

# WFD and Sea of Marmara: a benthic perspective

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Photo: <http://www.sciencephoto.com/media/136746/enlarge>

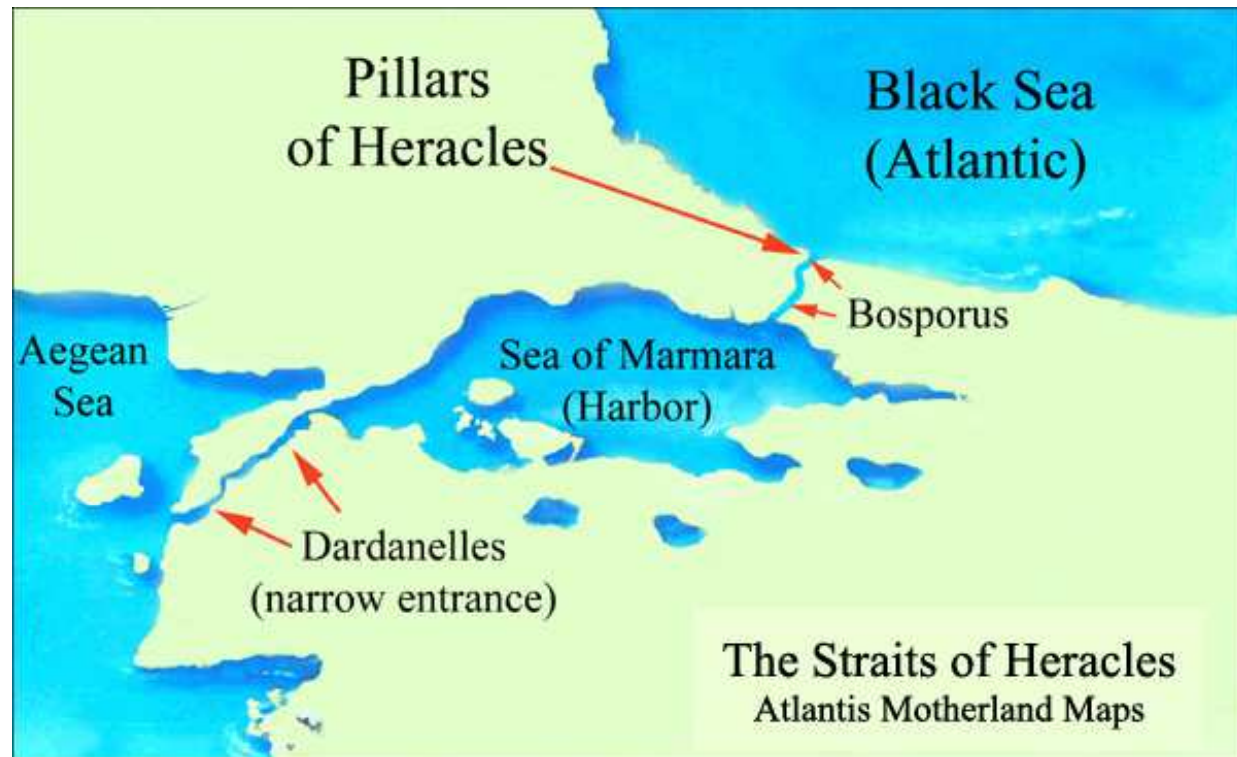
# Overview



Photo: <http://www.sciencephoto.com/media/136746/enlarge>

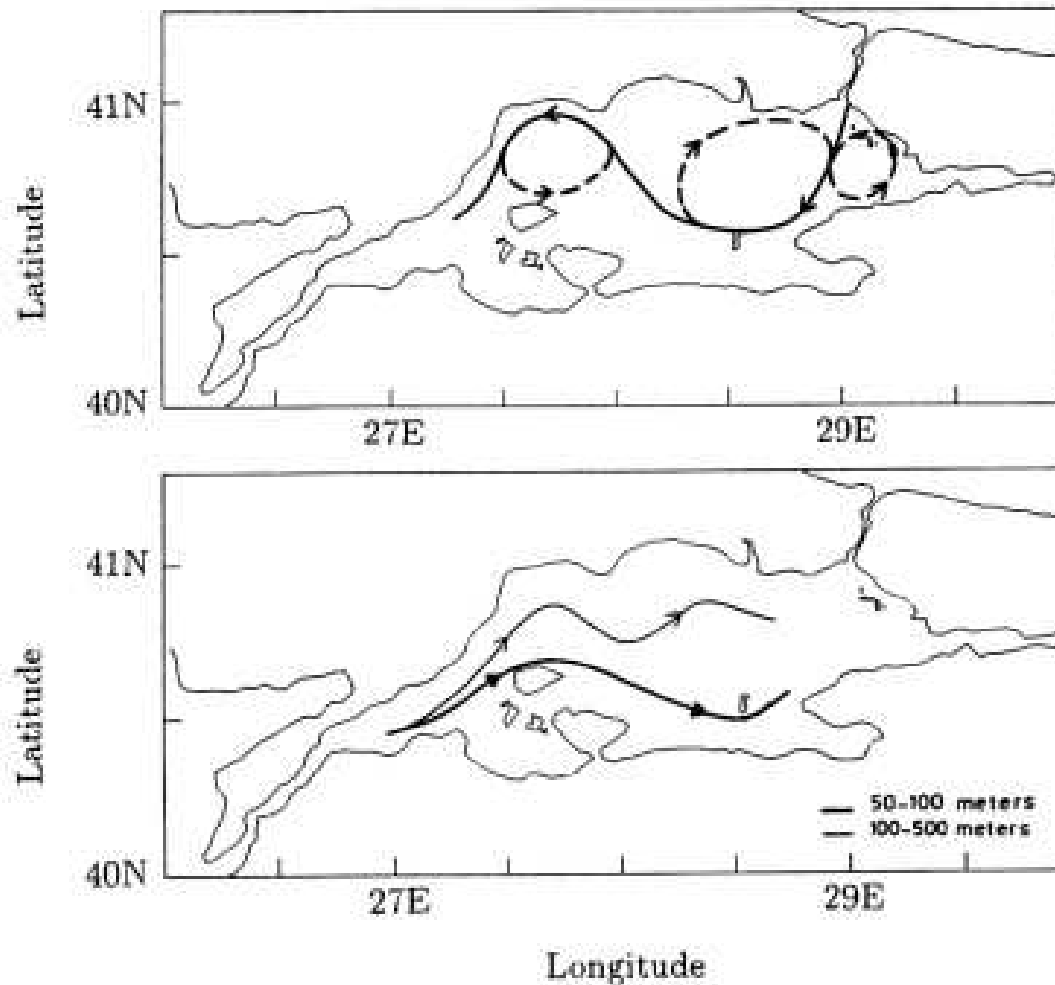
- Sea of Marmara
- Physical-chemical characteristics
- Drivers and pressures
- Where are we with WFD?
- Role as a benthic expert
- Benthic analysis being performed
- Benthic Indices

# Sea of Marmara: general



- Inland Sea
- Depth ~1400 m
- Size 70 x 250 km
- Permanent two-layered stratification
- Surface layer (0-25 m) low salinity (18-22) Black Sea water flows to Aegean
- Deeper later (>25 m) high salinity (38.5) Mediterranean water flows to Black Sea
- Renewal time surface 5-6 months; bottom 6-7 years

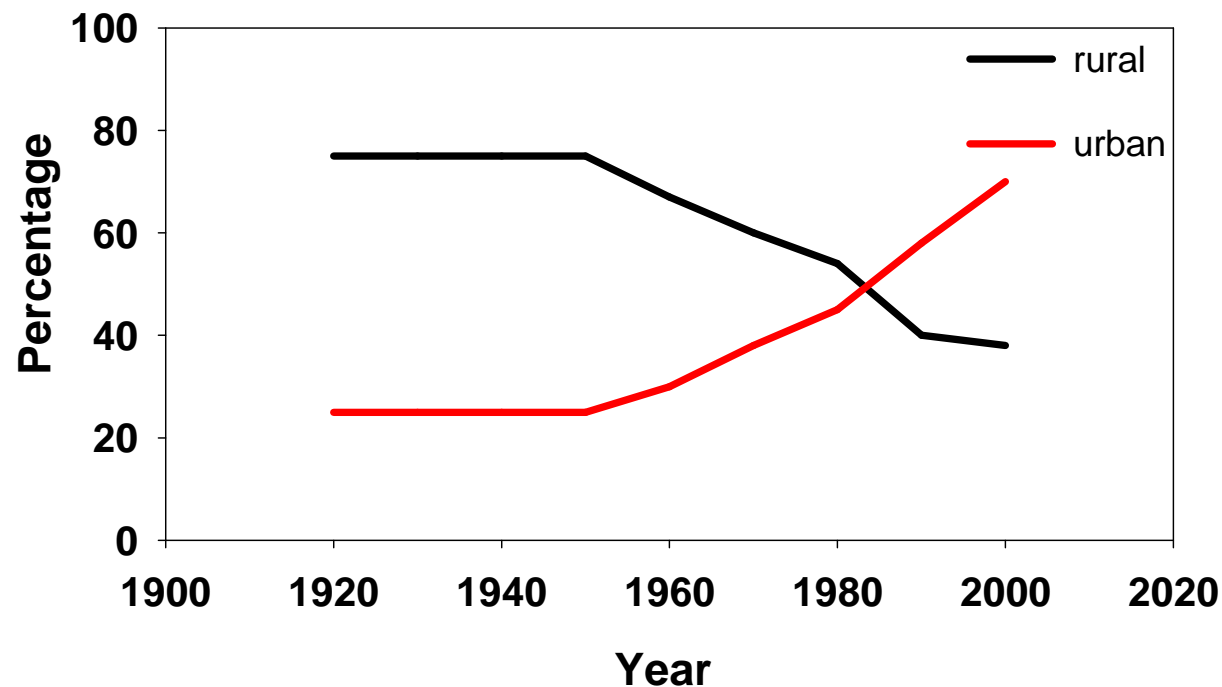
# Sea of Marmara: circulation



- Surface layer

- Deeper layer

# Driving forces and pressures: **Urbanization**



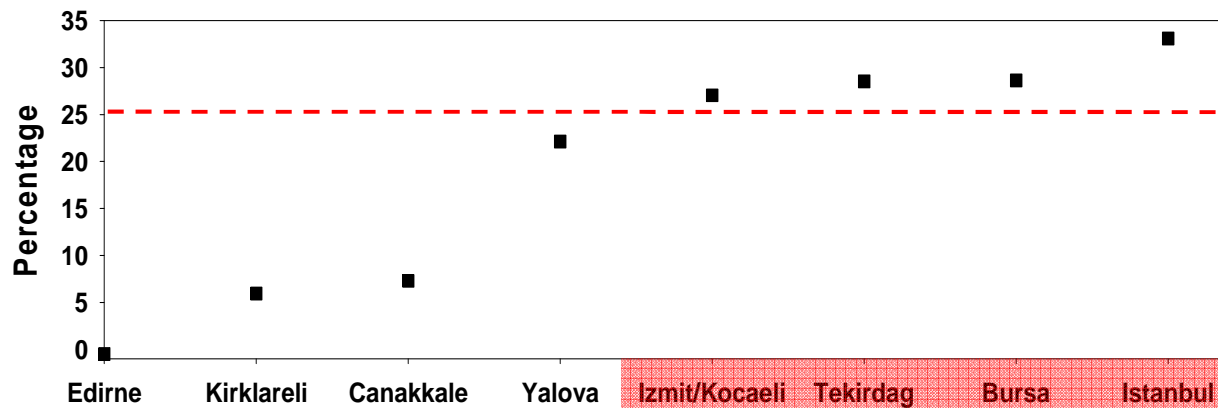
- Since the 1950's there has been a steady migration of people towards more socio-economically developed parts of the country such as Marmara coastal regions.

# Driving forces and pressures: **Population growth**



- Attraction to city centers: Istanbul, Bursa
- Industrial facilities: Izmit/Kocaeli, Bursa, Istanbul
- Tourism, holiday housing developments: Tekirdag
- Provinces with highest population densities: Istanbul, Yalova, Kocaeli

Mean annual rate of population increase (%) between 1990 & 2000



Marmara Region

Re-plotted from PAP/RAC: 2005

# Driving forces and pressures: **Tourism**

- Number of incoming tourists has multiplied 15-fold from 1985-2003.

| 2002                 | Number of Foreign Tourists | % total |
|----------------------|----------------------------|---------|
| Marmara Region       | 4,448,725                  | 33.58*  |
| Aegean Region        | 2,792,660                  | 21.08   |
| Mediterranean Region | 5,031,208                  | 37.98*  |
| Black Sea Region     | 183,285                    | 1.38    |

Due to visits to Istanbul

Winter sports  
 Thermal (health)  
 Cultural  
 Religious  
 Eco-tourism  
 Cruise liners (Istanbul)

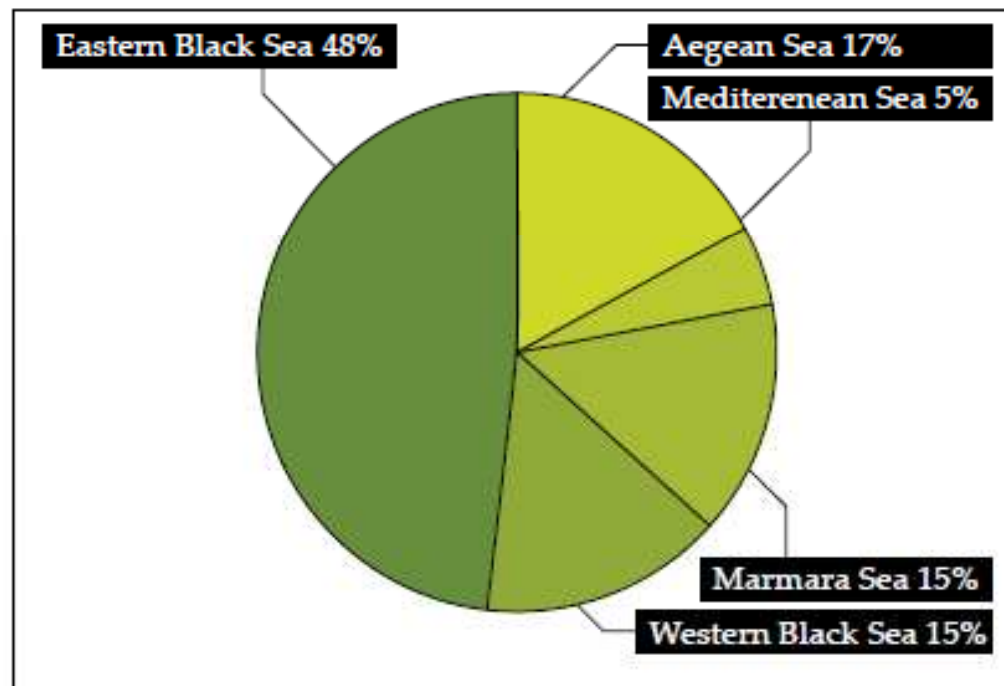
| Region        | 1999 | Number of Domestic Tourists | % total |
|---------------|------|-----------------------------|---------|
| Marmara       |      | 3,627,993                   | 22.11 * |
| Aegean        |      | 4,451,442                   | 27.13 * |
| Mediterranean |      | 2,273,621                   | 13.86   |
| Black Sea     |      | 1,996,569                   | 12.17   |

- Over last 2 decades there has been substantial growth in boating/yacht tourism



# Driving forces & pressures: Agriculture & Fisheries

- 40% of the total agricultural lands are in coastal regions
- 8% of this is in the Marmara region
- Since 1989 agriculture has been reduced due to tourism, industry and urbanization



- The geographic breakdown of the total catch in 1998



# Driving forces & pressures: Industry

- Marmara region is the most industrialized part of Turkey having >50% of the total number of industrial facilities.
- Istanbul and Kocaeli are the most industrialized provinces.
- In the 1960s and 1970s industrial facilities were located in coastal areas that were relatively sheltered such as the northern Marmara coast and Izmit bay. These areas are now among the major “hot spots” of environmental pressures (Ozhan 1996).
- Marmara region has several important minerals for mining and forms an important part of the economy.
- Highly eutrophic:
- Receives total of  $1.9 \times 10^6$  tons of TOC and  $2.7 \times 10^5$  tons TN per year from Black Sea inflow.
- Untreated wastewater from domestic & industrial facilities (Albayrak et al. 2006).



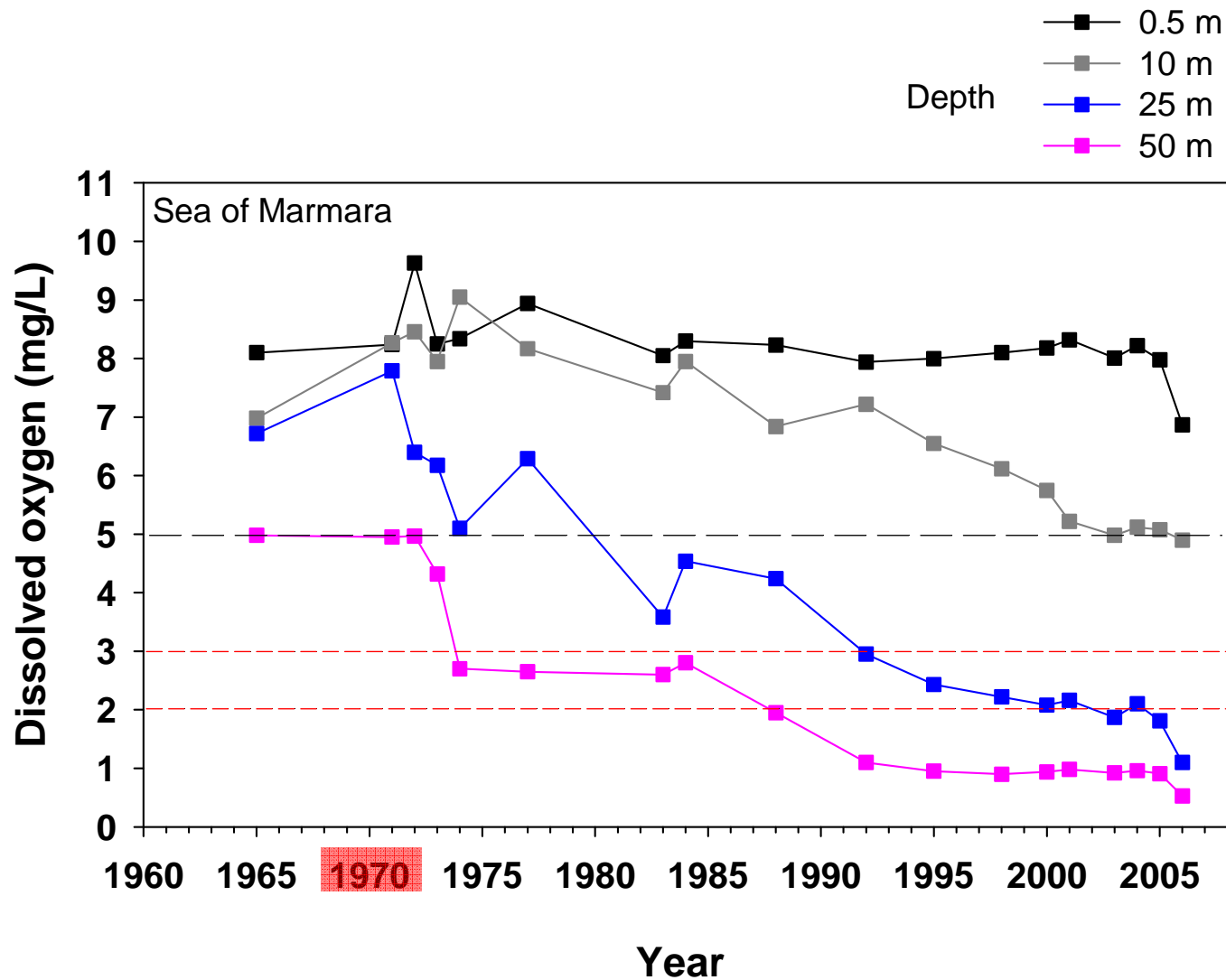
# Driving forces and pressures: **Maritime transport**

- Heavy ship traffic
- Oil spills
- Each day (1996) 140 cargo ships and 1000-1500 passenger boats navigated through the Bosphorus Strait and the Sea of Marmara
- 1970-1991 there were 3-35 oil spills/year releasing 50, 000 to 700, 000 tons of oil
- In Istanbul 94 ferries make ~750 round trips/day (125 million passengers/year)



PAP/RAC: 2005

# Sea of Marmara: Dissolved oxygen trends



Re-plotted from Artüz, 2007

# Where are we: WFD

- Data mining (who, where and what)
- Soliciting and organizing experts (chemical, physical, phytoplankton, benthic, macroalgae, chemical)
- Process of assigning typologies to 4 regions (Med., BS, Aegean, Marmara)
- **June 19-20, 2012** hosting a workshop “Determination and Classification of Marine and Coastal Water Quality”
- Purpose: to bring together experts that want to provide data and or detailed analyses for the purpose of WFD, as well as guidance and expertise.
- Focus will be on the North Aegean and Marmara Sea

# Role as a benthic expert

- Benthic expert
- Determine potential reference areas in the Sea of Marmara
  - combination of data and expert judgment
- Access and / or develop benthic index
  - current focus AMBI and BENTIX
  
- **HOW? (in the process of):**
- Reading published material (historical to current).
- Performing a detailed analysis of available benthic data for Sea of Marmara
  - community analysis (e.g., PCA, richness, diversity).
  - examine observed patterns in relation to both \*\*\*natural and \*anthropogenic parameters (e.g., salinity, depth, location, TOC, contaminants, DO etc.).
  
- calculate AMBI/BENTIX , assess performance, and pros/cons or applicability to Sea of Marmara.

# AMBI index

## Considerations for applying the AMBI:

- Robustness of the index can be reduced when a low number of taxa (1-3) and or individuals ( $<3$ ) are found in a sample
- If the percentage of unassigned species is high ( $>20\%$ ), Borja and Muxika (2005) caution that index values can be difficult to interpret, and should be evaluated very carefully
- If the percentage of species is  $>50\%$  the index should not be used

# Indices (e.g., AMBI, BENTIX)

## Considerations for applying any index:

- Species assignments must be accurate (expensive and time consuming).
- Lack of information and accuracy on life history, tolerances etc. Can be subjective.
- Several species often not identified to species level (key characters lost in processing, larval or juvenile forms). Thus assignments can be subjective (strict vs. general assignments).
- Species list in index programs or list of species being provided may not be up to date with current taxonomy. Synonymies must be checked (e.g., ITIS or WoRMs).
- Once species synonymies have been checked not all species will be available in the index database being used.



## Literature Cited / Thank you

- Artüz, L.M. 2007. Bilimsel Açidan Marmarn Denizi. Türkiye Barolar Birliği. Ankara
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- Chiggiato J., Jarosz E., Book J.W, Dykes J, Torrisi L., Poulain P., Gerin R., Horstmann J and Beşiktepe, Ş. 2011. Dynamics of the circulation in the Sea of Marmara: numerical modeling experiments and observations from the Turkish straits system experiment. Ocean dynamics. DOI 10.1007/s10236-011-0485-5
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