N, P, and isotopes from the nearshore/offshore Lake Erie nutrient study (NOLENS).

C.M. Pennuto[1,2], A. Pérez-Fuentetaja[1,2], A. Karatayev[1,2], L. Burlakova[1,2], G. Matisoff[3], D. Bade[4], J. Conroy[5], E.A. Marschall[5], and J. Kramer[6].

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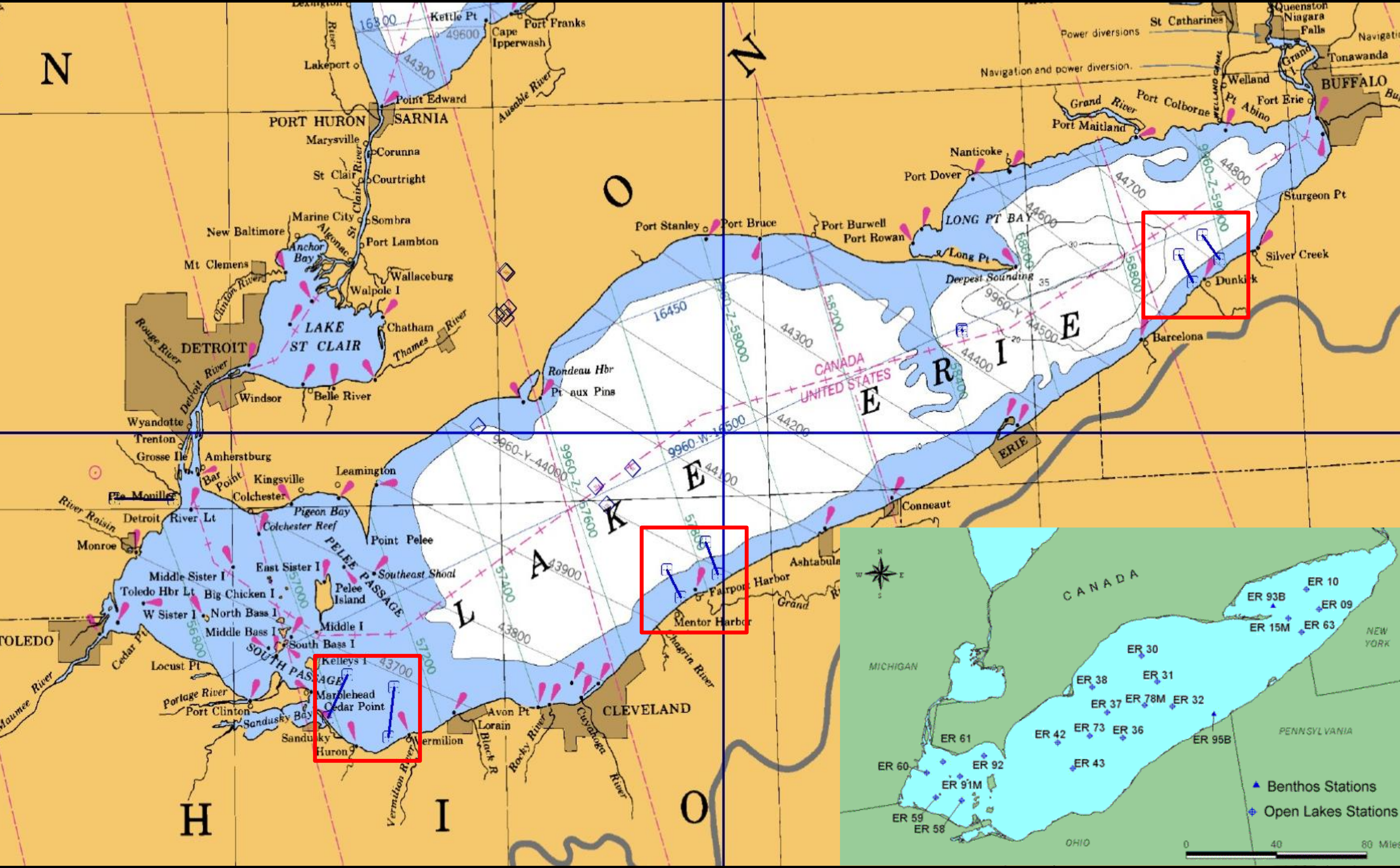
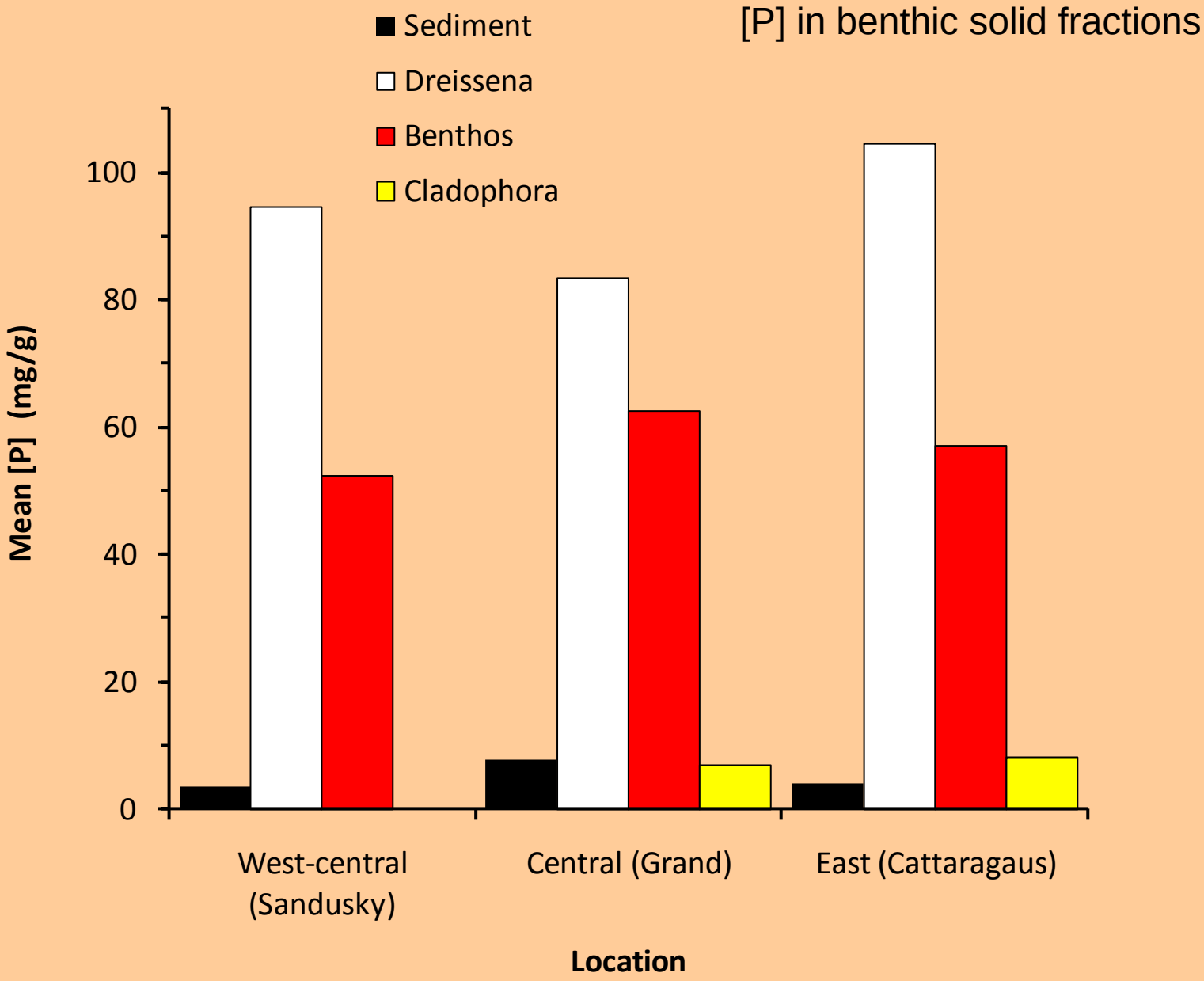
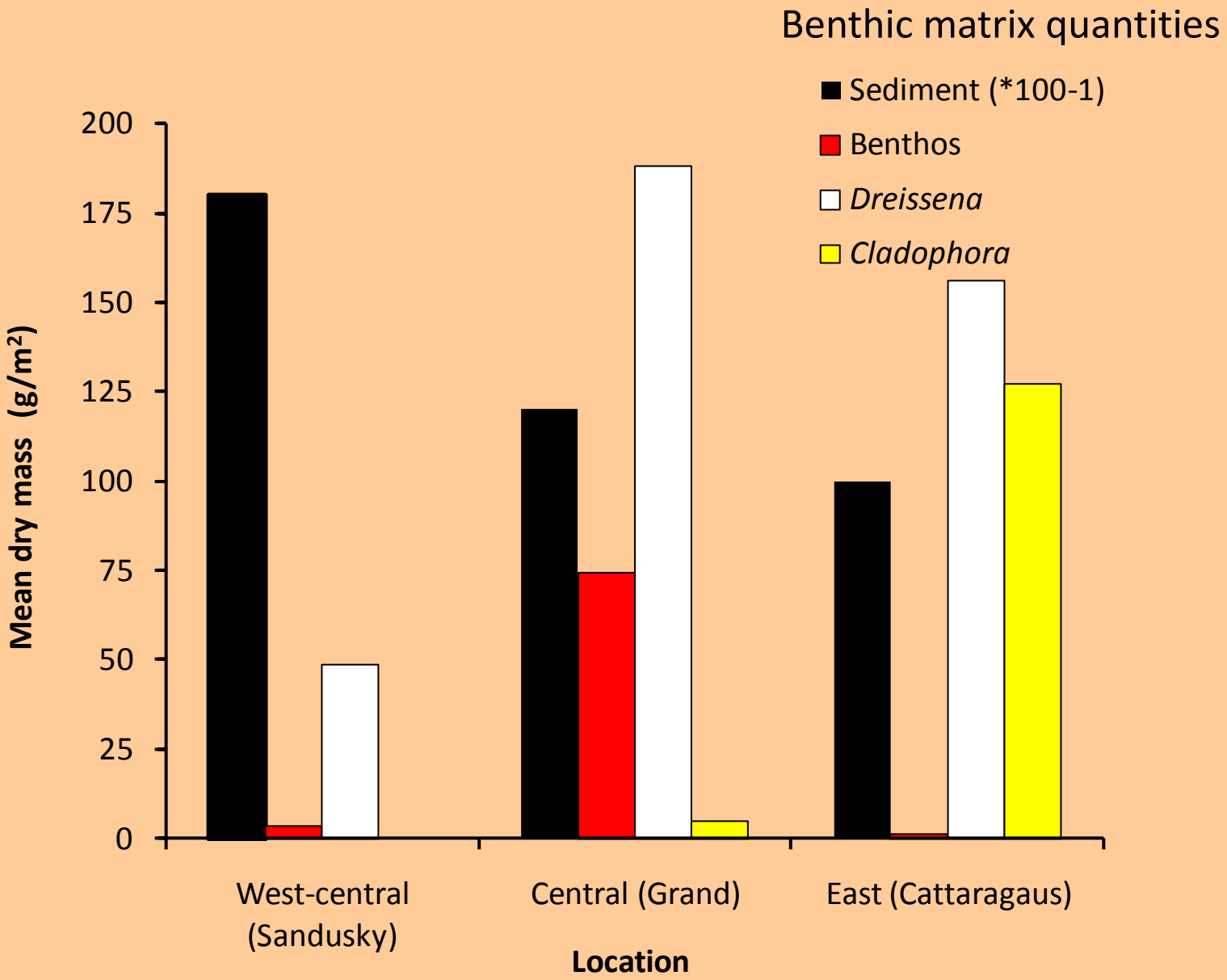

LAKE ERIE
LAKE ST CLAIR
DETROIT
TOLEDO
CLEVELAND
BUFFALO
ERIE
SARNIA
PORT HURON
CANADA
UNITED STATES
Port Stanley
Port Bruce
Port Burwell
Port Rowan
Long Pt
LONG PT BAY
Port Dover
Nanticoke
Port Maitland
Port Colborne
Fort Erie
Welland
St Catharines
Niagara Falls
Queenston
Tonawanda
Sturgeon Pt
Silver Creek
Dunkirk
Barcelona
Conneaut
Ashtabula
Fairport Harbor
Mentor Harbor
Avon Pt
Lorain
Vermilion
Huron
Sandusky
Sandusky Bay
Cedar Point
Marblehead
Kelleys I
South Bass I
Middle Bass I
North Bass I
Middle I
Pelee Island
Point Pelee
Pigeon Bay
Leamington
Kingsville
Colchester
Amherstburg
Wyandotte
Trenton
Grosse Ile
Monroe
Windsor
Belle River
Chatham
Wallaceburg
Walpole I
Rondeau Hbr
Pt aux Pins
Deepest Sounding
Port Clinton
Portage River
Maumee River
Locust Pt
Cedar Pt
Port Edward
Point Edward
Kettle Pt
Port Franks
Cape Ipperwash
Lakeport
Marysville
Corunna
St Clair
Courtright
Marine City
Sombra
Port Lambton
New Baltimore
Anchor Bay
Mt Clemens
Power diversions
Navigation and power diversion.
SOUTH PASSAGE
PELEE PASSAGE
Southeast Shoal
Colchester Reef
Detroit River Lt
East Sister I
Middle Sister I
Big Chicken I
W Sister I
Toledo Hbr Lt
Grand River
Cuyahoga River
Rocky River
Black R
Chagrin River
Vermilion River
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
ER 10
ER 93B
ER 09
ER 15M
ER 63
ER 30
ER 38
ER 31
ER 37
ER 78M
ER 32
ER 42
ER 73
ER 36
ER 95B
ER 61
ER 43
ER 60
ER 92
ER 91M
ER 59
ER 58
Benthos Stations
Open Lakes Stations
0
40
80 Miles

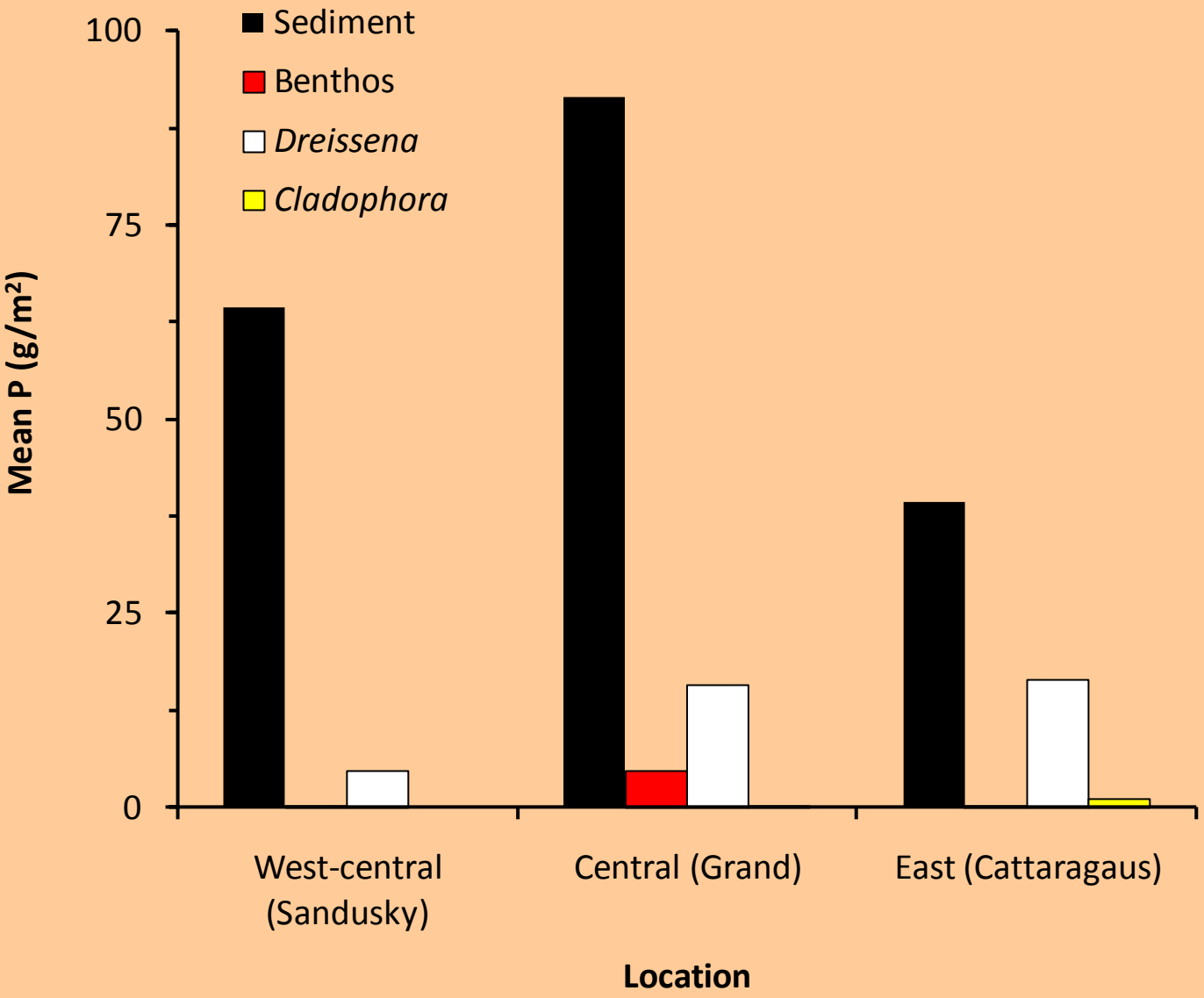
Sampling approach

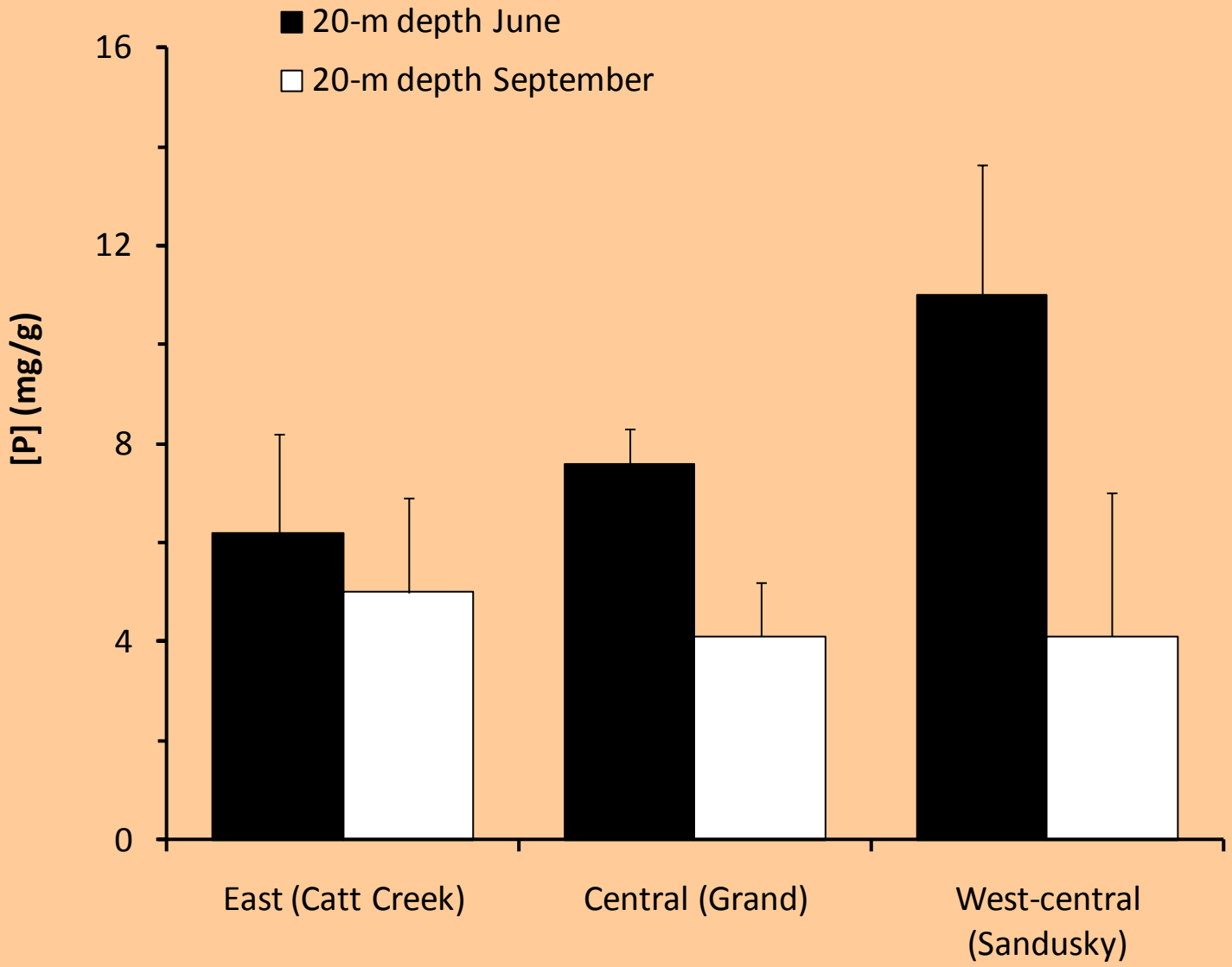
- NS-to-OS transects bracketing major tribs to C & E basins…also allowed coordination with other trib/watershed groups
- NS: *R/V J.J. Freidhoff*/whalers; OS: *R/V Lake Guardian*
- fixed stations (2, 5, 10, 20 m), June and late Aug/early Sept sampling
- quantify water column and benthic P pools…bacterial, phytoplankton, 3 zooplankton sizes, *Dreissena* mussels, dominant infaunal/epifaunal, *Cladophora*, sediments (both mussel bed and non-mussel bed)
- estimate fluxes…bacterial and phytoplankton productivity, sedimentation
- link pools and fluxes via stable isotope analyses and hydrodynamic model of particle transport

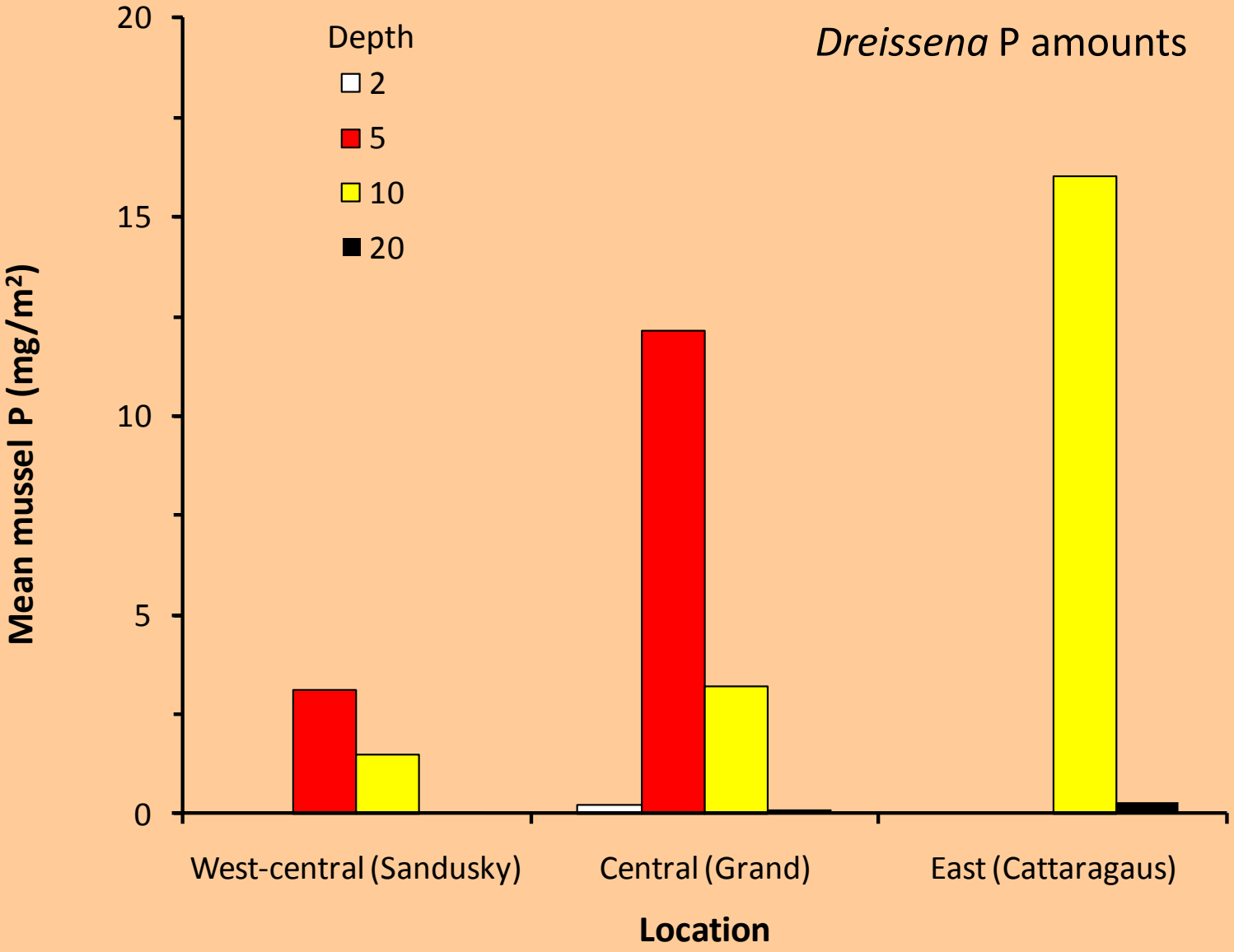

[P] in benthic solid fractions
Sediment
Dreissena
Benthos
Cladophora
Mean [P] (mg/g)
0
20
40
60
80
100
West-central (Sandusky)
Central (Grand)
East (Cattaragaus)
Location


Benthic matrix quantities
Sediment (*100-1)
Benthos
Dreissena
Cladophora
Mean dry mass (g/m²)
200
175
150
125
100
75
50
25
0
West-central (Sandusky)
Central (Grand)
East (Cattaragaus)
Location

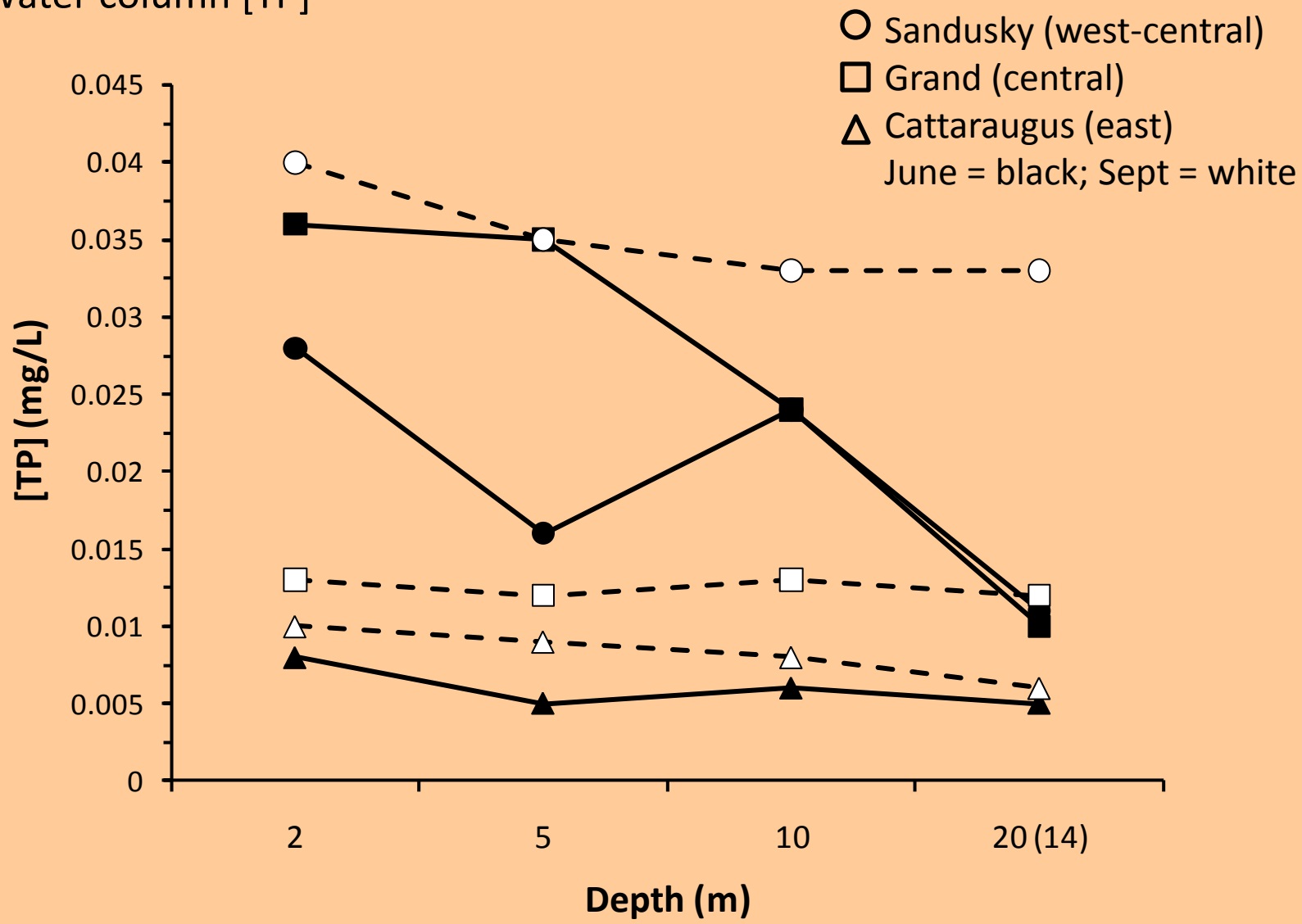
Benthic matrix P amounts



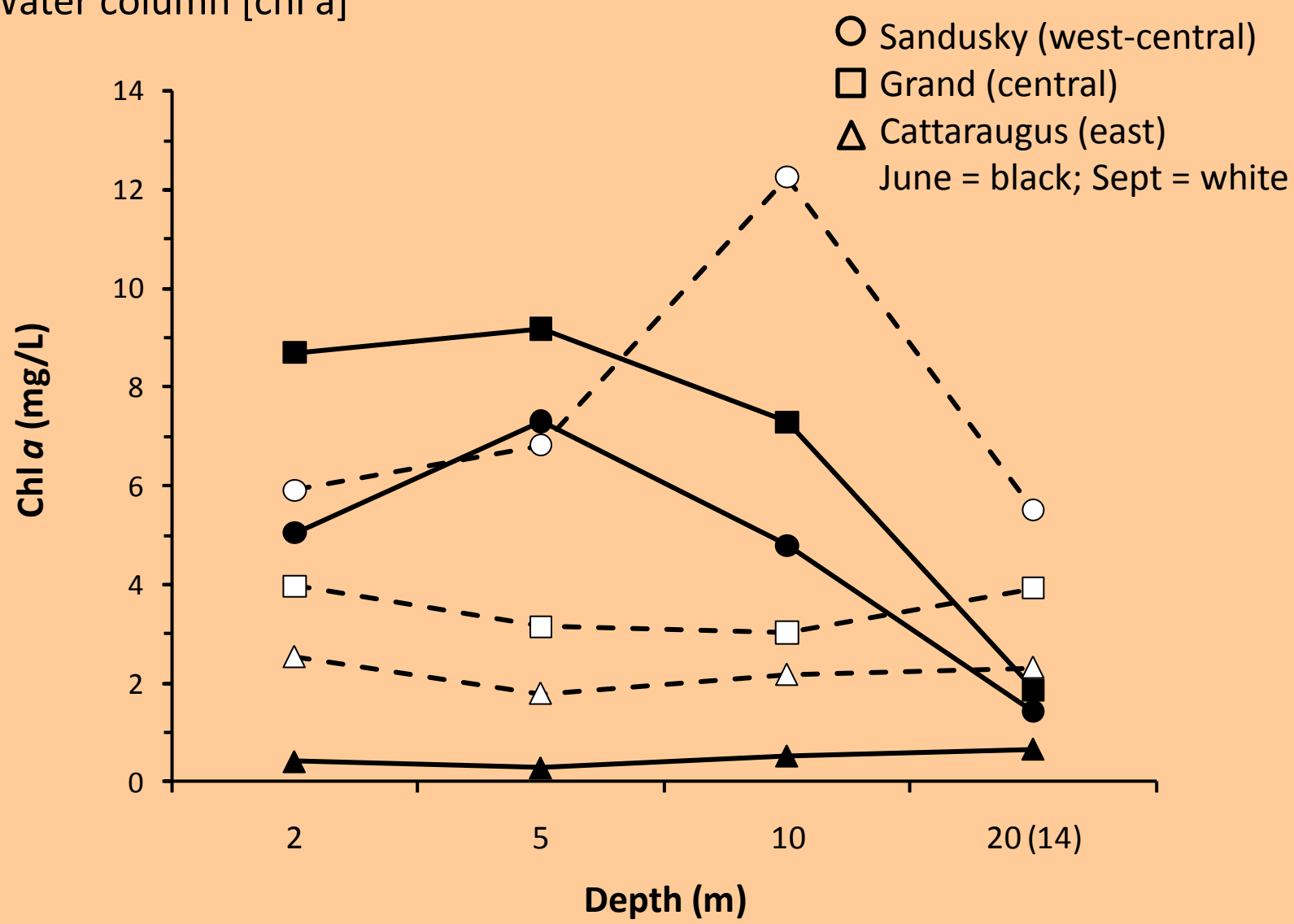

20-m depth June
20-m depth September
16
12
8
4
0
[P] (mg/g)
East (Catt Creek)
Central (Grand)
West-central (Sandusky)


Dreissena P amounts
Depth
2
5
10
20
Mean mussel P (mg/m²)
20
15
10
5
0
West-central (Sandusky)
Central (Grand)
East (Cattaragaus)
Location

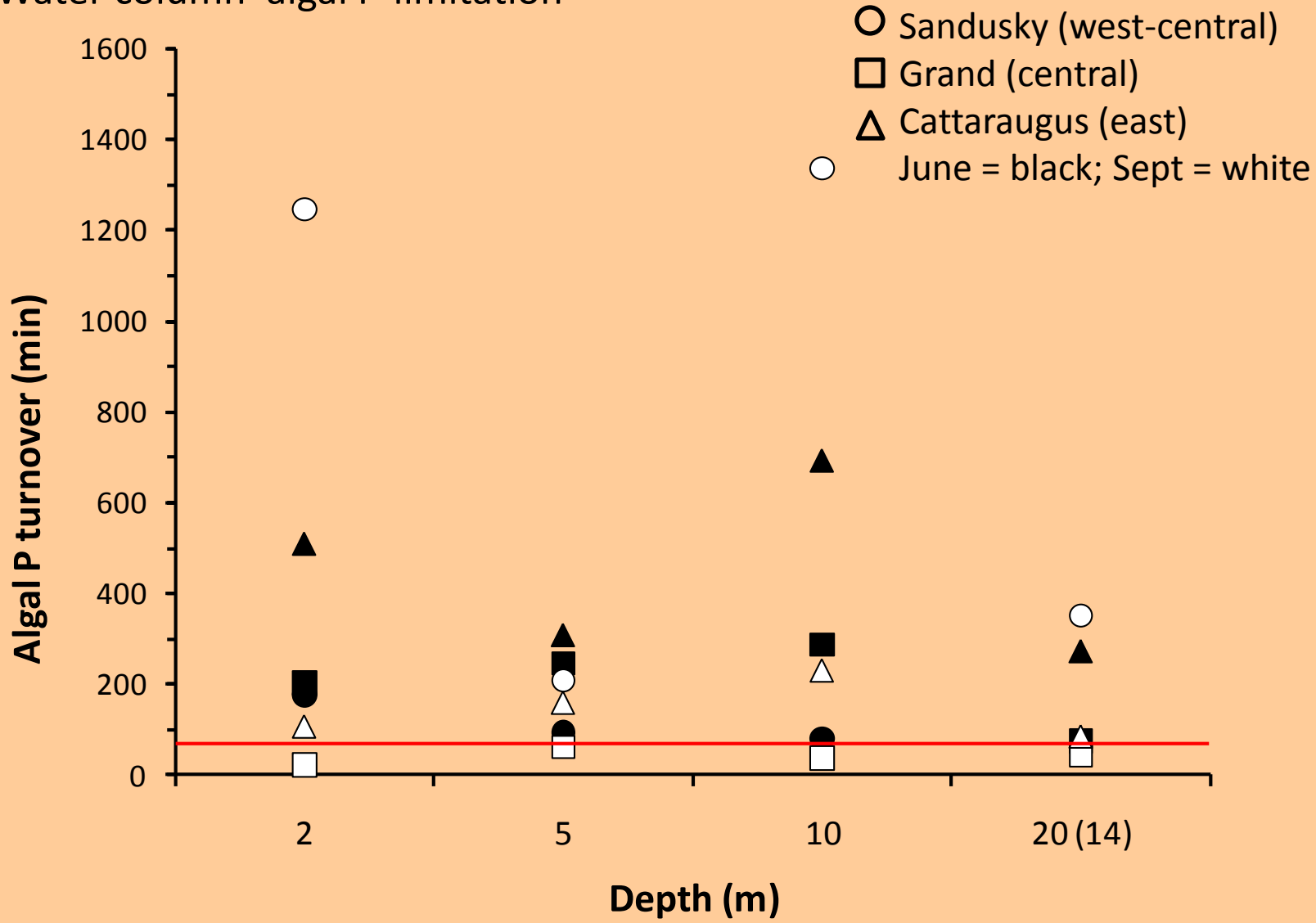
Water column [TP]

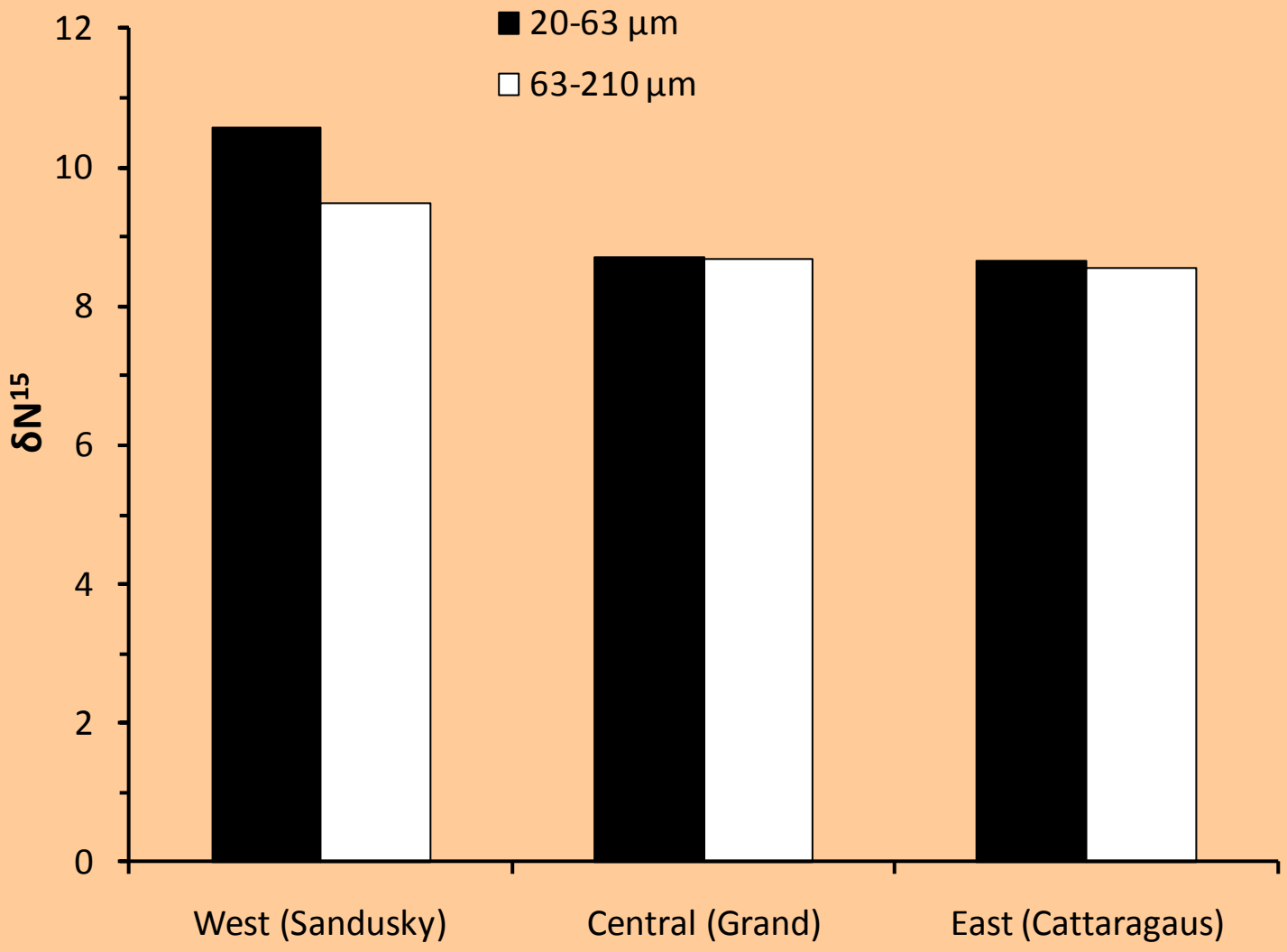


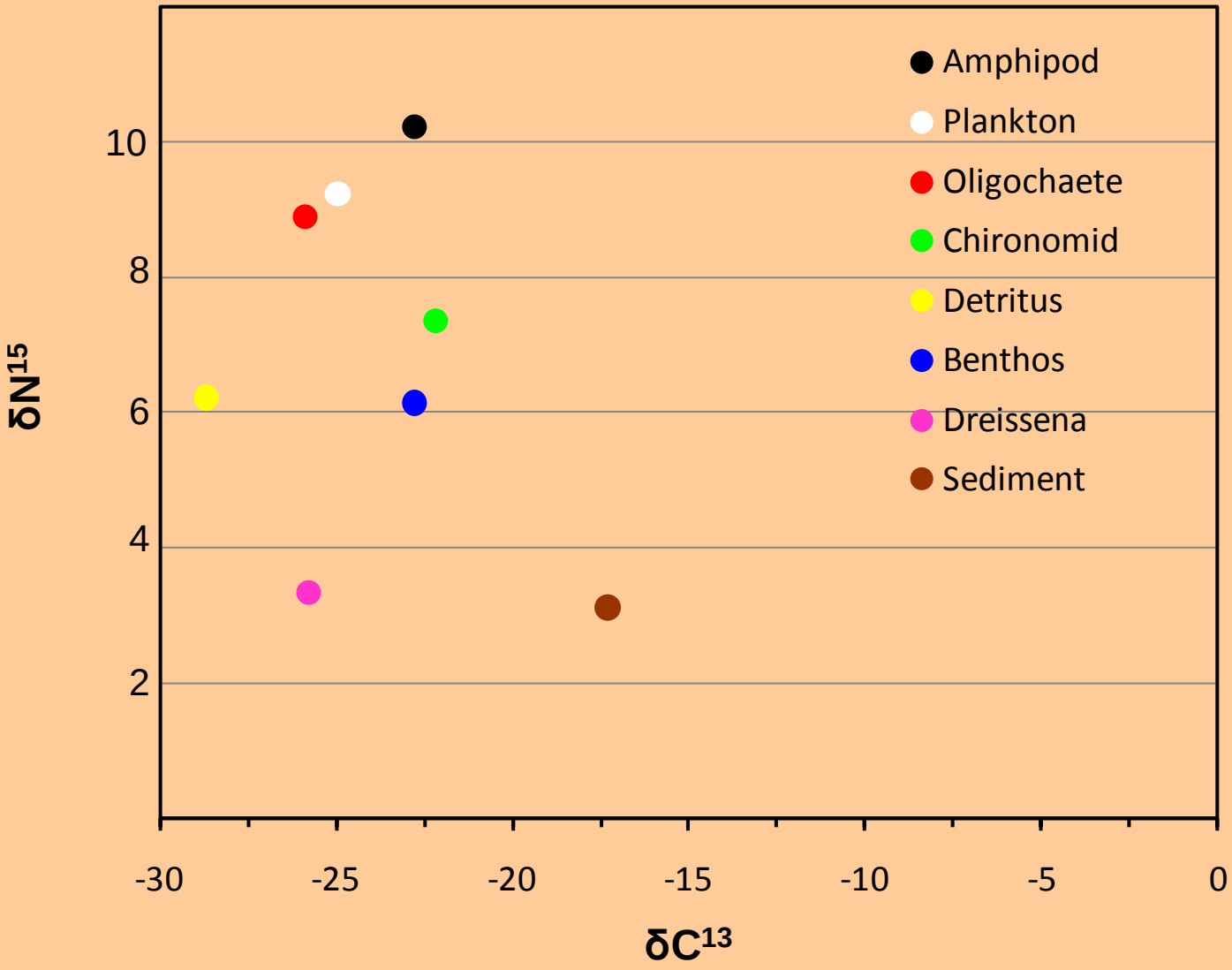
Water column [chl a]



Water column algal P-limitation




20-63 µm
63-210 µm
δN15
12
10
8
6
4
2
0
West (Sandusky)
Central (Grand)
East (Cattaragaus)


Amphipod
Plankton
Oligochaete
Chironomid
Detritus
Benthos
Dreissena
Sediment
10
8
6
4
2
δN15
-30
-25
-20
-15
-10
-5
0
δC13

Results summary

- Distinct NS-to-OS reductions in water column [TP] at all 3 locations, WC & E basin increase [TP] with season, but C decreased with season
- Algal abundance (chl a) matched [TP] in both seasons and across basins, declining NS to OS and increasing or decreasing with [TP]; generally declining west to east
- Algal and bacterial communities were P-limited in the C, but not the WC or E basins in fall
- WC basin plankton exhibits a slightly higher δN, suggesting either longer chains or a different basal resource
- The majority of organic particulate P resides in *Dreissena* tissues, but mussel abundance is very different in the basins and at different depths
- Sediments harbor the largest pool of P in the lake. Although C basin sediments have the highest [P] averaged across all depths, and the highest P pool, WC basin sediments have the highest OS [P]

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