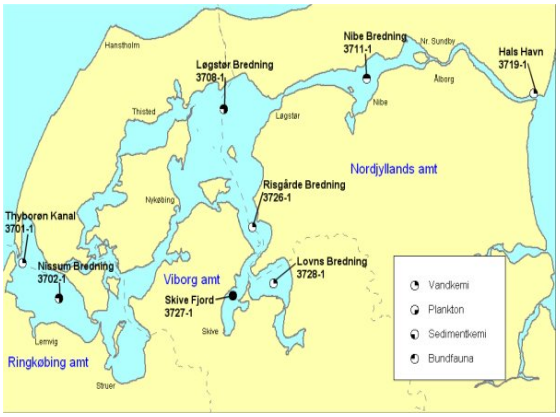
WT 7.5 LIMFJORDEN, DENMARK

1. Host Institution: Technical University of Denmark - Danish Institute for Fisheries Research**. Contact:** Josianne Støttrup jgs@dfu.min.dk



2. The Limfjord is situated in North Jutland, with western inlet to the North Sea and a narrow channel leading to the Kattegat.

3. Characteristics

Marine System	With a surface area of 1500 km3 and about 1000 km of coastline, the Limfjord is the largest fjord in Denmark. The fjord receives saltwater (32-34 ppt) from the North Sea in the west, and from Kattegat (19-25 ppt) in the east. Wind generated currents and tidal currents generate an average flow of 6.8 km3 from west to east through the fjord. The fjord consists of a system of shallow broads (5-8 m) linked by deeper sounds (18-22 m).The estuary is strongly impacted by an intensive blue mussel commercial fishery causing habitat changes and heavy eutrophication resulting in frequent oxygen depletion events. The fjord is used for ship transport from the North Sea to the Kattegat and viceversa and water-related recreational activity.
Watershed	The catchment area is relatively flat, expands over 51 counties covering an area of 7528 km2 and provides on average 2.7 km3 of freshwater runoff annually. The freshwater input is equivalent to about 1/3 of the total volume of the Limfjord. Nutrient loading is primarily from non-point sources. The primary land-use is agriculture covering about 62% of the area. About 15% is covered with forest and the remaining 22% is semi-urban and open nature. Suspended matter has a great influence on light penetration in this relatively shallow fjord and consists of phytoplankton and re-suspended matter, especially in the wind-exposed western part of the fjord.
Human Activities	Agriculture, Large catchment with intensive agriculture results in high annual nutrient input. Commercial fishing for shellfish. A large mussel fishing industry based on bottom dredging. Stones and shells removed are not returned to the estuary resulting in habitat degradation.
Impact Responses	**Eutrophication** has caused enhanced oxygen depletion occurrences and durations and changes in benthic-pelagic coupling **Impact of mussel dredging** from the commercial fishery has caused changes in musselstocks, in- and epifauna, sediment complexity and coupled effects on species interactions, sediment resuspension, seagrass and macroalgae and led to conservation measures as MPA **Other**: Over-fishing, Bio-chemical pollution - Trophic Web Change - Use Depreciation

4. Policy

Policy issues	**Fisheries policy**. Much effort has been put into devising a fisheries policy for the whole system, with participation from all the counties (management), research institutions and user groups. A fishery plan was published in 2000 and as a consequence of this several policy measures have been taken, such as; closing trawl fishery for eel and closing areas for all fishery with mobile gear. In 2004 a committee established by the Danish minister of fishery recommended on new regulation and initiatives towards a sustainable shellfish fishery and improved production of mussels by aquaculture. Danish authorities have to implement a number of these recommendations in the next years. A new tool is recently developed using GIS for the management mussel and oyster fishery and aquaculture and taking into consideration biological, political and user issues for the definition of potential sites/areas for

	fisheries or aquaculture within the whole Limfjord.
Policy changes	**Fisheries Policy** in particular a policy for mussel and oyster fishery within the Limfjord has been established. A policy for increased production by mussel farming (aquaculture) has been established. A new **land-use policy** is currently being proposed to redistribute land use relative to watershed characteristics and potential run-off/nutrient leakage.

5. Stakeholders and Institutional Governance

Major organisations	County and Municipal administrations surrounding the fjord, Ministry of Fisheries, Ministry of Environment, Fishermen organisations, Agriculture Organisation, Aquaculture Organisation.
Other leading organisations	National Agency for the Environment, Coastal Authority Directorate, Tourist industry, Nature Conservation organisations such as Danish Nature.

6. Partner Collaboration

SPICOSA Partner Collaborations.	Partner: **NERI-AU** Aarhus University - National Environmental Research Institute (Professor Stiig Markager); Systems Modelling; **SDU** : University of Southern Denmark (Dr. Marianne Holmer). Marine Ecology

7. Systems Studies

Long time series	Hydrochemical, -physical and phytoplankton data, river discharge and nutrient loads of 30 years. Benthos, fish, birds and seals data over 10-20 years. Various and large amounts of additional data e.g. meteorological, hydrodynamic, sediment, heavy metal, biological data. A 3-page listing detailing all available time-series data has been collated.
Research Projects	- A project "GIS-Limfjord" was initiated in 2004 introducing GIS data both on land and sea data as a tool in fisheries management within the Limfjord. It would be possible to access these data to integrate them. For summary see:**http://gis.dfu.min.dk/website/Limfjord/viewer.htm** - In 2002 a 3-year EU project EUROGEL was initiated with the aim to describe the distribution and temporal occurrence of jellyfish in the Limfjord and evaluating their grazing impact within the ecosystem. (2002-2004). Two EU projects (Essence and Mabene – 1999-2005) deal with the interactions between the benthic communities and the pelagic environment with particular emphasis on grazing aspects of mussel communities and on ecosystem modelling with focus on mussels. - A national project SUSTAINEX focus on impact of mussel dredging, recruitment processes of blue mussels, bentho-pelagic coupling all integrated in an ecosystem model. Several project deals with sustainable aquaculture of blue mussels and flat oyster coordinated by the Danish Shellfish Centre. One project deals with ecosystem models as tools for management. Funding is for 2007-2008. A close cooperation exists between research institutes, universities, and managers from the 3 counties bordering the fjord and stakeholders such as commercial and recreational
Social study	fishermen's organisations. - In 1996 a social study on "The fight for the Limfjord – Lifestyles, environmental values and policies" was completed analysing the fishing community their use of the fjord, which is directly impacted by the declining fish stocks and future fishery policies. The report analyses the different usages in the fjord, the conflicts and possible consequences of different policies for the local communities.