Status and Trends
Whole Effluent Toxicity Monitoring
Delaware Estuary
1990 to 2012

Toxics Advisory Committee
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Ron MacGillivray, Ph.D.
DRBC

Why Whole Effluent Toxicity (WET) Monitoring?

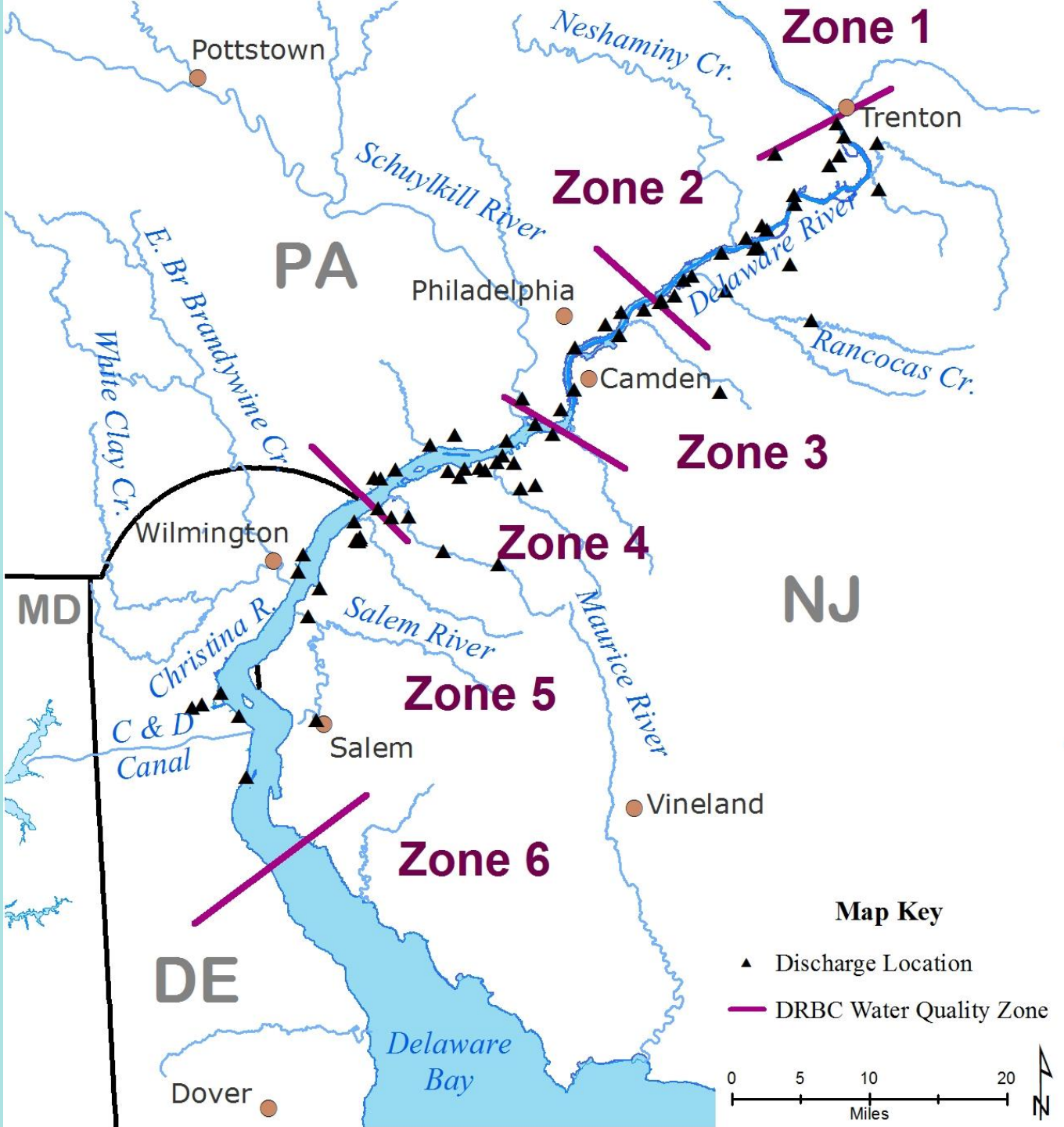
- WET tests evaluate the integrated effects of chemical mixtures in aqueous samples
- WET tests can measure toxicity caused by compounds without chemical-specific numeric criteria or specific analytical test methods

Why chronic toxicity?

- Short-term chronic toxicity tests (7 to 10 days) measure sublethal effects (growth and reproduction), acute toxicity tests (48 h to 96 h) measure lethality
- Chronic tests require younger often more sensitive life-stages of organisms
- Chronic toxicity tests detect effects at lower dose, estimating safe concentration of effluents in receiving waters
- Chronic toxicity tests = more ecologically relevant data

Which test species?

- Majority of the estuary discharges are to tidal freshwater
  - Freshwater organisms (predominant number of tests)
    Ceriodaphnia dubia (water flea)
    Pimephales promelas (fathead minnow)
  - Saltwater organisms (limited number of tests)
    Mysidopsis bahia (shrimp)
    Cyprinodon variegatus (sheapshead minnow)


Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Pottstown
Neshaminy Cr.
Trenton
Schuylkill River
Delaware River
PA
Philadelphia
E. Br Brandywine Cr.
White Clay Cr.
Rancocas Cr.
Camden
Wilmington
MD
NJ
Christina R.
Salem River
Maurice River
C & D
Canal
Salem
Vineland
DE
Delaware
Bay
Dover
Map Key
Discharge Location
DRBC Water Quality Zone
0
5
10
20
Miles
N

Zone	No. of Discharges	Total Design Flow (m^3/sec)
2	26	5.3
3	10	17.9
4	26	15.4
5	13	8.3

Status and Trends

Per test

- Toxic Units $_{\text{chronic}}$ (TU_c) $= \frac{100}{NOEC \text{ or } IC_{25}}$

By Zone

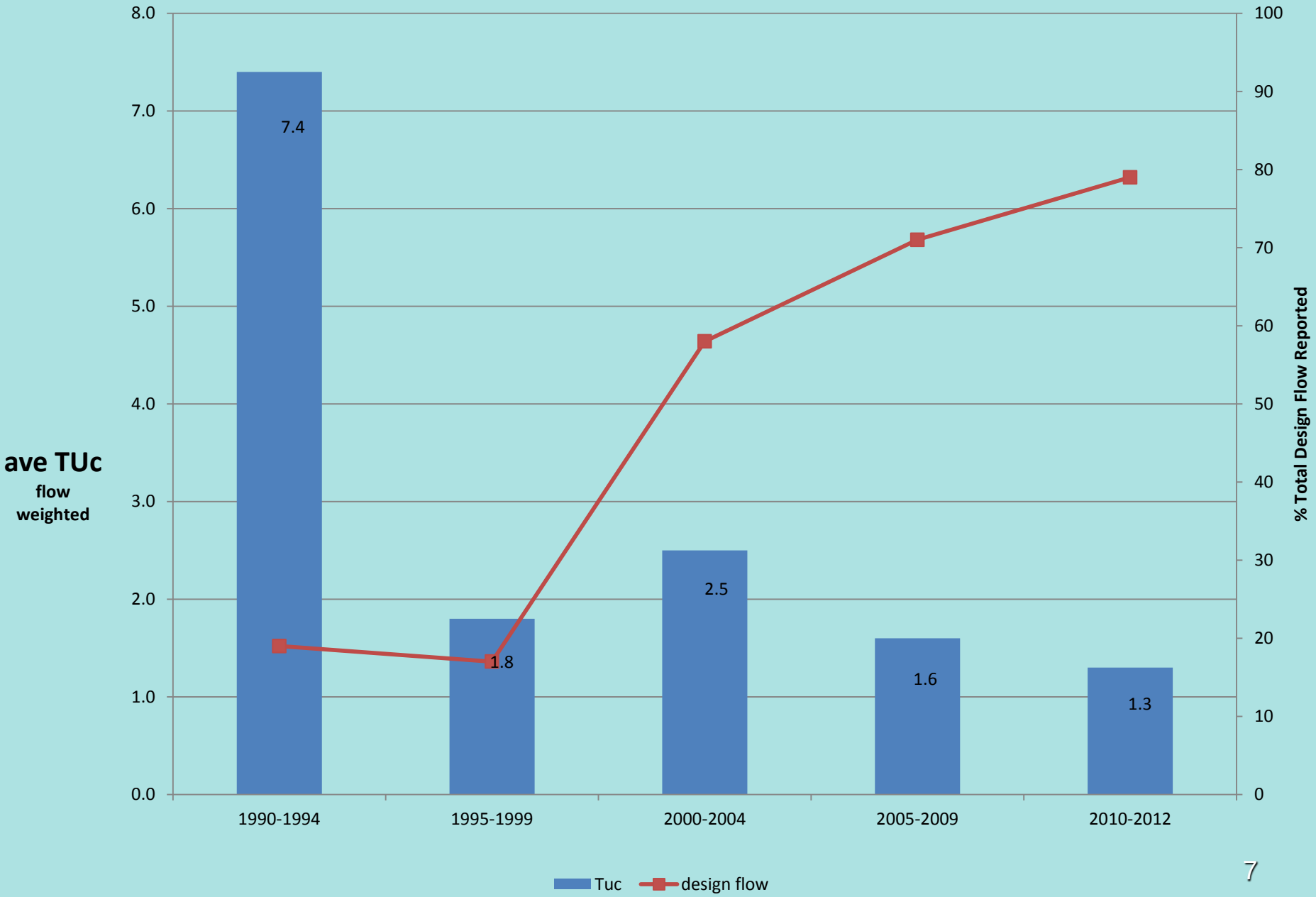
- Toxic Emission Rate (TER):

$$TER = \sum_{i=1}^{n} [ave\ TUc,_i \times design\ flow,_i]$$

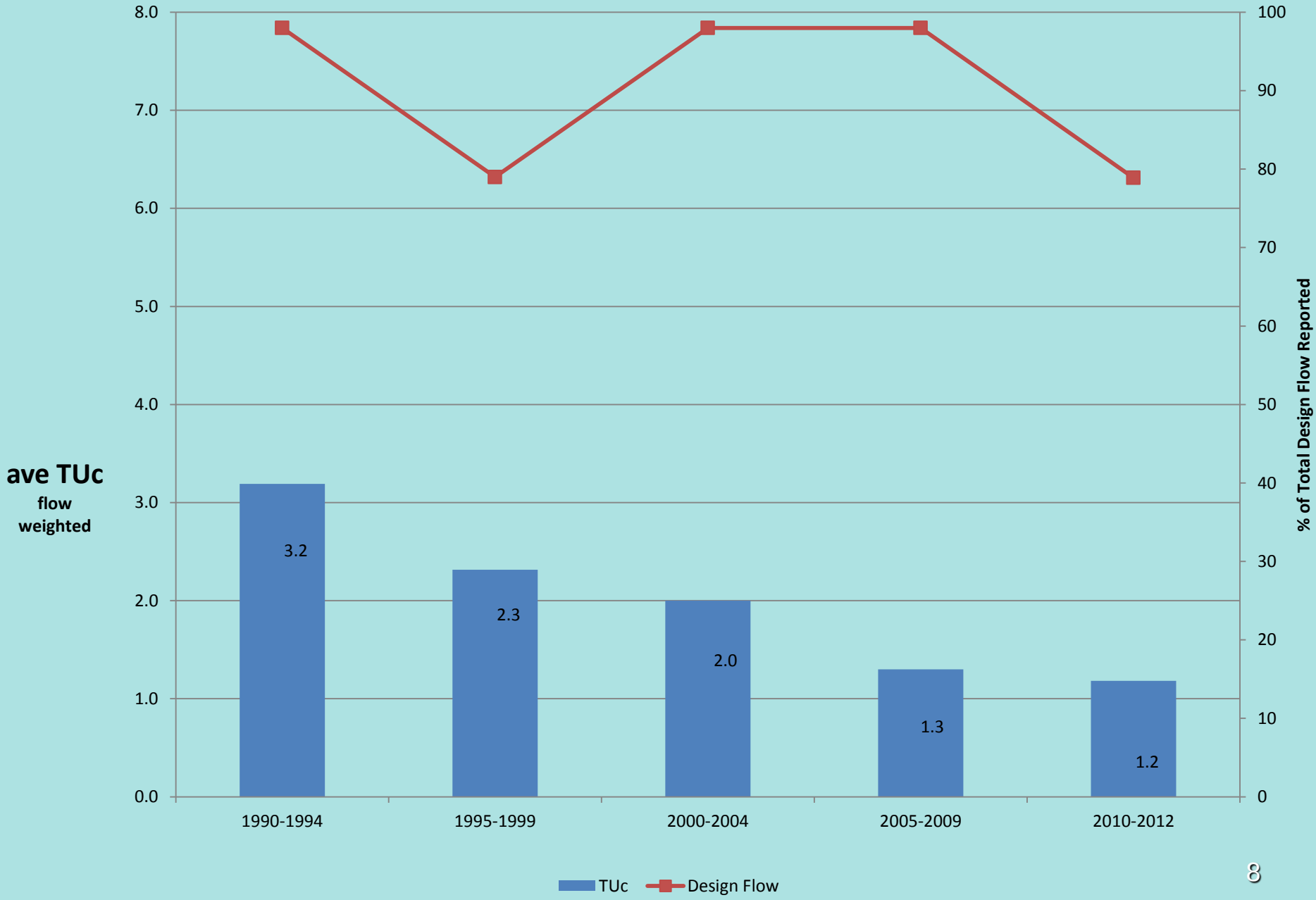
- Flow weighted Average TU_c:

$$flow\ weighted\ ave\ TUc = \frac{TER}{\sum flow} = \frac{\sum_{i=1}^{n} [ave\ TUc,_i \times design\ flow,_i]}{\sum_{i=1}^{n} design\ flow}$$

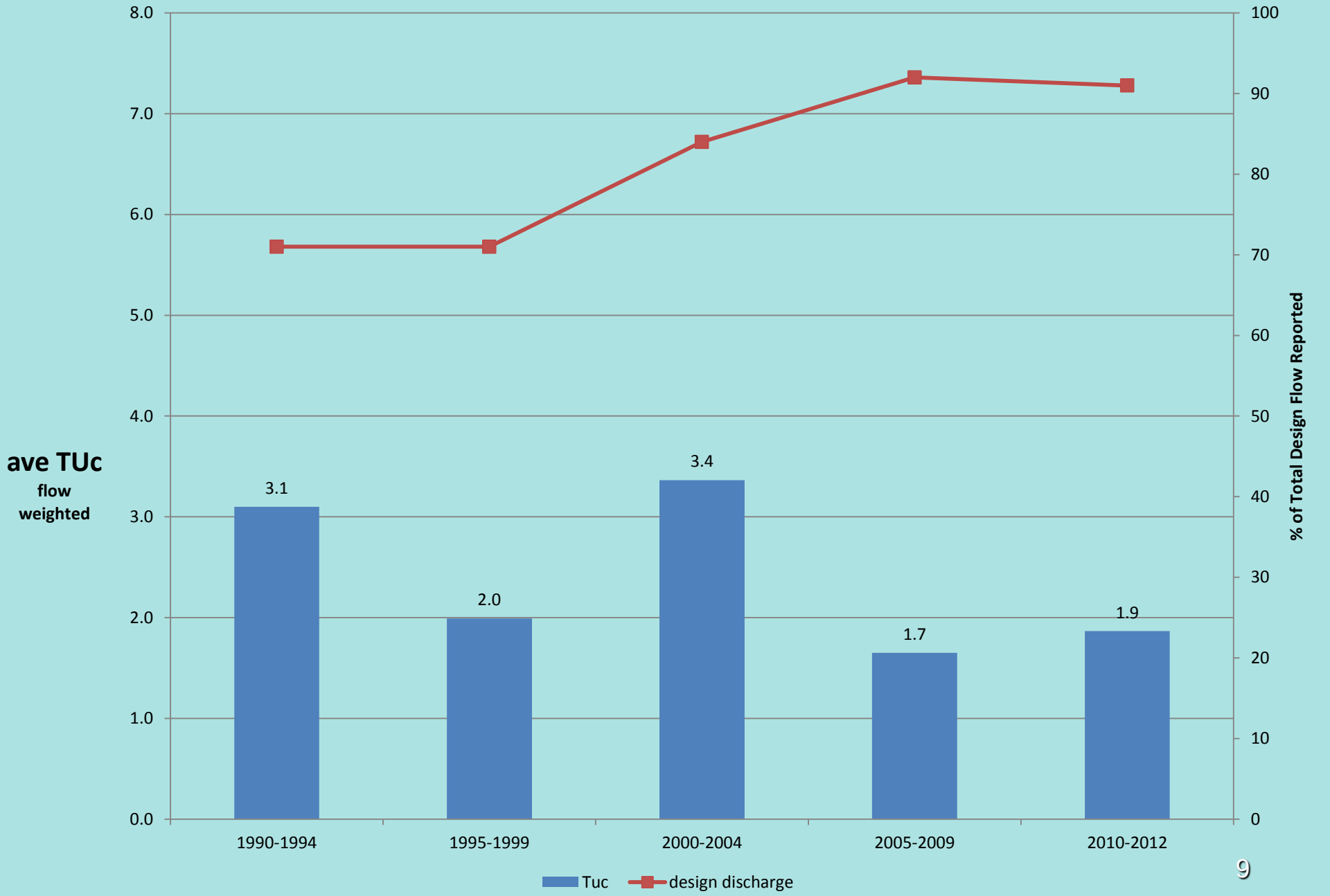
Zone 2 Flow Weighted Chronic WET Discharges

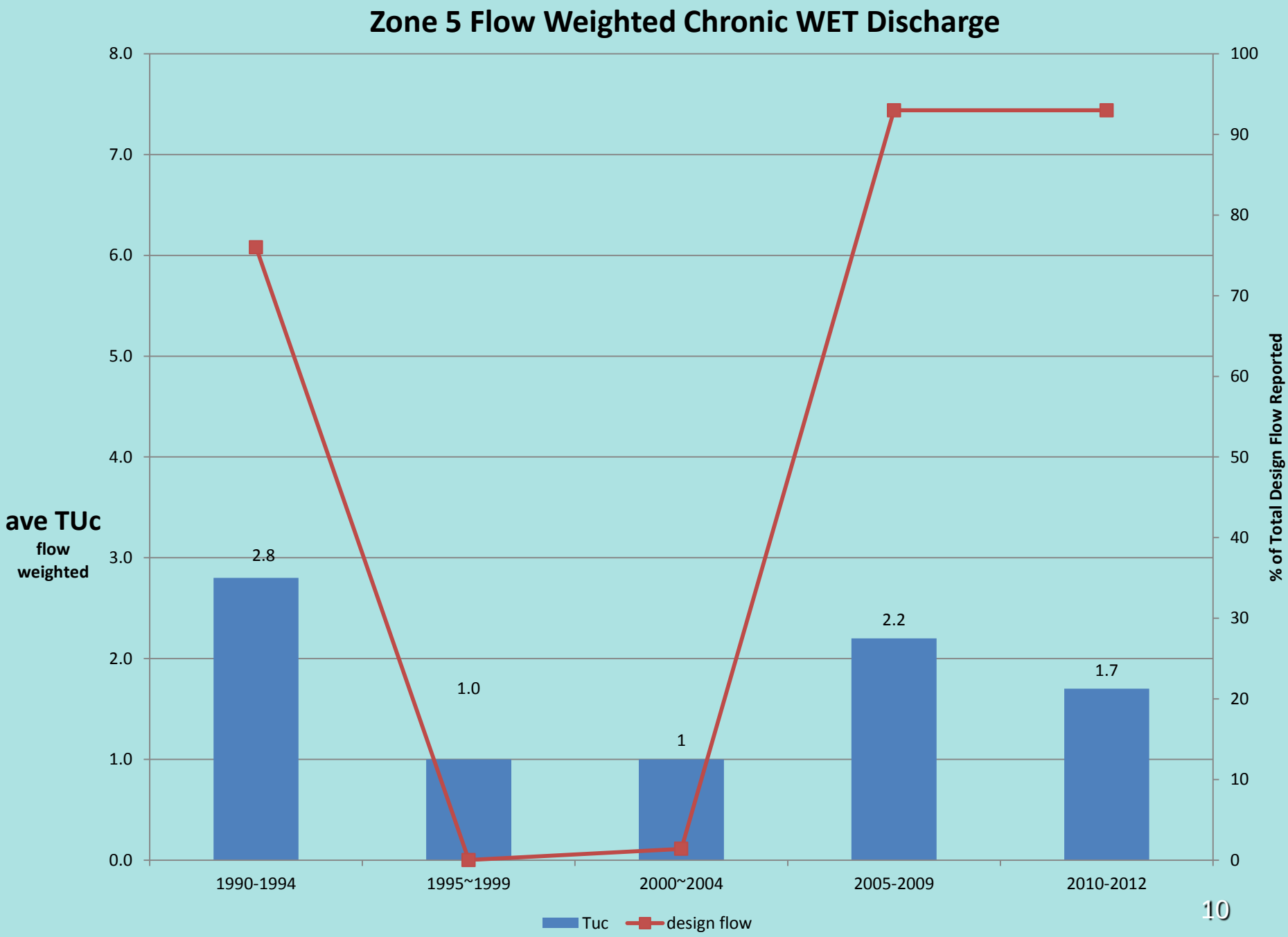


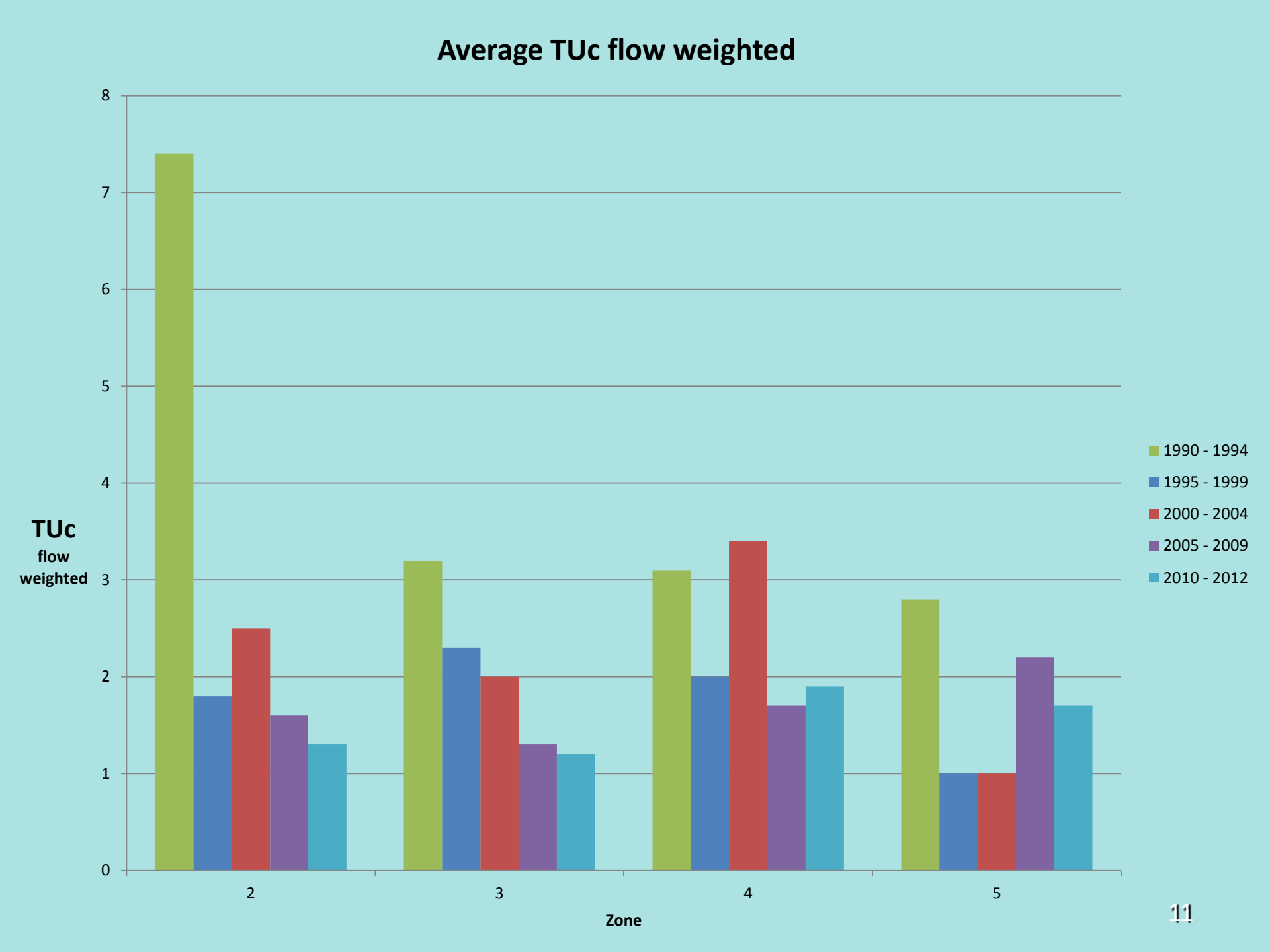
Zone 3 Flow Weighted Chronic WET Discharges



Zone 4 Flow Weighted Chronic WET Discharges




Zone 5 Flow Weighted Chronic WET Discharge
ave TUc
flow
weighted
% of Total Design Flow Reported
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
100
90
80
70
60
50
40
30
20
10
0
2.8
1.0
1
2.2
1.7
1990-1994
1995~1999
2000~2004
2005-2009
2010-2012
Tuc
design flow


Average TUc flow weighted
TUc
flow
weighted
8
7
6
5
4
3
2
1
0
2
3
4
5
Zone
1990 - 1994
1995 - 1999
2000 - 2004
2005 - 2009
2010 - 2012

Observations

- The flow weighted average TUc are generally showing decreasing trends

- The flow weighted average TUc are above 1.0 TUc (NOEC or IC25 in 100% effluent) for all zones

  - ✓ Need to characterize the nature and extent of cumulative chronic toxicity

  - ✓ Ambient chronic toxicity monitoring to assess background toxicity and cumulative impacts from multiple discharges to receiving water is ongoing

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By Zone

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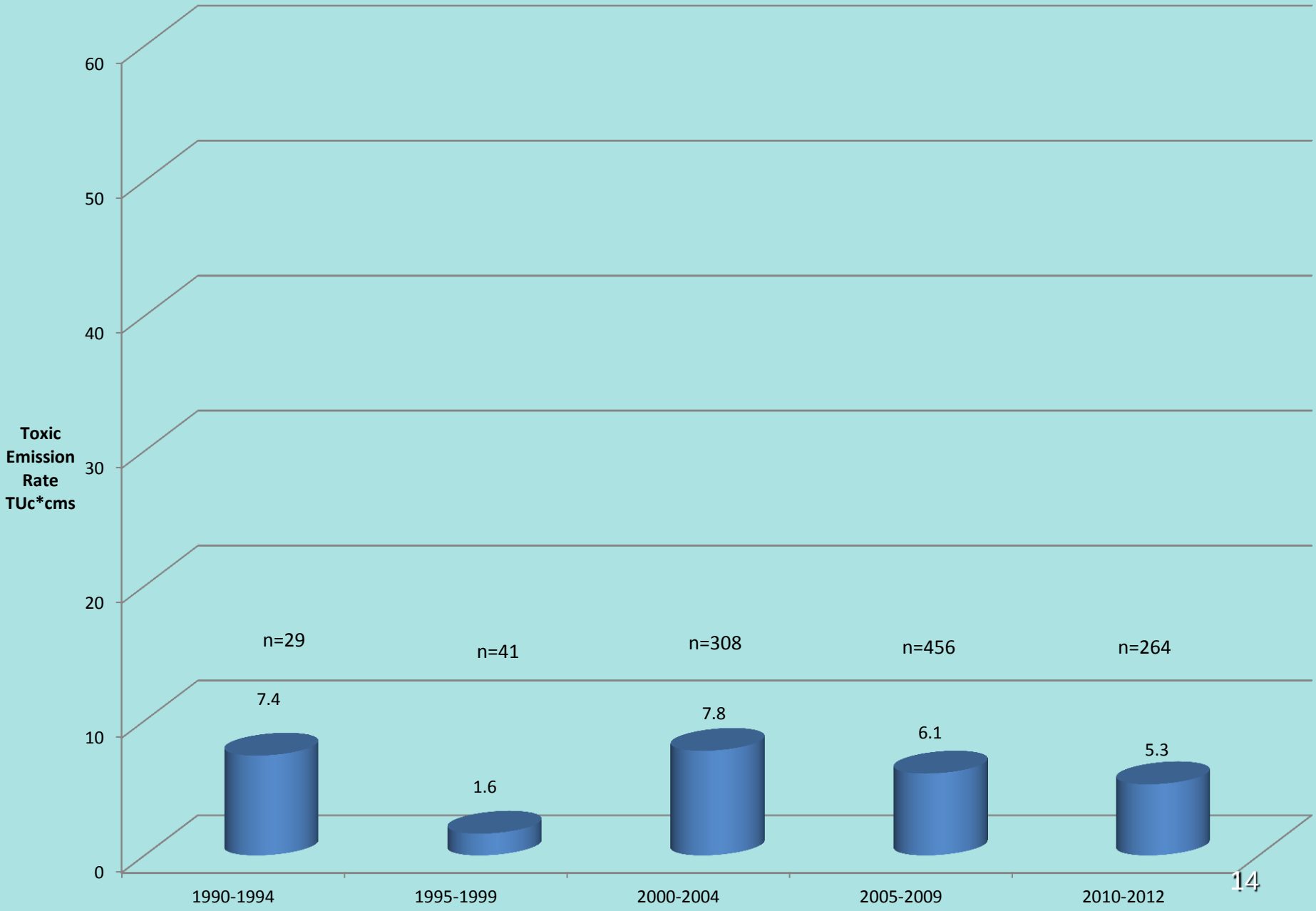
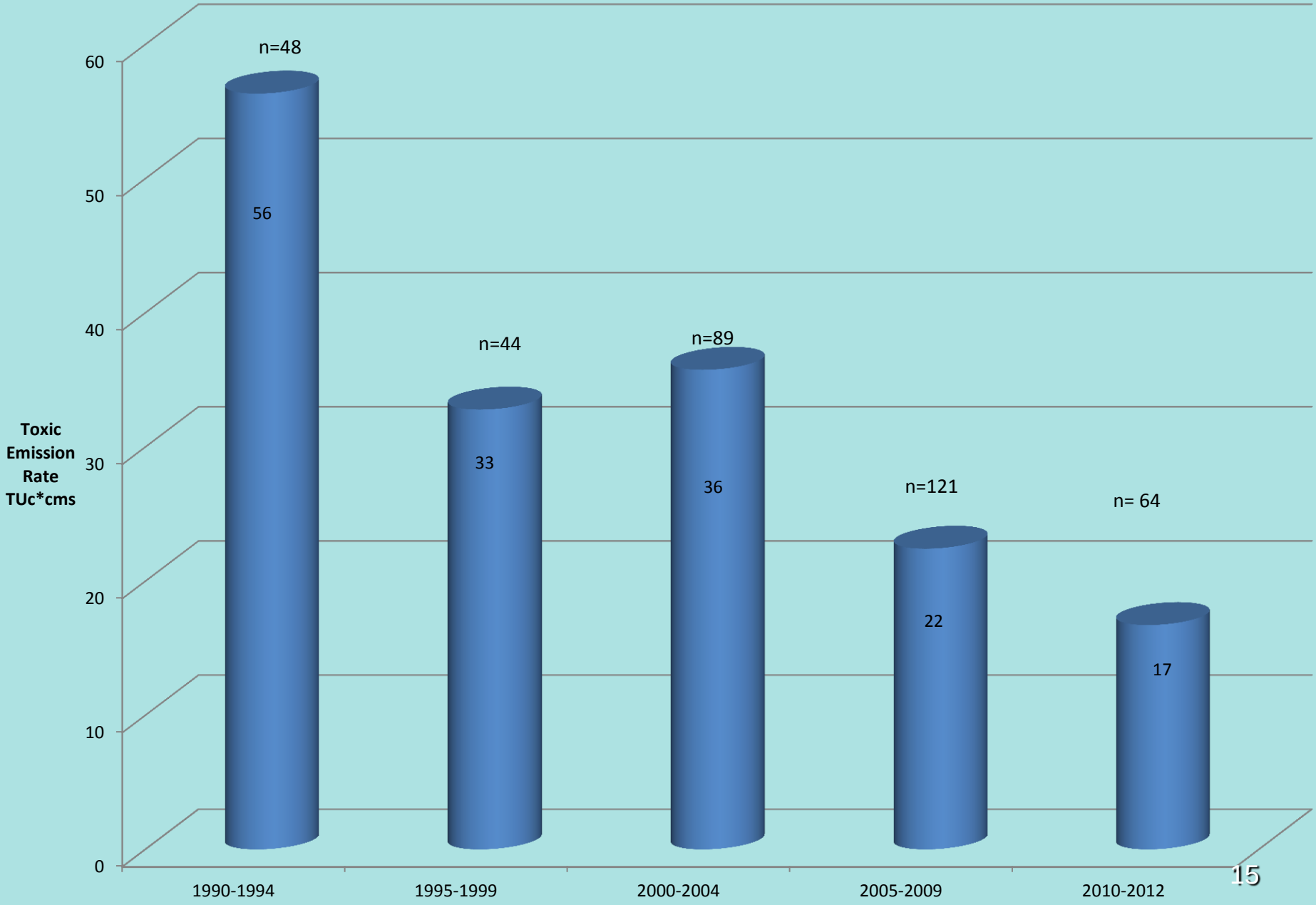
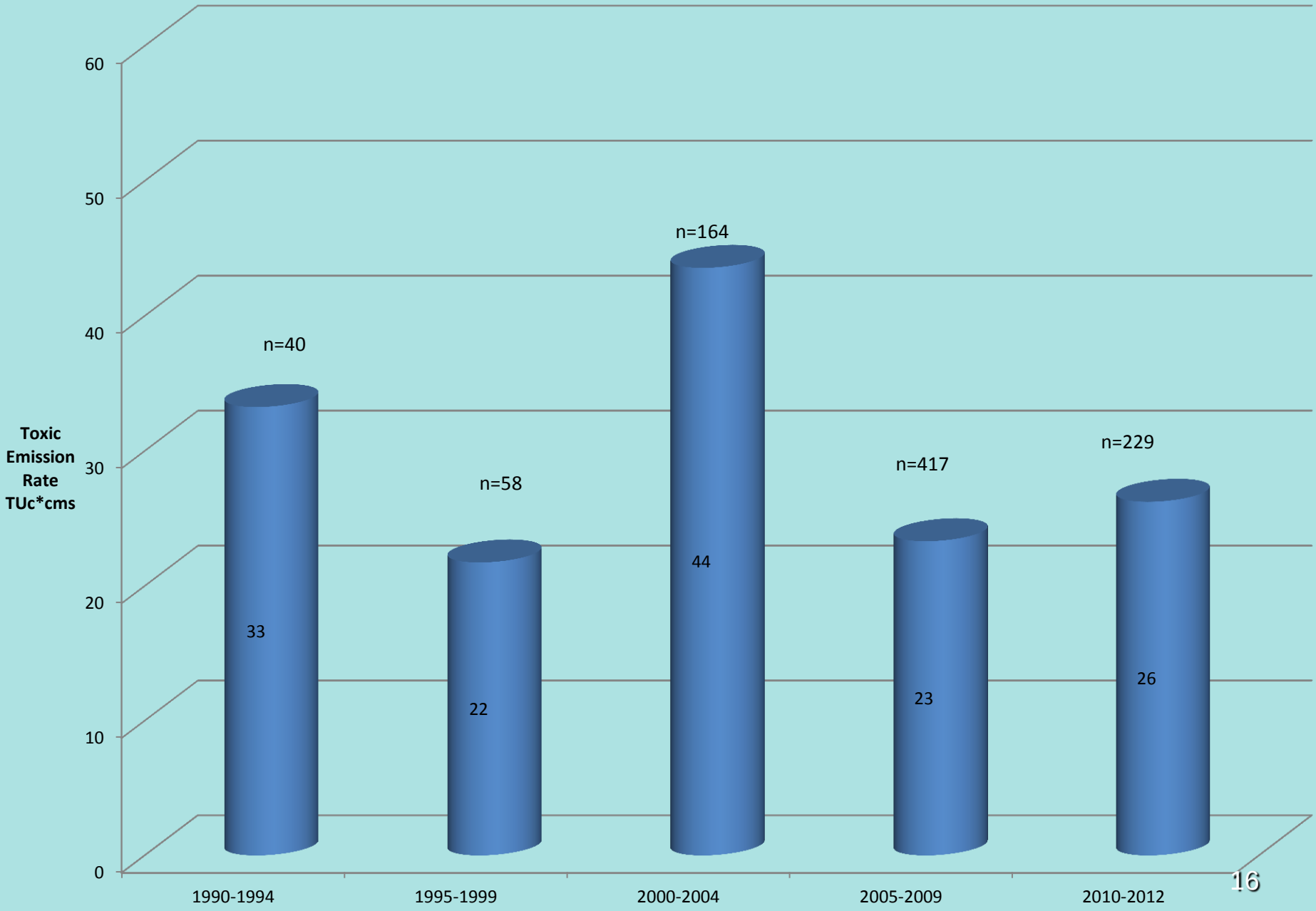
Zone 2 WET Toxic Emission Rate



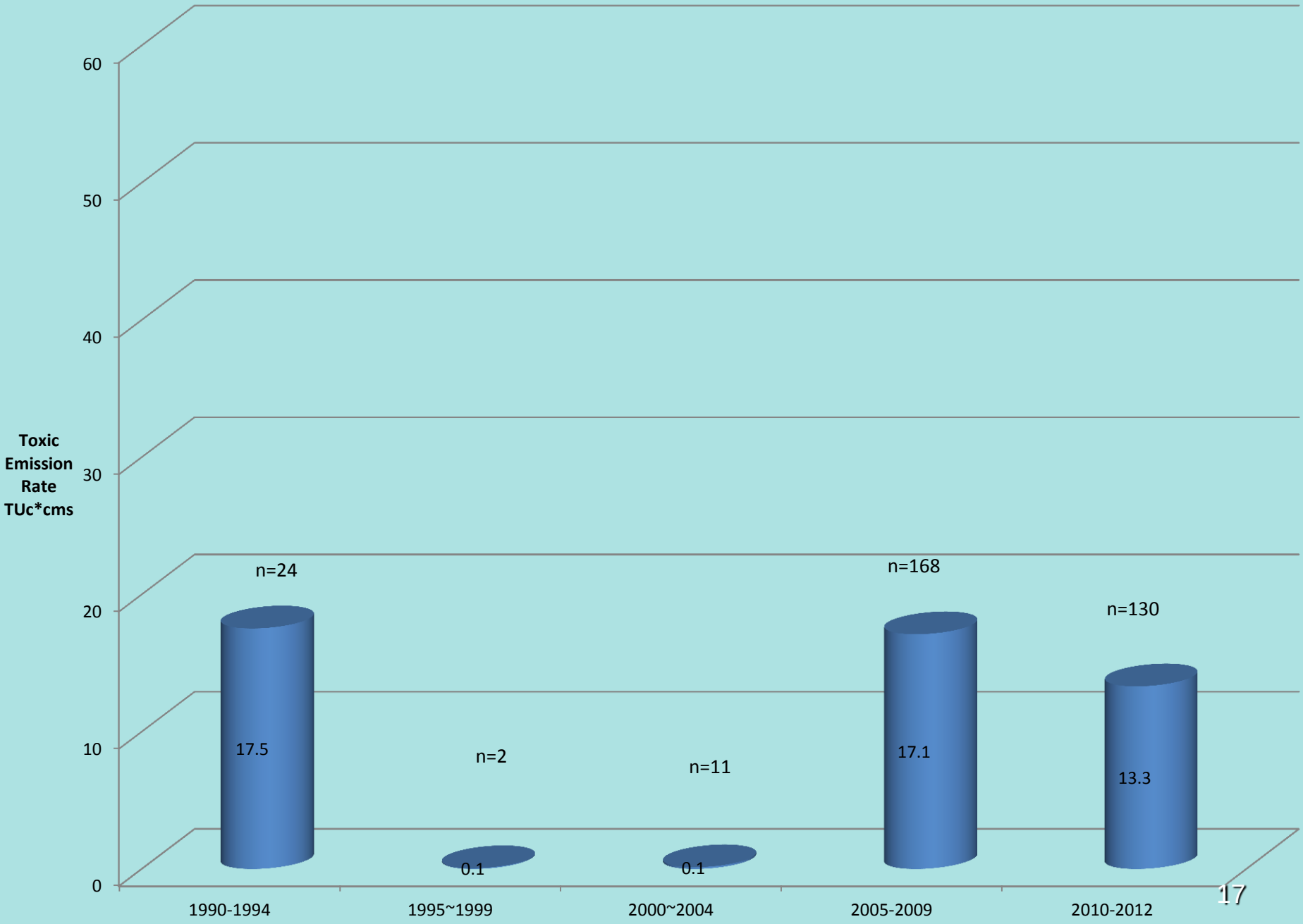
Zone 3 WET Toxic Emission Rate

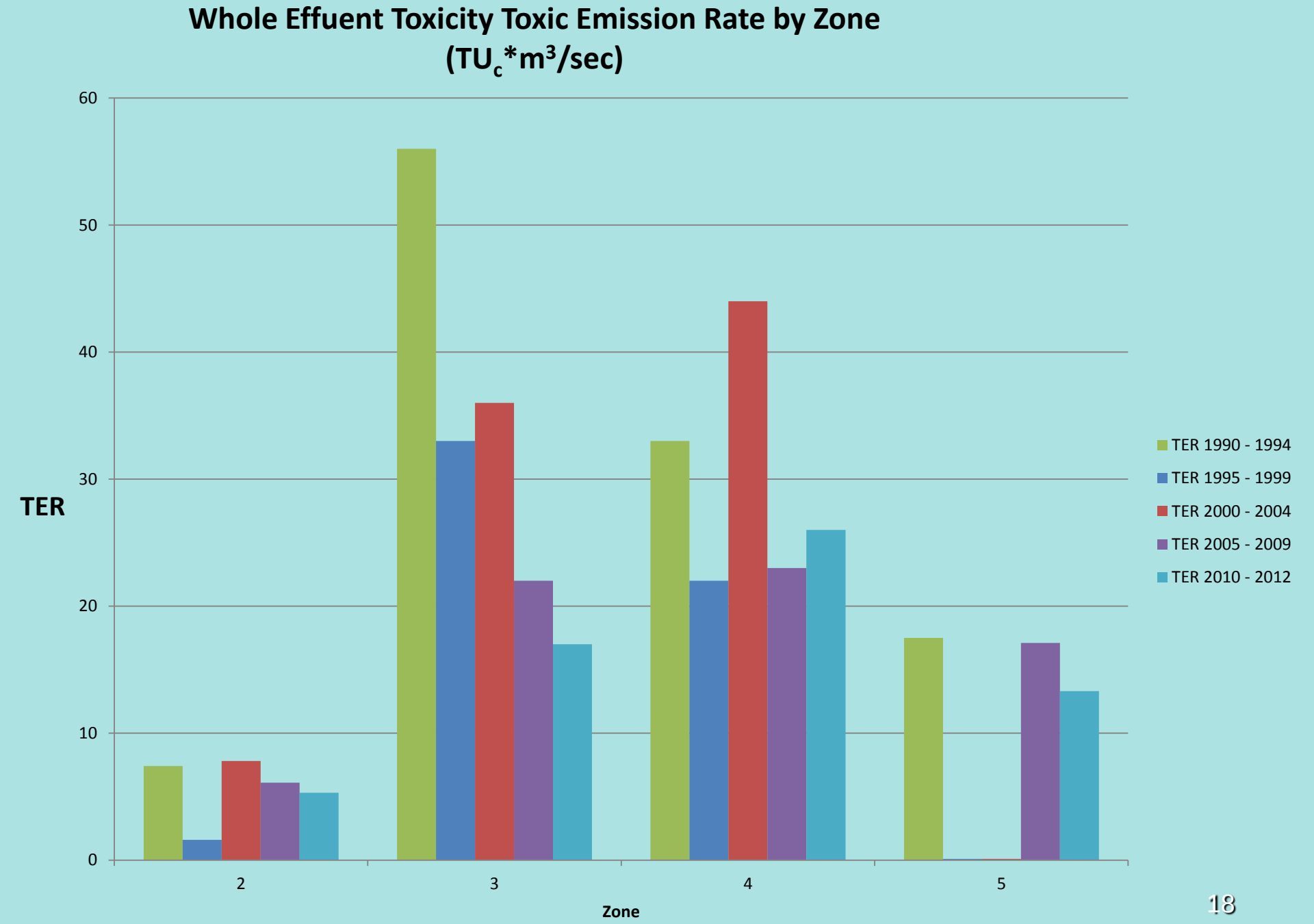


Zone 4 WET Toxic Emission Rate



Zone 5 WET Toxic Emission Rate




Whole Effuent Toxicity Toxic Emission Rate by Zone
(TU_c*m^3/sec)
TER
60
50
40
30
20
10
0
2
3
4
5
Zone
TER 1990 - 1994
TER 1995 - 1999
TER 2000 - 2004
TER 2005 - 2009
TER 2010 - 2012

Observations

- **WET in Delaware River in Zones 2, 3, 4 and 5 trending downward 1990 to 2012**

Profile of discharges differs by zone:

- Zone 2, twenty discharges account for 96% of effluent flow with reduction of 7.4 to 5.3 TER
- Zone 3, three large municipal dischargers account for 98% of effluent flow with reduction of 56 to 17 TER
- Zone 4, thirteen discharges account for 93% of effluent flow reduction of 33 to 26 TER
- Zone 5, six dischargers account for 99% of the effluent flow reduction of 17.5 to 13.3 TER

Observations

- Magnitude of whole effluent toxicity emissions rates (TER) by zones of the tidal Delaware River in descending order
  - Zone 4 > Zones 3 > Zone 5 > Zone 2
  - 2010 to 2012 TER were 26, 17, 13.3 and 5.3, respectively

Recommendations

- Continued coordination among DRBC, basin states, and USEPA on WET testing
- Convert WET data management to electronic format
- Investigate causes of observed trend toward reduced effluent toxicity
- Continue effluent and receiving water monitoring for toxicity to ensure Delaware River Estuary supports aquatic life
  - Assessment for water column toxicity linked with assessment of sediment toxicity and water quality chemistry at targeted locations