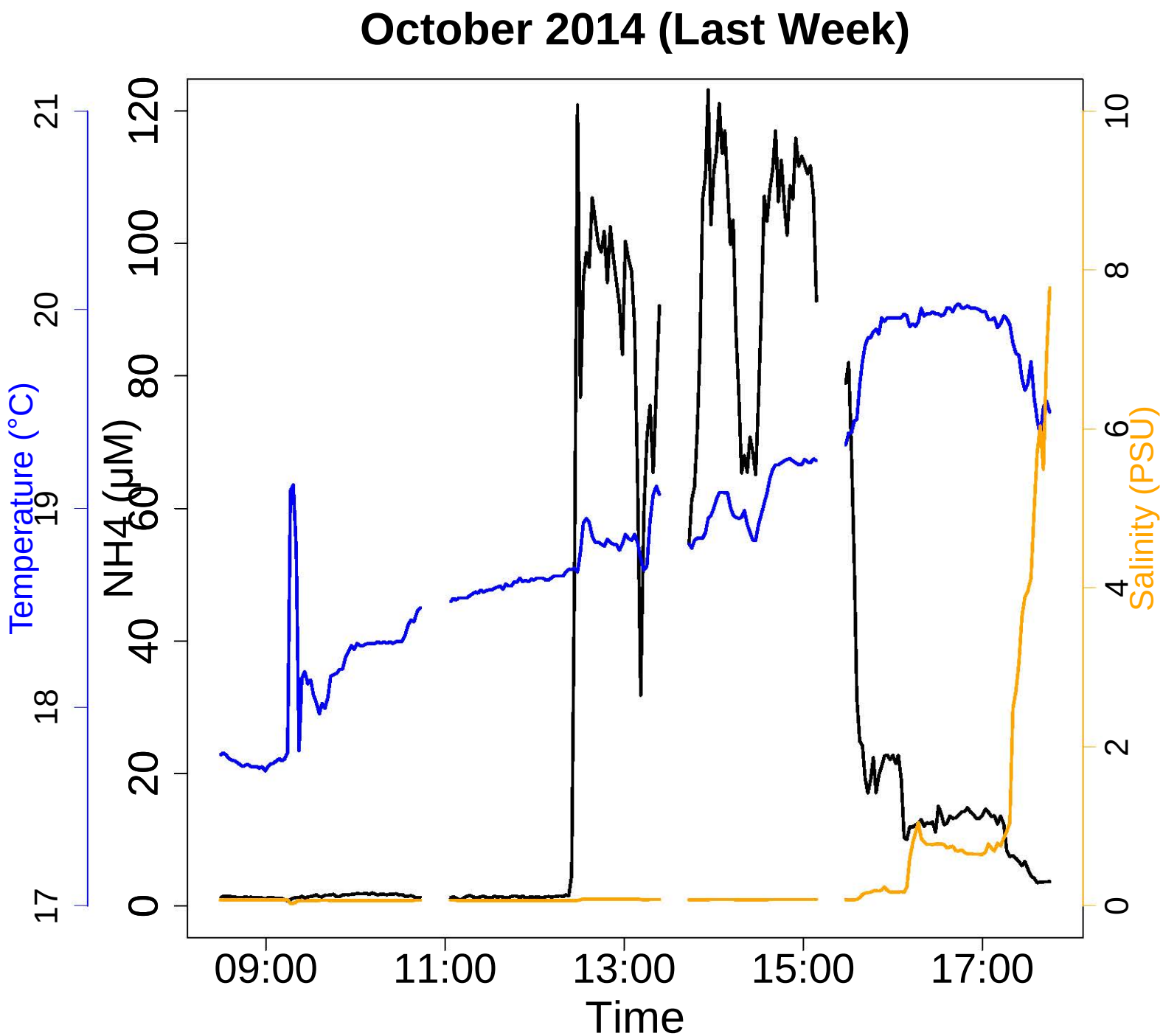


August 2014
R/V Questuary

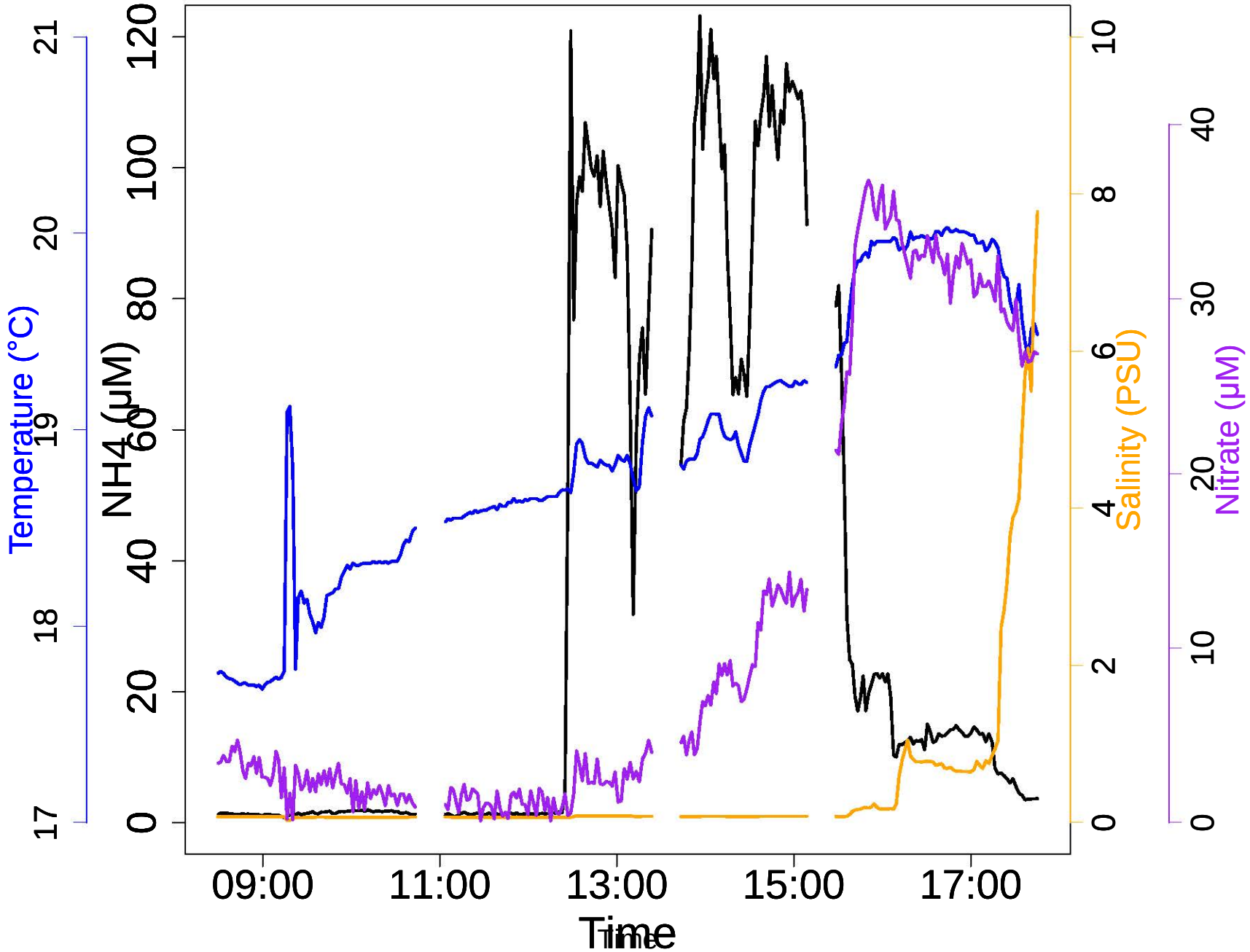


October 2014
R/V Questuary


August 27, 2014
Temperature (°C)
Chl a (µg/L uncalibrated fluorescence)
NH4 (µM)
Salinity (PSU)
Turbidity (uncalibrated)
Time
09:00
11:00
13:00
15:00
17:00


October 2014 (Last Week)
Temperature (°C)
NH4 (µM)
Salinity (PSU)
Time
09:00
11:00
13:00
15:00
17:00
17
18
19
20
21
0
20
40
60
80
100
120
0
2
4
6
8
10

October 2014 (Last Week)



Take-Aways

- Consistent meso-scale patterns→ dilution.
- NO_3 data → Nitrification and mixing.
- Chlorophyll → No clear patterns at this scale (evidence of positive, negative and no relationship in different locations).

Future Directions

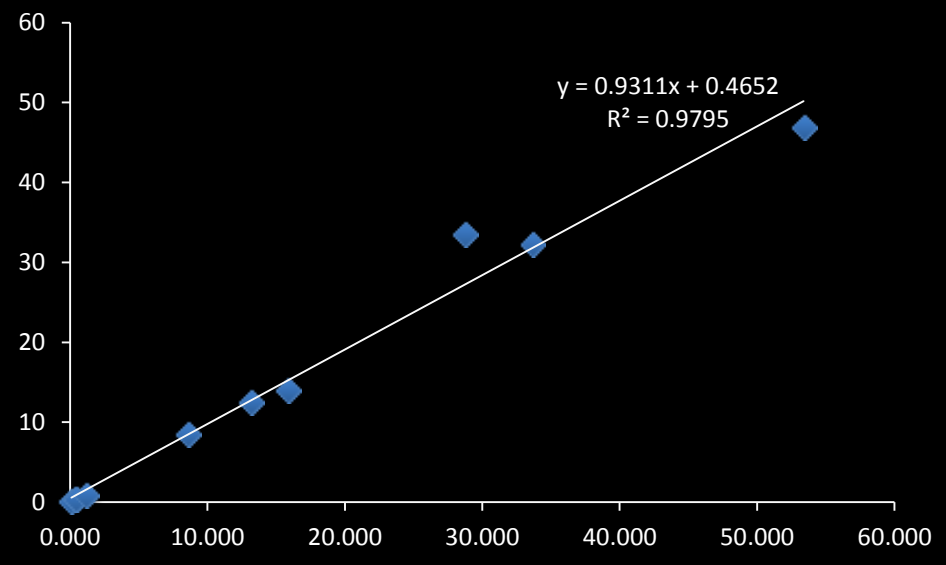
- Complete yearly time series of monthly and quarterly sampling.
- Pair underway nitrate and ammonium data with simple mixing model to assess nitrification.
- Pair variable fluorescence (yield) and underway nutrient data

Co-Authors, Collaborators and Acknowledgements

- Stanford Environmental Ventures Project Team: Chris Francis, Stephen Monismith, Kevin Arrigo, Matt Mills, Julian Damashek, Ivy Huang
- USGS Water Resources: Jim Cloern, Tara Schraga, Erica Nejad, Charlie Martin
- Crew of USGS R/V Polaris: Scott Conard and Joel Fritsch
- Collaborators at UCSC and AMS: Raphe Kudela, Miné Berg, Kendra Hayashi
- Crew of R/V Questuary: David Bell and David Morgan
- Undergraduate Research Assistants: Tynan Challenor, Anna Wietelmann, Matthew Arrigo

Calibration Check

Underway Closest Time-Stamp Samples



Discrete Samples

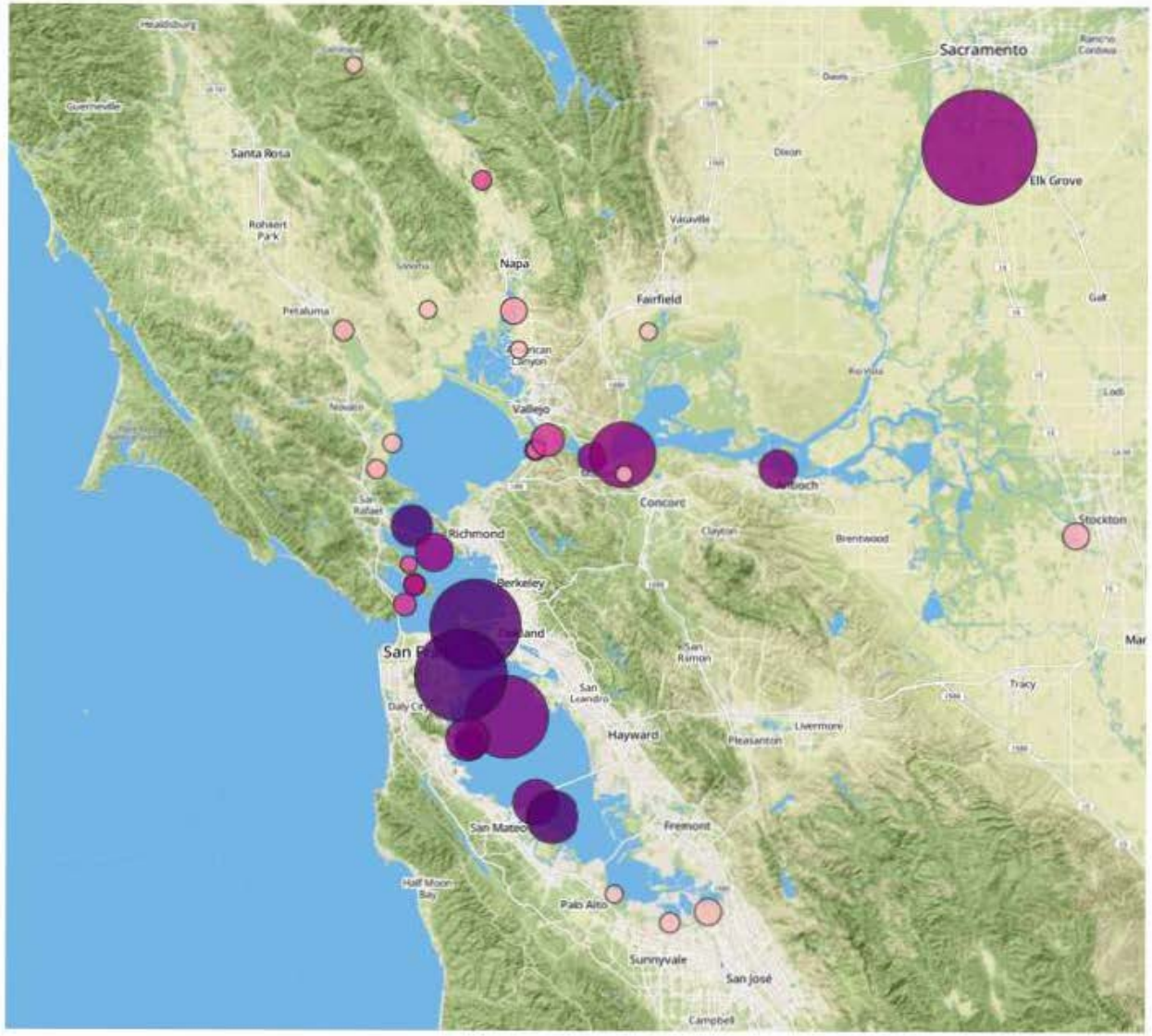
Sacramento Regional WWTP

Ammonia load: 13,053.8 kg/d

Ammonia Concentration: 26 mg/L

Receiving water: Sacramento River

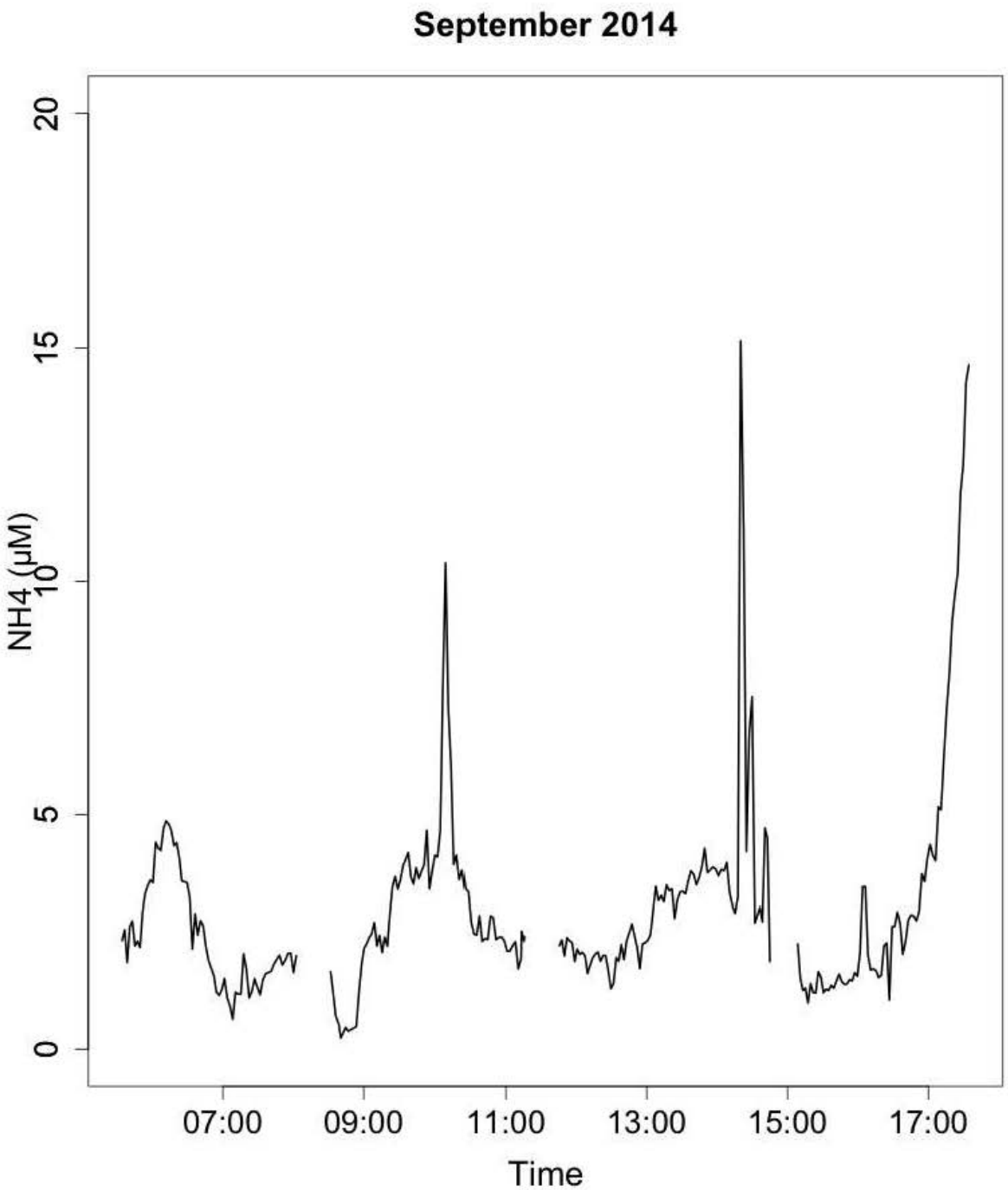
Data summary: Average from Sep. 2011 and March 2012

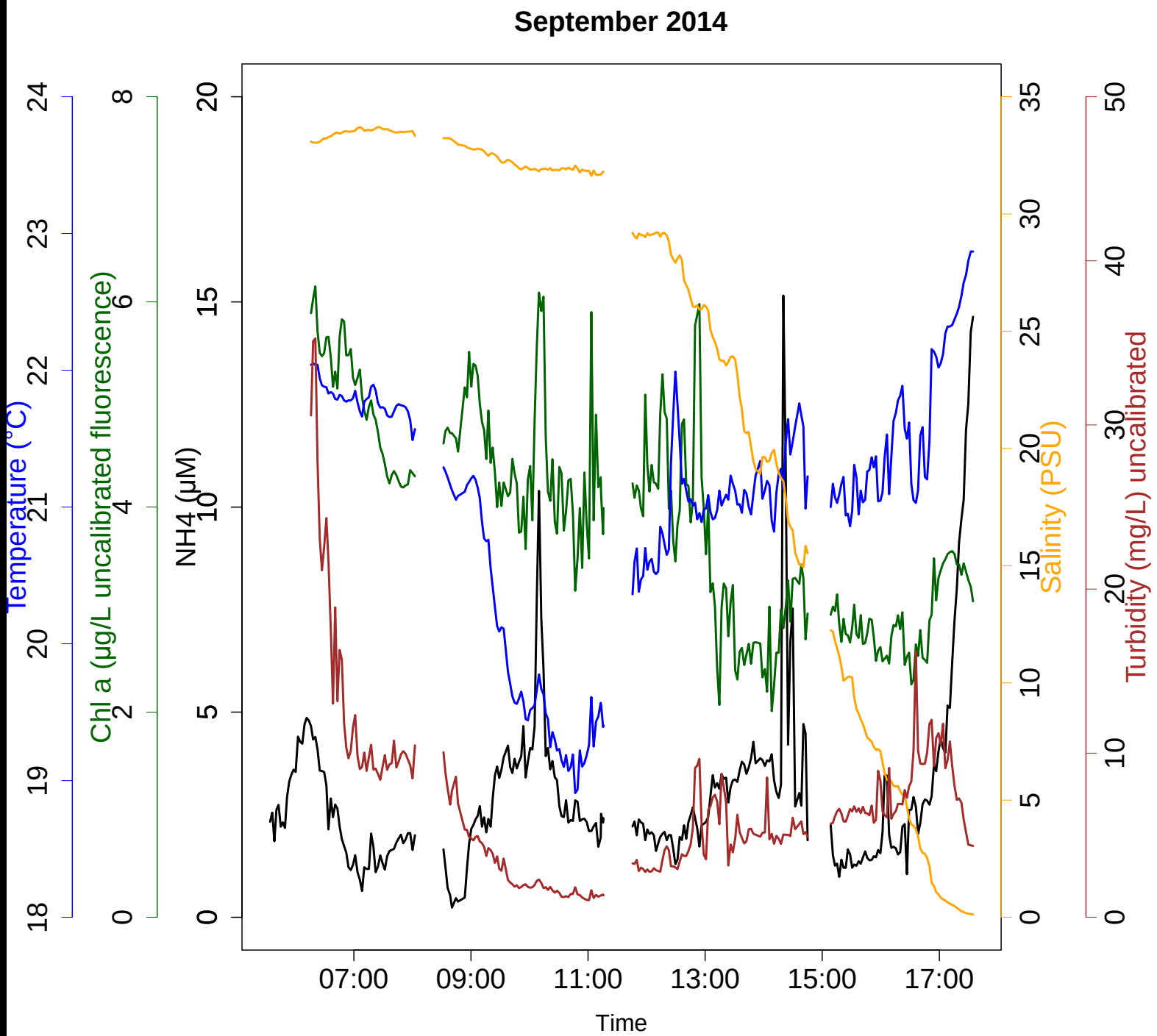


Daily Load

Average ammonia concentration

0 7 14 21 28 35+ mg/L


September 2014
NH4 (µM)
0
5
10
15
20
07:00
09:00
11:00
13:00
15:00
17:00
Time


September 2014
Temperature (°C)
Chl a (µg/L uncalibrated fluorescence)
NH4 (µM)
Salinity (PSU)
Turbidity (mg/L) uncalibrated
Time
07:00
09:00
11:00
13:00
15:00
17:00