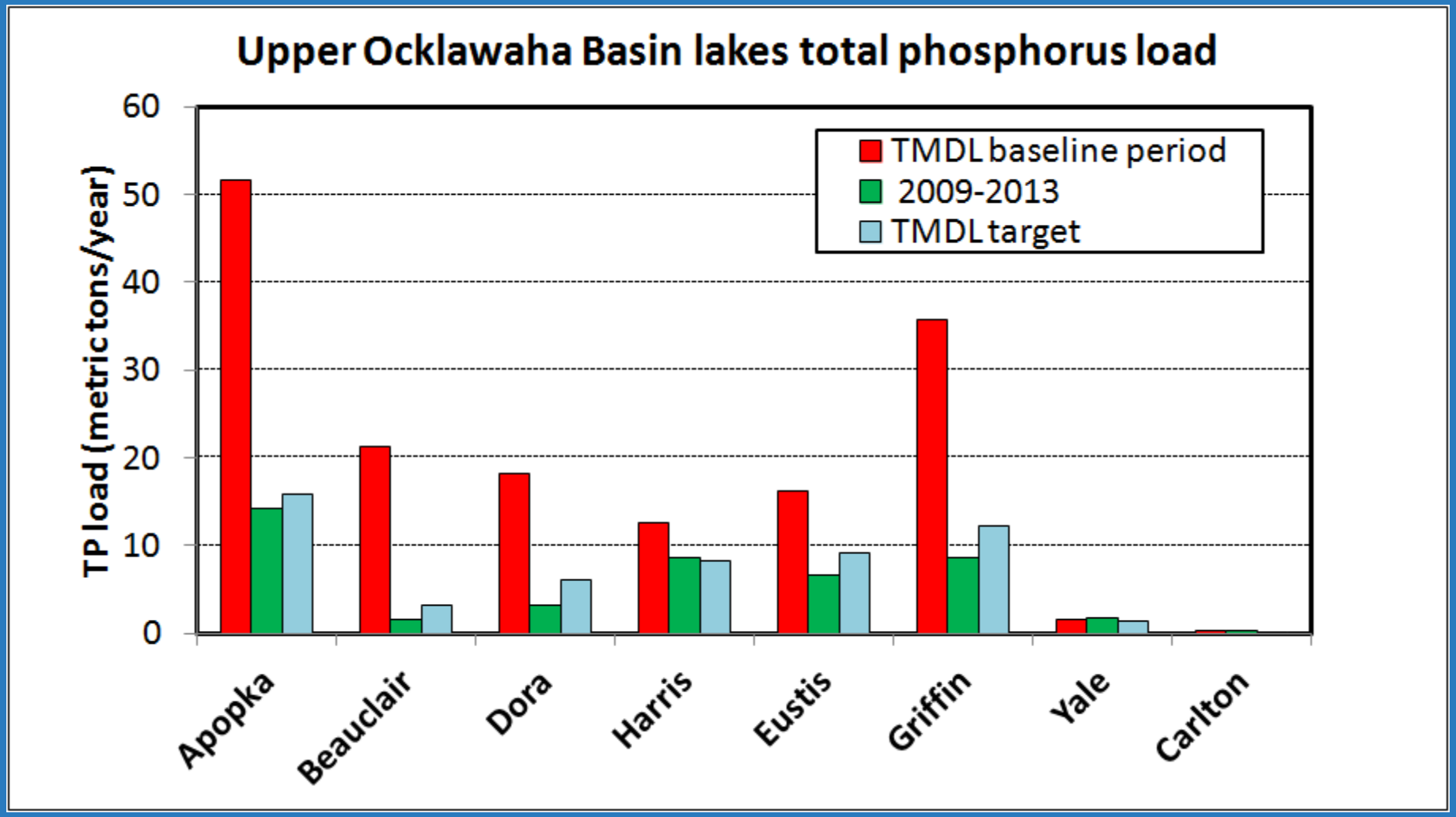
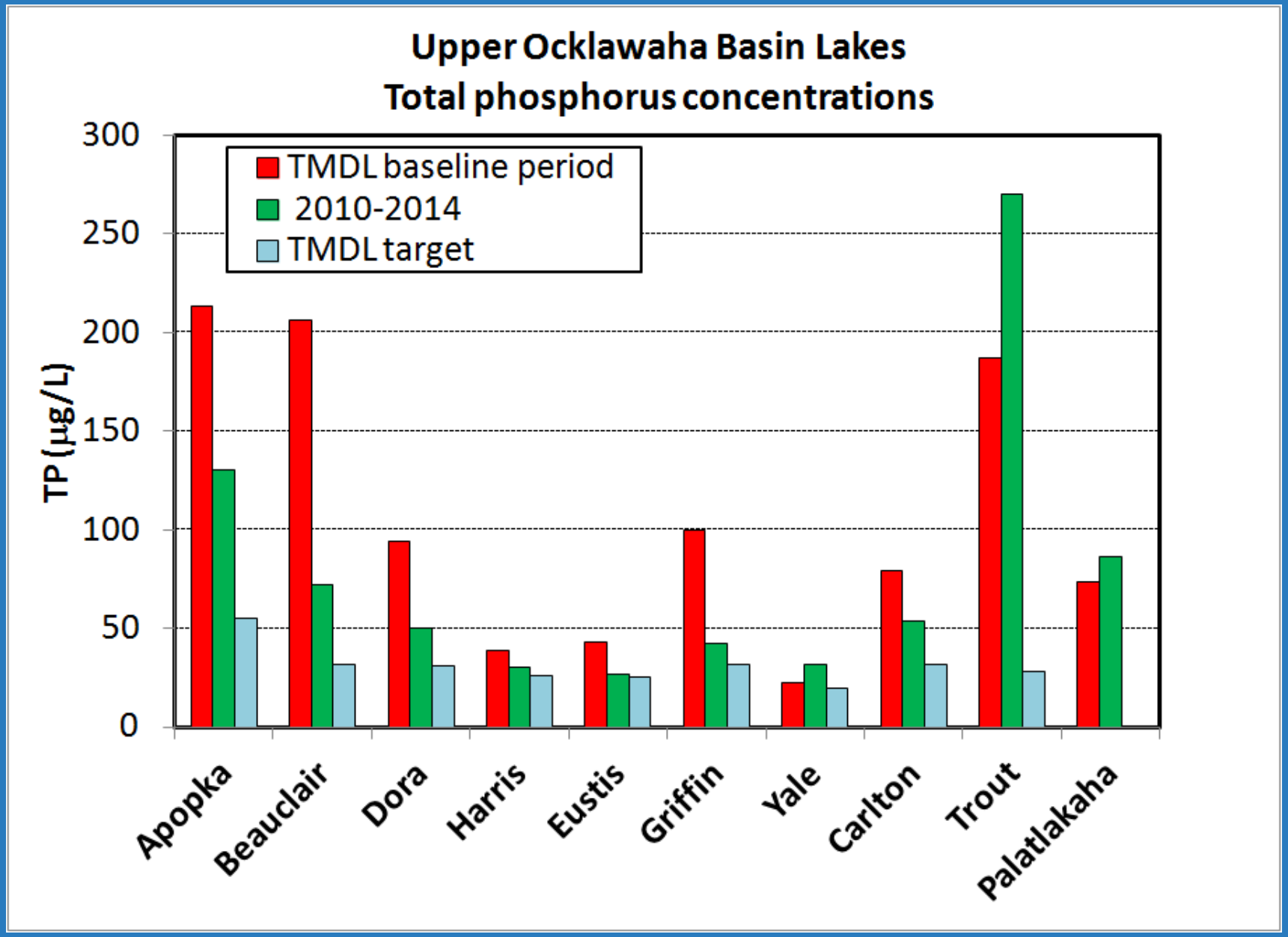
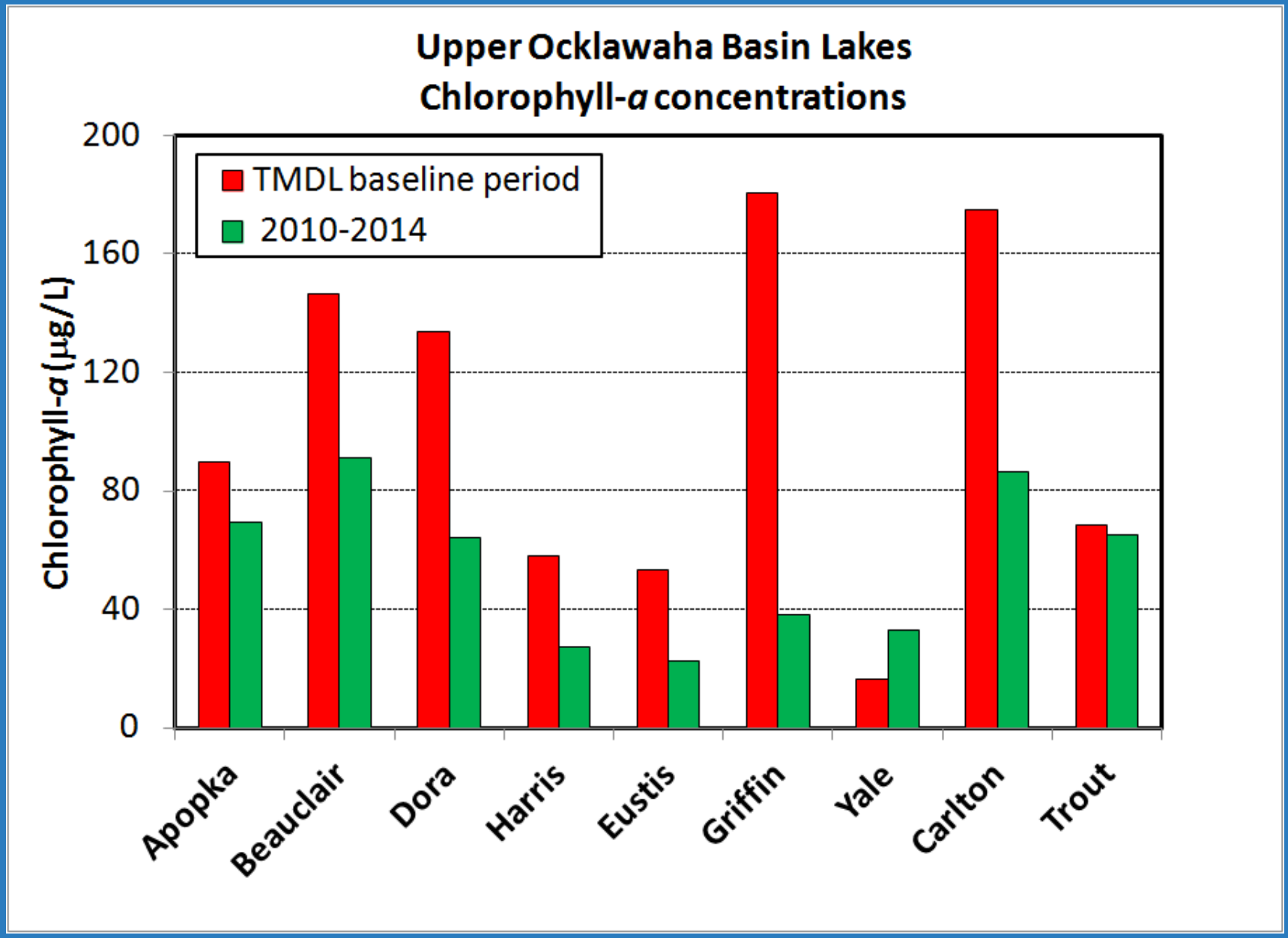
Trends in total phosphorus loading and water quality in the Upper Ocklawaha BMAP lakes

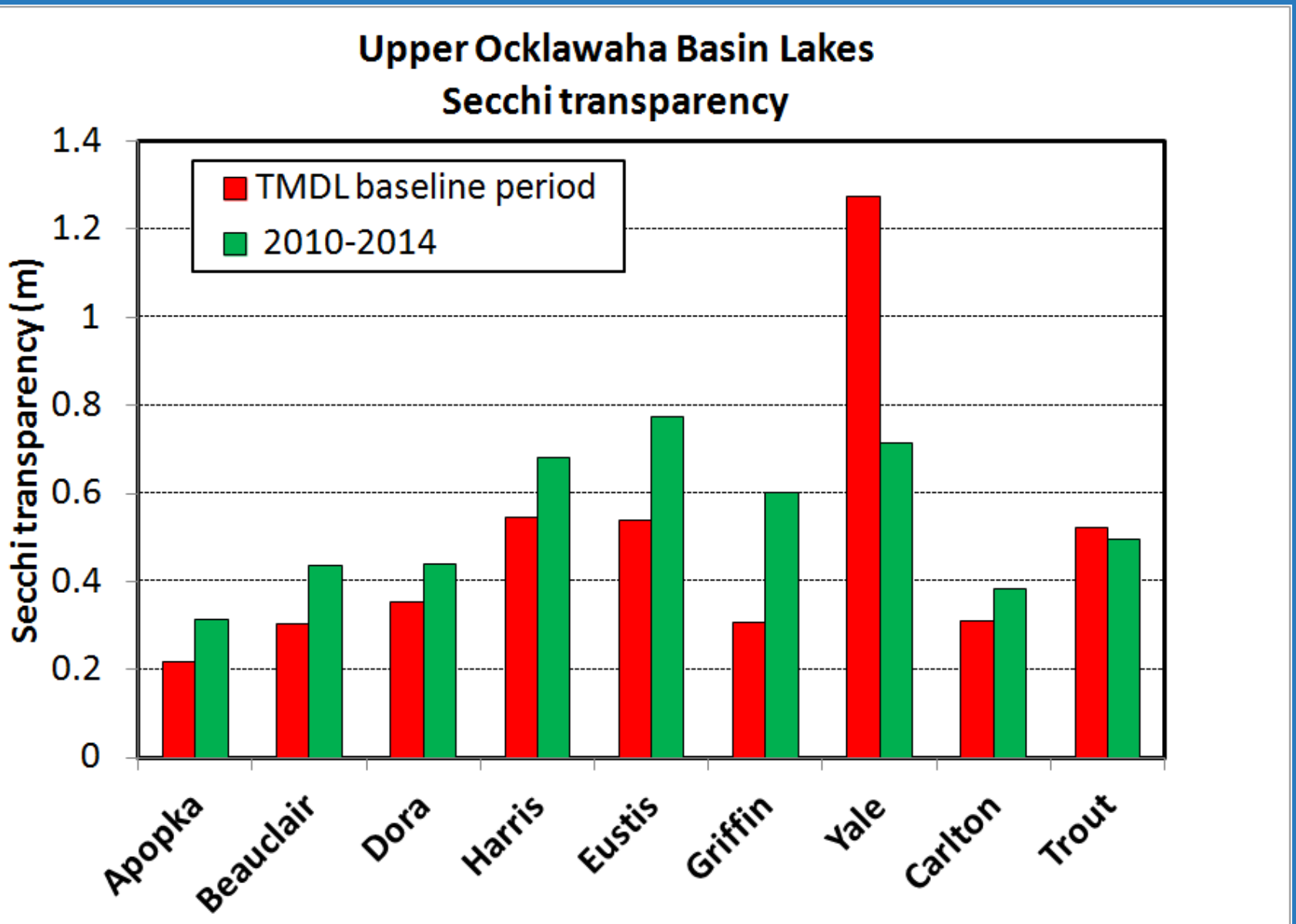
Rolland Fulton

Feb. 25, 2015

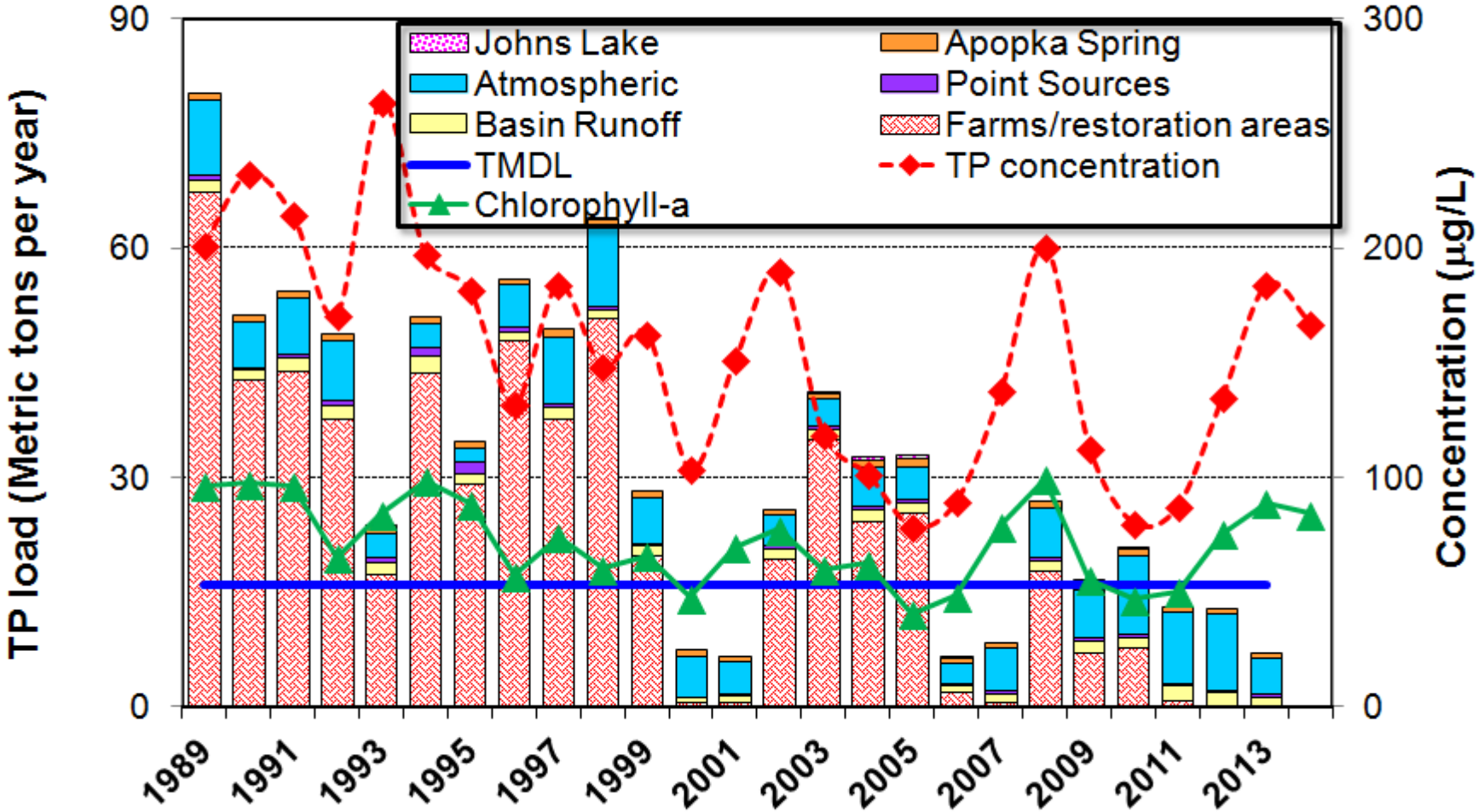

Upper Ocklawaha Basin lakes total phosphorus load
TP load (metric tons/year)
60
50
40
30
20
10
0
TMDL baseline period
2009-2013
TMDL target
Apopka
Beauclair
Dora
Harris
Eustis
Griffin
Yale
Carlton

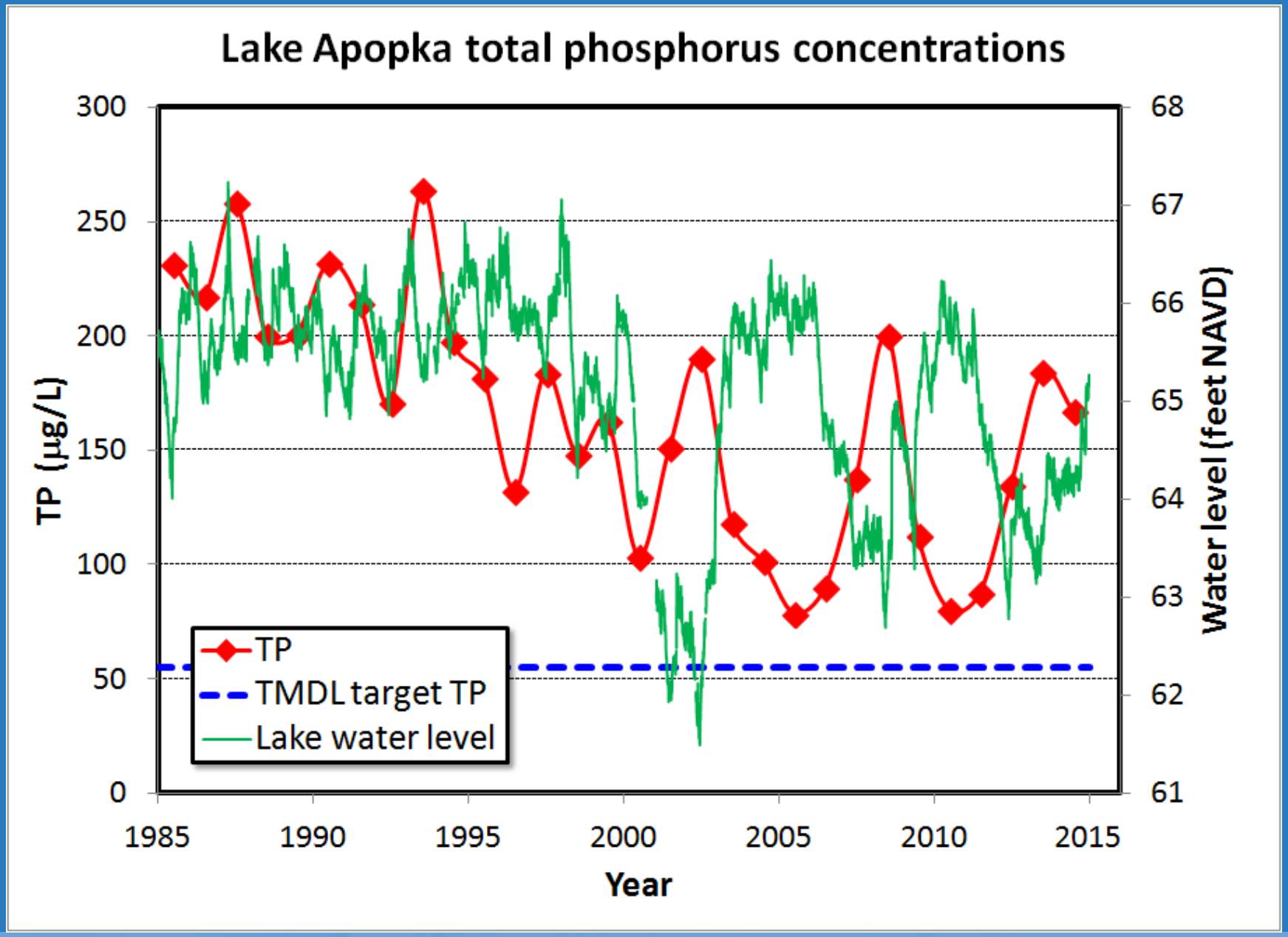

Upper Ocklawaha Basin Lakes
Total phosphorus concentrations
TMDL baseline period
2010-2014
TMDL target
TP (µg/L)
300
250
200
150
100
50
0
Apopka
Beauclair
Dora
Harris
Eustis
Griffin
Yale
Carlton
Trout
Palatlakaha

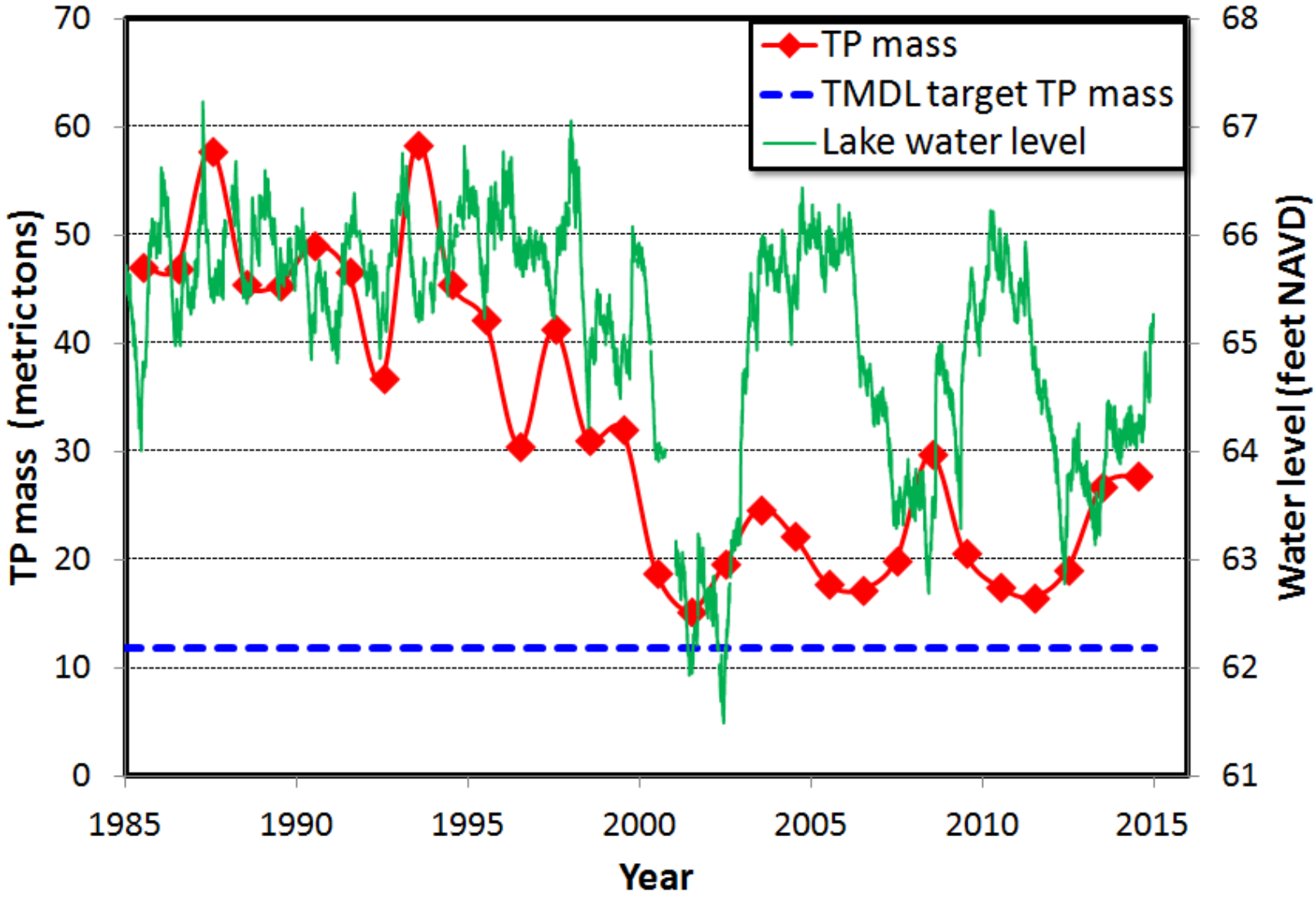

Upper Ocklawaha Basin Lakes
Chlorophyll-a concentrations
TMDL baseline period
2010-2014
Chlorophyll-a (µg/L)
200
160
120
80
40
0
Apopka
Beauclair
Dora
Harris
Eustis
Griffin
Yale
Carlton
Trout


Upper Ocklawaha Basin Lakes
Secchi transparency
TMDL baseline period
2010-2014
Secchi transparency (m)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Apopka
Beauclair
Dora
Harris
Eustis
Griffin
Yale
Carlton
Trout

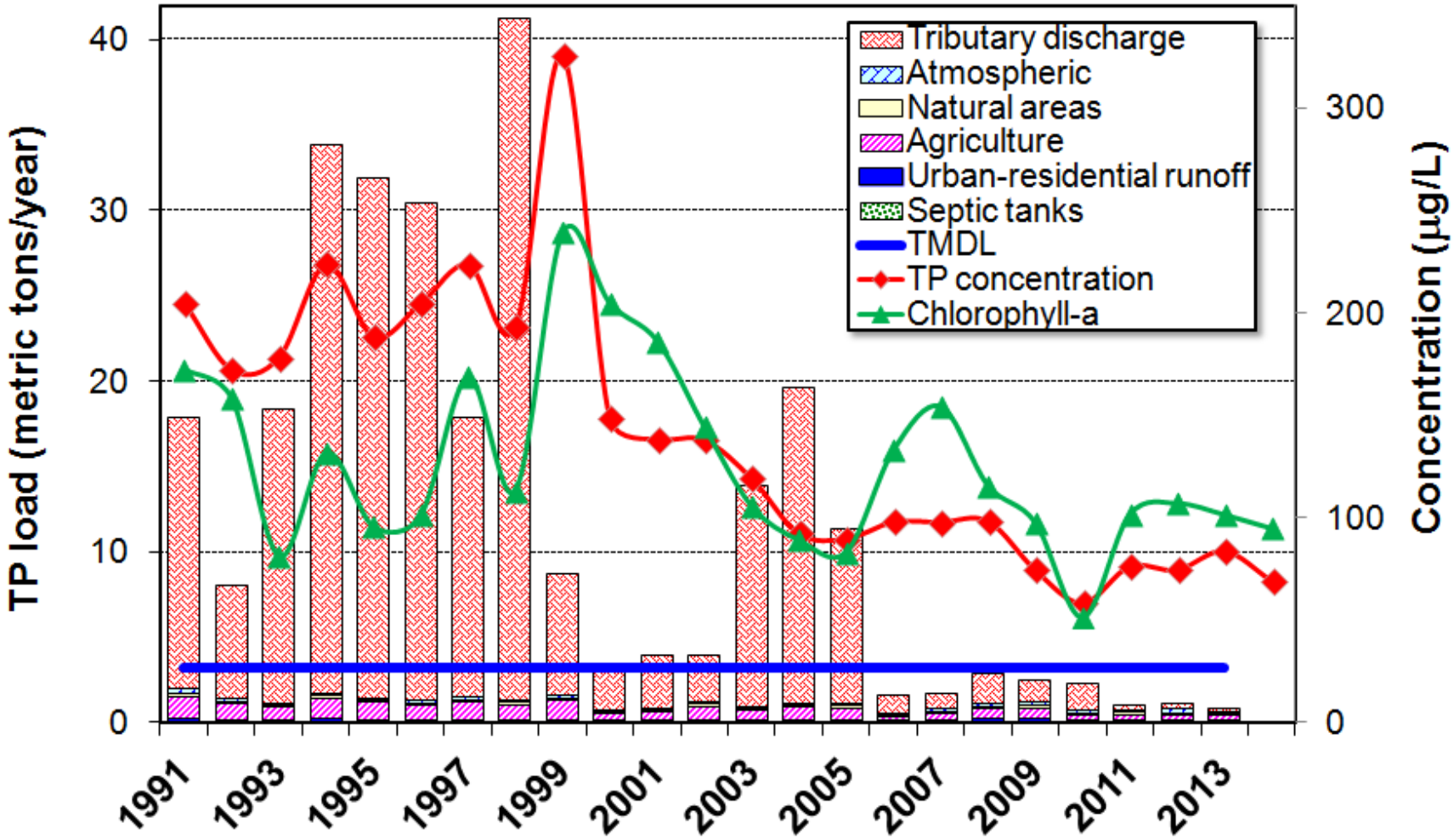
Lake Apopka estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-*a*

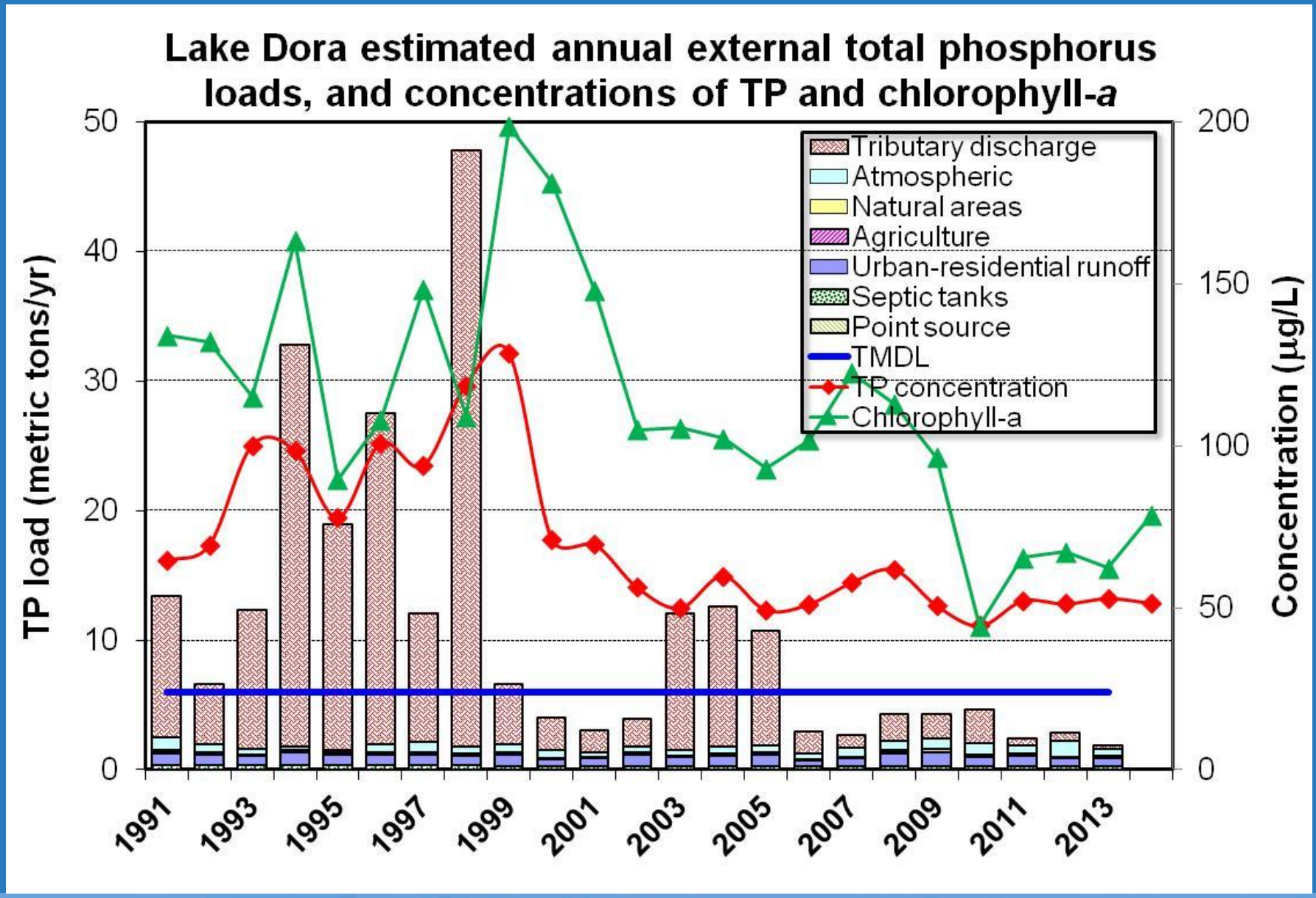



Lake Apopka total phosphorus concentrations
TP (µg/L)
Water level (feet NAVD)
Year
TP
TMDL target TP
Lake water level
300
250
200
150
100
50
0
68
67
66
65
64
63
62
61
1985
1990
1995
2000
2005
2010
2015

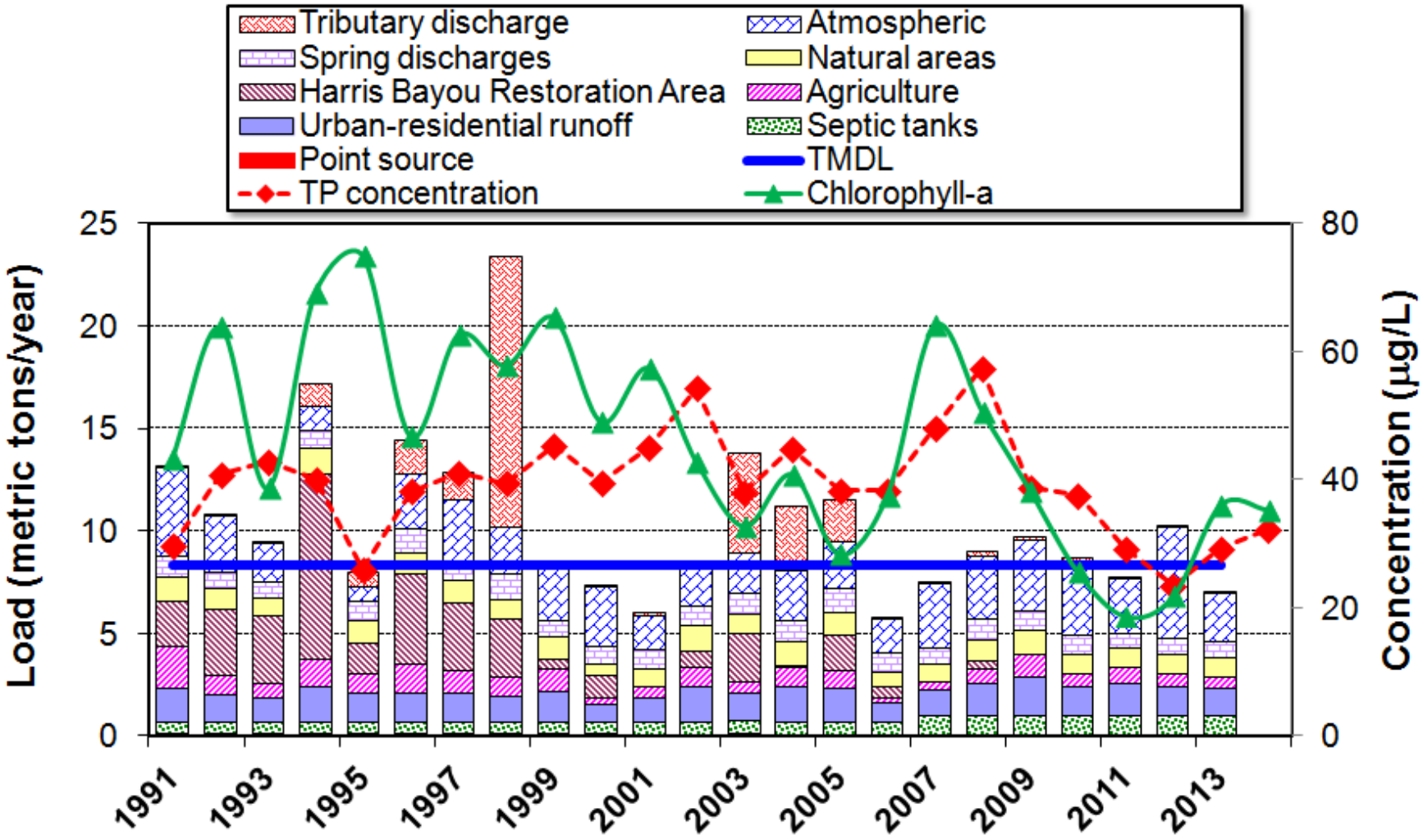

Lake Apopka total phosphorus mass
TP mass
TMDL target TP mass
Lake water level
TP mass (metric tons)
Water level (feet NAVD)
Year
0
10
20
30
40
50
60
70
61
62
63
64
65
66
67
68
1985
1990
1995
2000
2005
2010
2015

Lake Beauclair estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-*a*

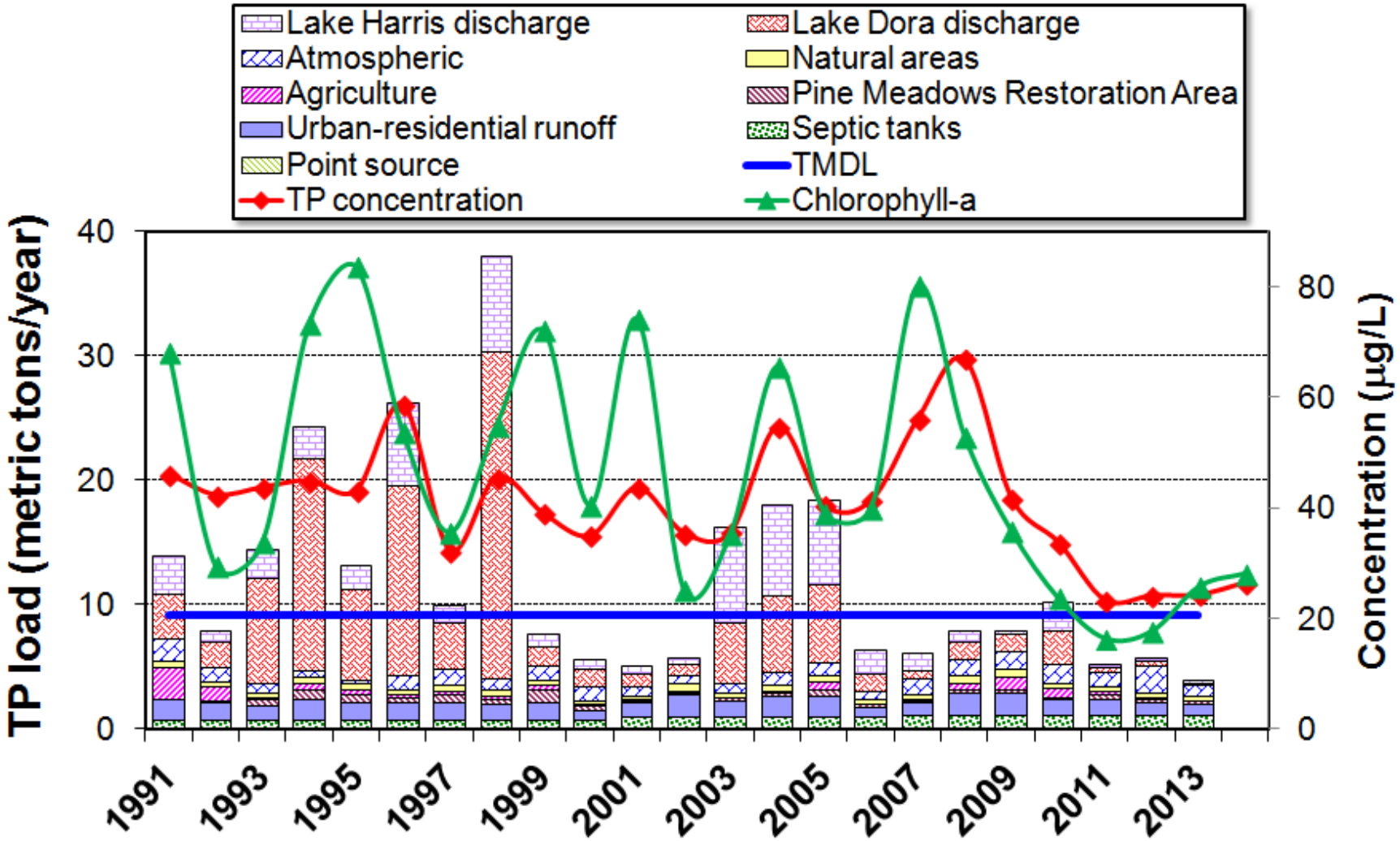



Lake Dora estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-a
TP load (metric tons/yr)
Concentration (µg/L)
0
10
20
30
40
50
0
50
100
150
200
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
Tributary discharge
Atmospheric
Natural areas
Agriculture
Urban-residential runoff
Septic tanks
Point source
TMDL
TP concentration
Chlorophyll-a

Lake Harris estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-*a*



Lake Eustis estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-*a*



Lake Griffin – late 1990s

Orlando Sentinel – 8/26/01

SPECIAL REPORT

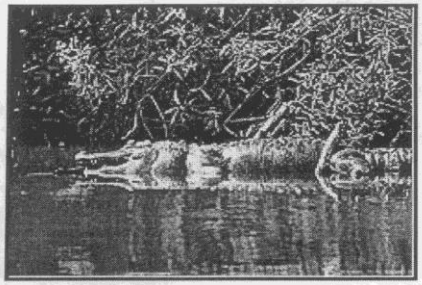
Toxic algae in our lakes

Menace lurks hidden in lakes

A study reveals how risky it may be to go into the water

Killed by Cy? A gator lies dead in Lake Griffin. Scientists think the killer may be a tiny organism nicknamed `Cy.'

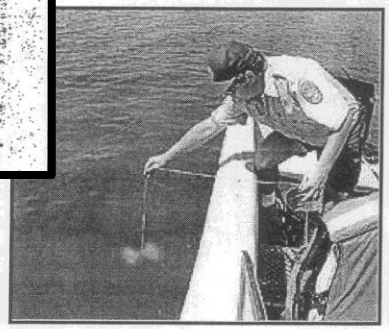
TOM BENITEZ/THE ORLANDO SENTINEL



Do lakes hold a killer algae?

Robert Sargent Jr. and Ramsey Campbell
of The Sentinel Staff

...ntinel on July 22, 1999.



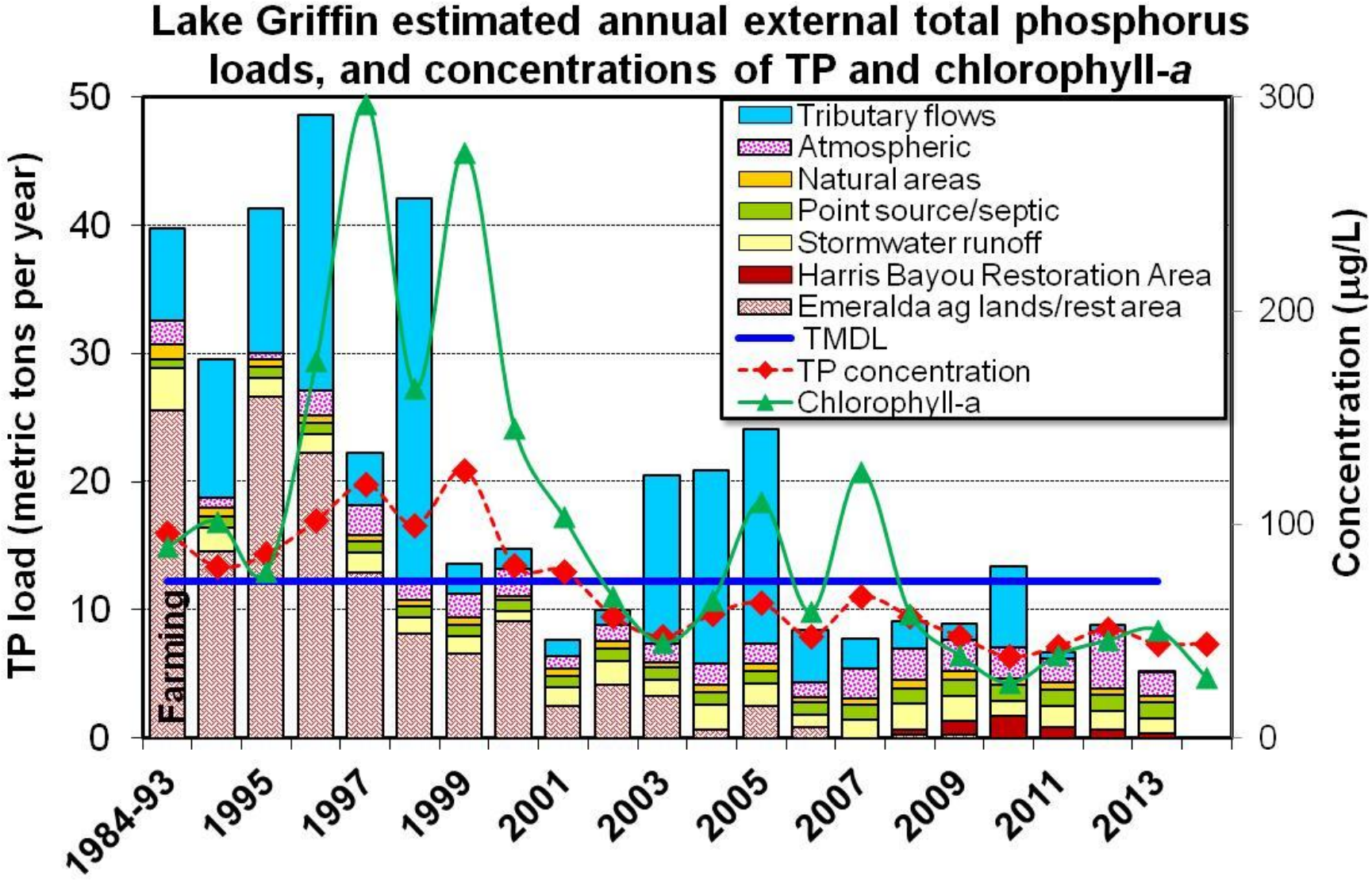
...water in Lake Griffin for visibility

TOM BENITEZ/THE ORLANDO SENTINEL

Test confirms bacteria will poison lake

Ramsey Campbell
of The Sentinel Staff

Published in The Orlando Sentinel on July 23, 1999.


Lake Griffin estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-a
TP load (metric tons per year)
Concentration (µg/L)
50
40
30
20
10
0
300
200
100
0
Farming
Tributary flows
Atmospheric
Natural areas
Point source/septic
Stormwater runoff
Harris Bayou Restoration Area
Emeralda ag lands/rest area
TMDL
TP concentration
Chlorophyll-a
1984-93
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013

North American Lake Management Society Technical Merit Award November 2014

SJRWMD Lake Griffin Nutrient Restoration project

the best paper published in *Lake and Reservoir Management* as determined by the editor and associate editors.

This year's technical merit awards are:

TECHNICAL MERIT AWARD FOR *SUCCESSFUL PROJECTS*

Lake Griffin Nutrient Restoration Project

Lake Griffin is a large (surface area about 38 km^2), shallow (mean depth about 2 m) lake located in central Florida. Lake Griffin is the most downstream of the Ocklawaha Chain-of-Lakes, and discharges to the Ocklawaha River, which discharges further downstream into the St. Johns River. Large floodplain wetland areas along the east shore of Lake Griffin were drained to develop muck farms beginning in the 1950s.

Lake Griffin has been hypereutrophic since at least the early 1980s, with total phosphorus (TP) and chlorophyll-*a* concentrations often exceeding 100 µg/L since that time. In the 1990s, Lake Griffin had persistent severe cyanobacterial blooms, dominated by *Cylindrospermopsis raciborskii*, which ranged up to 98 percent of total phytoplankton biovolume. Gizzard shad (*Dorosoma cepedianum* Le Sueur) dominated the fish biomass in Lake

Accepting the Lake Griffin award are (from left) Michael F. Coveney, Rolland S. Fulton III, and Victoria R. Hoge (all with SJRWMD), with Reed Green and Ann B. Shortelle.

St. Johns River Water Management District

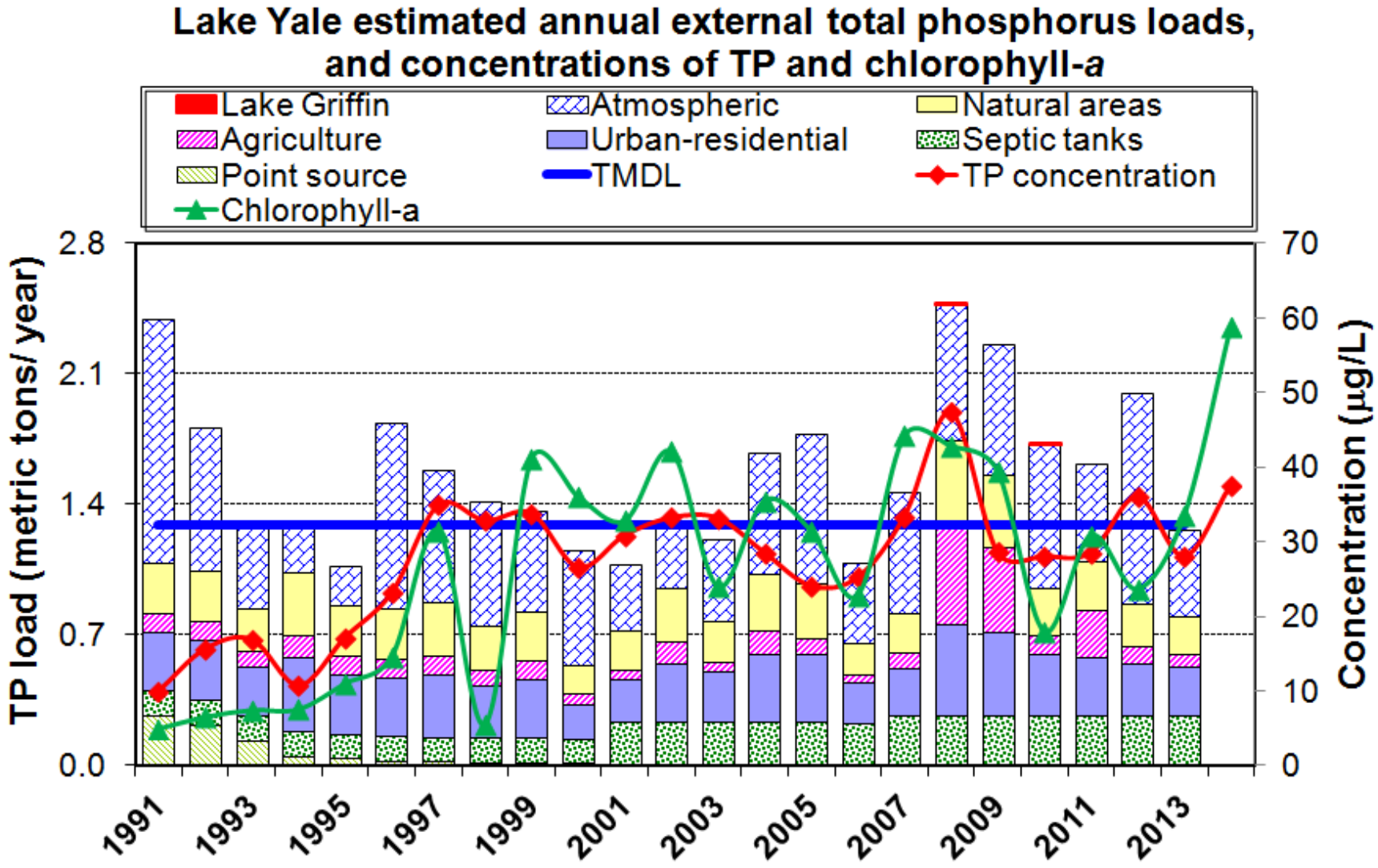
Water quality changes following nutrient loading reduction and biomanipulation in a large shallow subtropical lake, Lake Griffin, Florida, USA

Rolland S. Fulton, Walter F. Godwin & Maynard H. Schaus

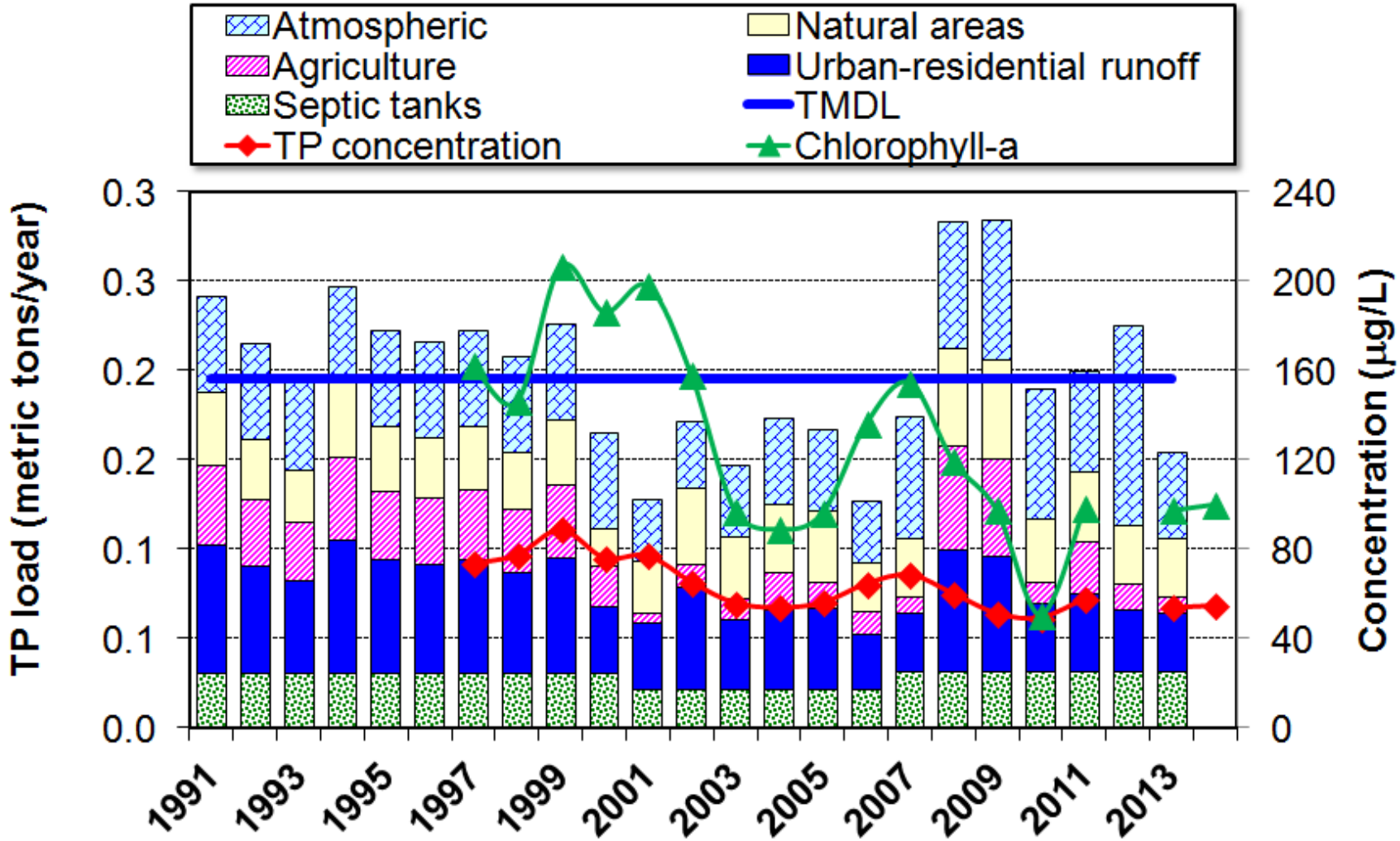
Hydrobiologia
The International Journal of Aquatic Sciences

ISSN 0018-8158

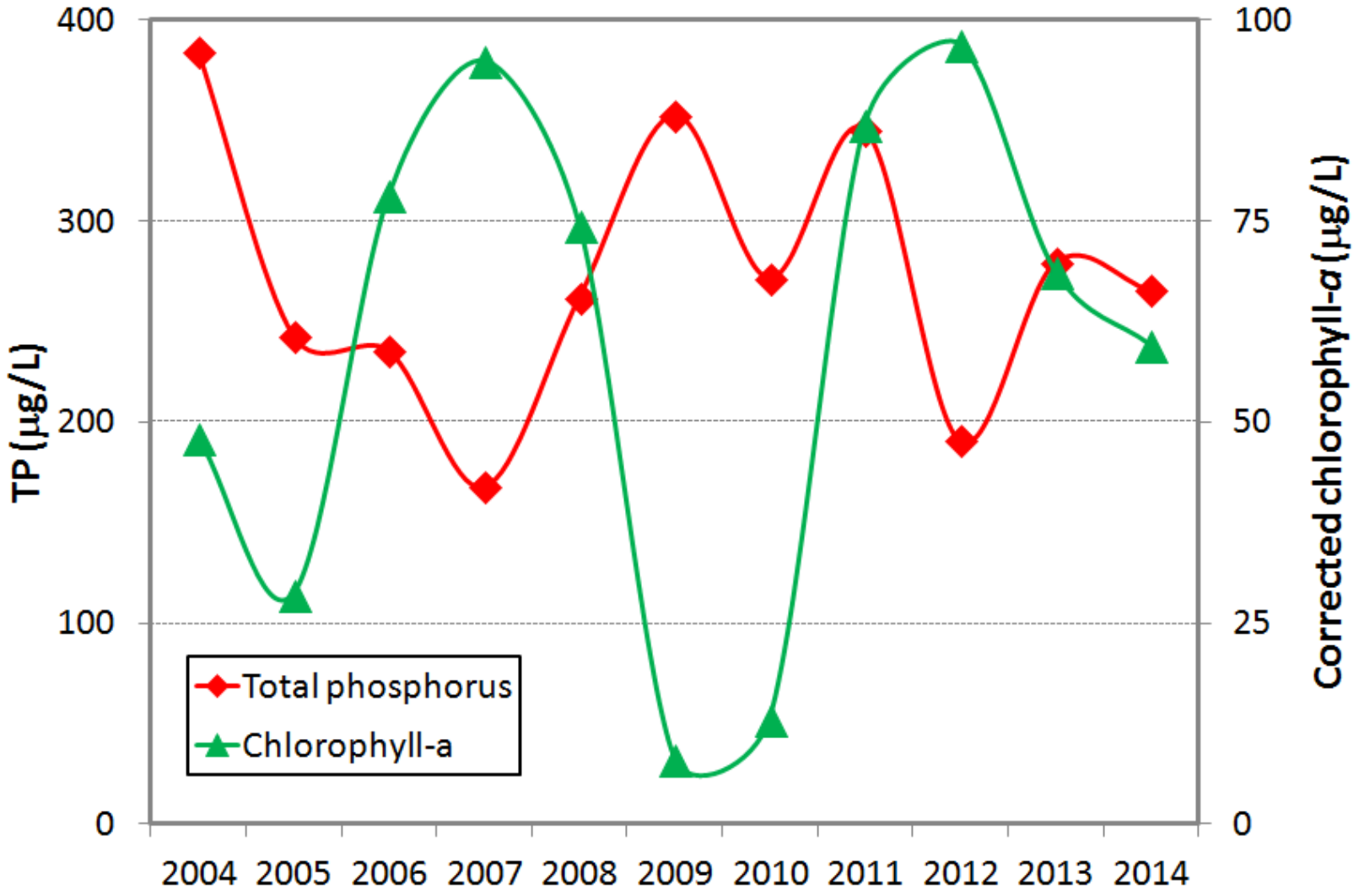
Hydrobiologia
DOI 10.1007/s10750-015-2210-8


Lake Yale estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-a
Lake Griffin
Atmospheric
Natural areas
Agriculture
Urban-residential
Septic tanks
Point source
TMDL
TP concentration
Chlorophyll-a
TP load (metric tons/ year)
Concentration (µg/L)
2.8
2.1
1.4
0.7
0.0
70
60
50
40
30
20
10
0
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013

Lake Carlton estimated annual external total phosphorus loads, and concentrations of TP and chlorophyll-a



Trout Lake mean annual total phosphorus and chlorophyll-*a* concentrations



Summary (1)

- Generally best water quality in lakes Harris, Eustis, and Yale
- TP load decreases and substantial water quality improvements in lakes Apopka, Beauclair, Dora, and Griffin
  - Due primarily to SJRWMD and LCWA projects

Summary (2)

- Smaller load decreases and water quality improvements in lakes Harris, Eustis, and Carlton
  - May reflect reduced loading due to extended dry conditions, upstream restoration activities, basin stormwater projects
- Water quality deterioration in Trout Lake and Lake Yale
  - No projects in Yale basin