

# Kelp and ecosystem recovery

Hartvig Christie et al.  
NIVA



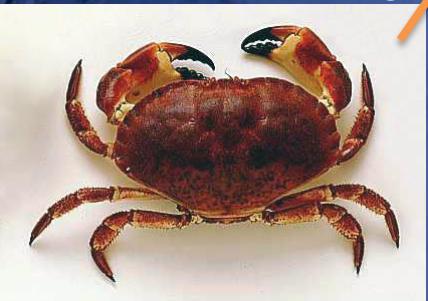
# Kelp forest recovery

Barent Sea



KING CRAB

Norwegian Sea



Ocean warming

1990s-2017  
660 km  
Ca 26 km/year

63° N

Norway

North Sea

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2009 DigitalGlobe  
Image © 2009 TerraMetrics  
Image IBCAO  
64°40'25.04"N 14°59'06.33"E elevar 352 m

©2009 Google

Øyehøyde 2033.52 km

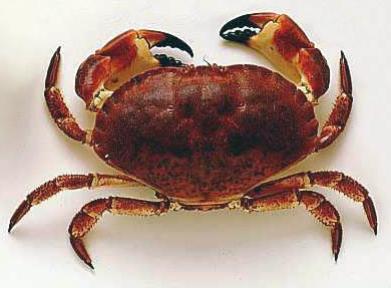
# Reduction of sea urchin populations caused by (as long as no intensive harvest have started)

Increasing temperature

Increasing sea  
temperature

positiv

crab predation



negativ

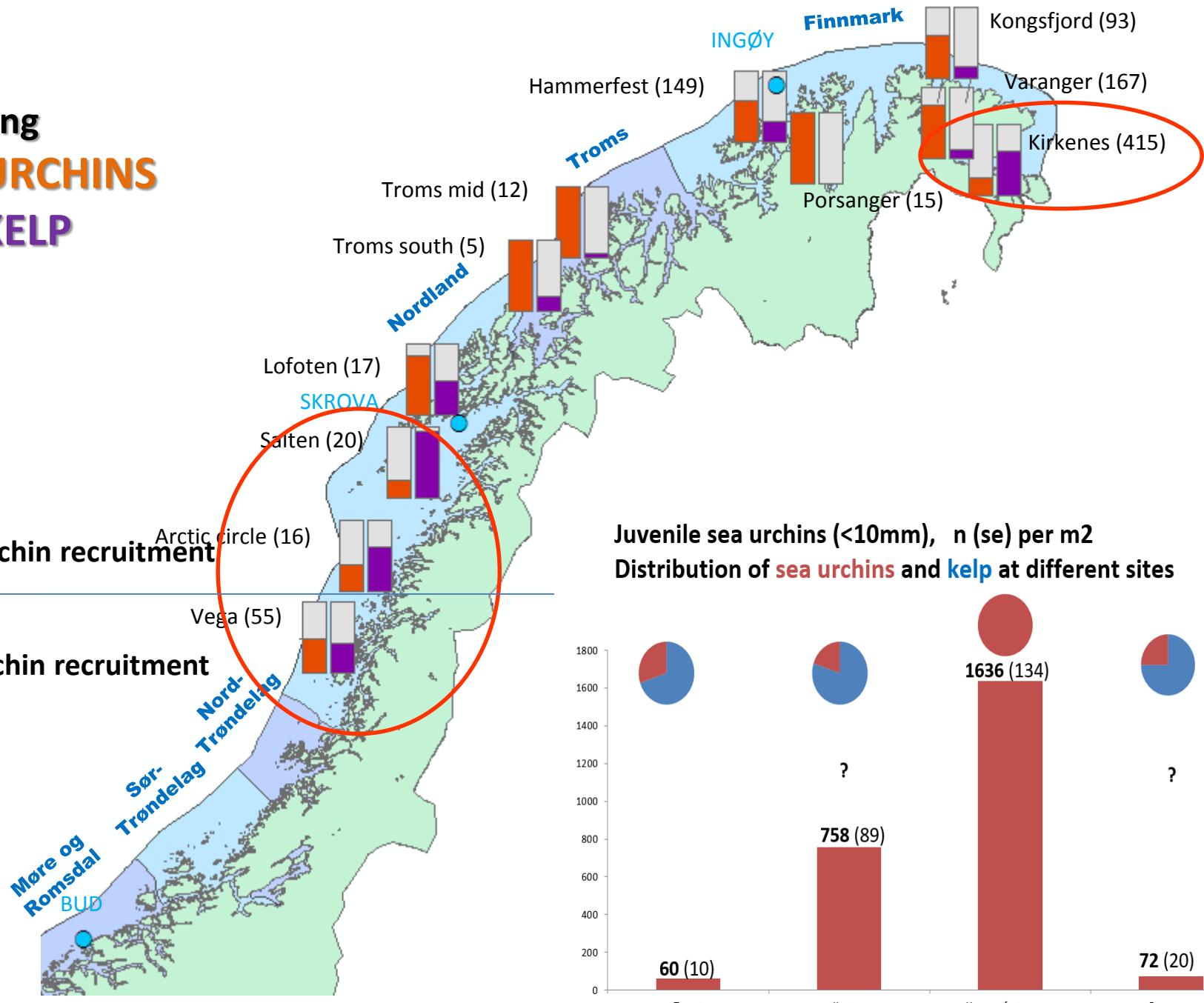
negativ

71°N

# Mapping SEA URCHINS and KELP

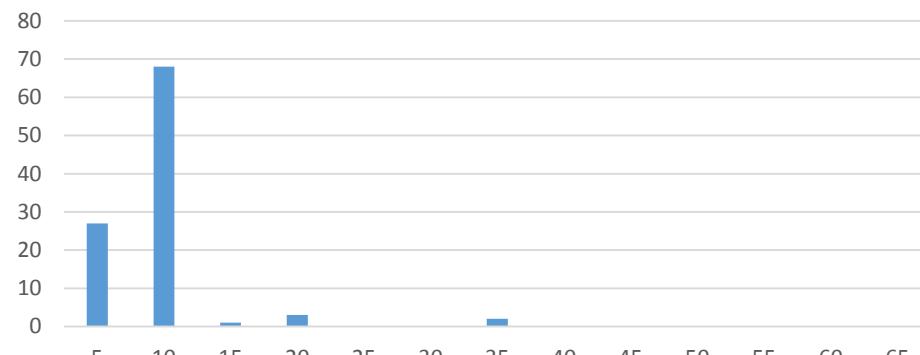
High sea urchin recruitment

Low sea urchin recruitment



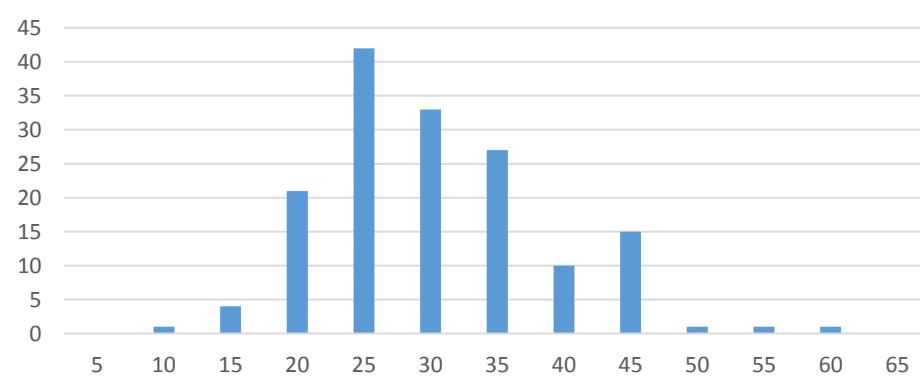
500 – 1000  
per m<sup>2</sup>

Size frequency Maerl

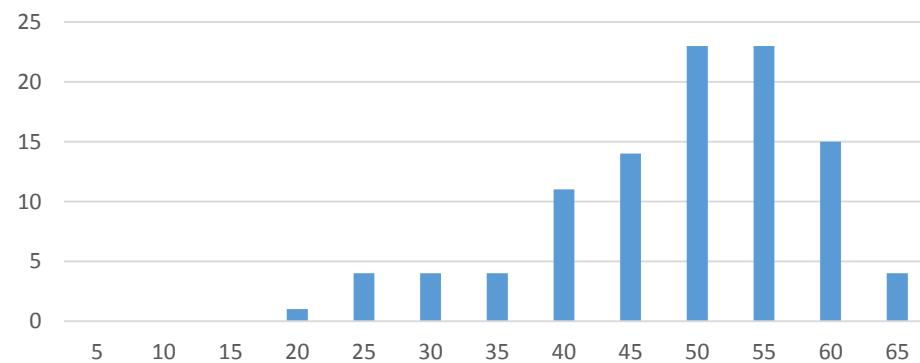


20 – 100  
per m<sup>2</sup>

Size frequency stony



Size frequency bedrock













10-40 kg per m<sup>2</sup>

A large, dense field of sugar kelp (Saccharina latissima) is shown from an underwater perspective. The kelp forms a thick, undulating canopy that covers the entire frame. Sunlight filters down from the surface in bright rays, creating highlights on the fronds and casting deep shadows in the crevices between them. The color palette is dominated by various shades of green and yellow-green, with some darker, more shadowed areas towards the bottom.

**Sugar kelp (*Saccharina latissima*)**  
**10-20 kg per m<sup>2</sup>**  
**Annual production = biomass**





# New kelp vs barren grounds

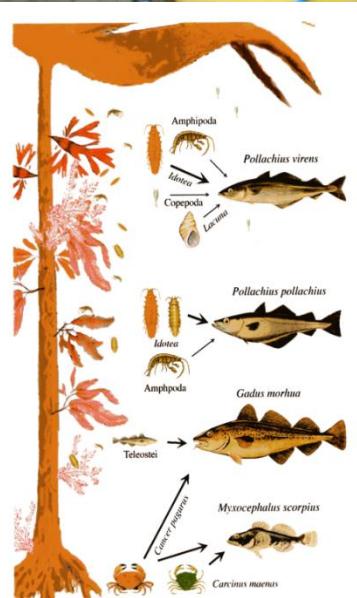
Methods/sampling:

Mobile fauna traps

Gill nets (3 different)

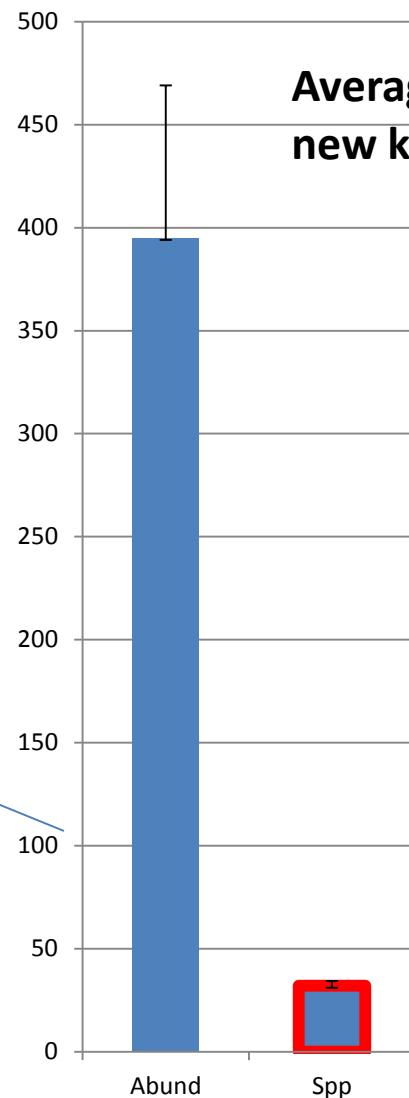
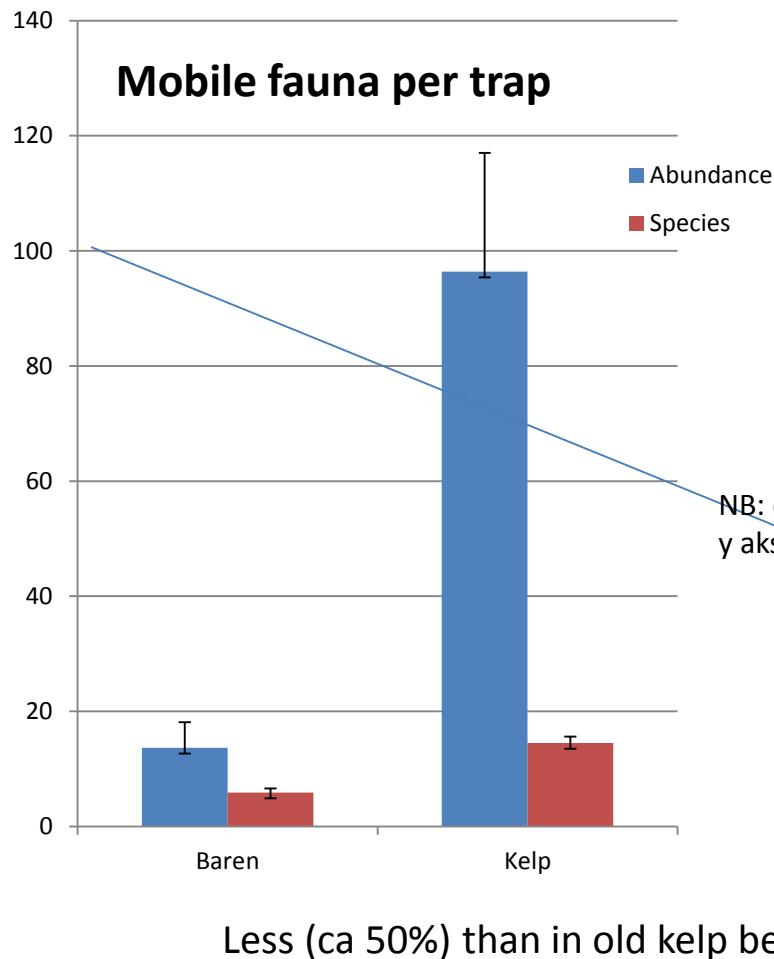
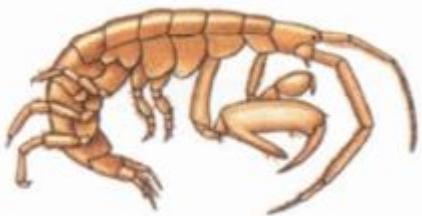
Fish stomach content

Natural substrate (kelp only)









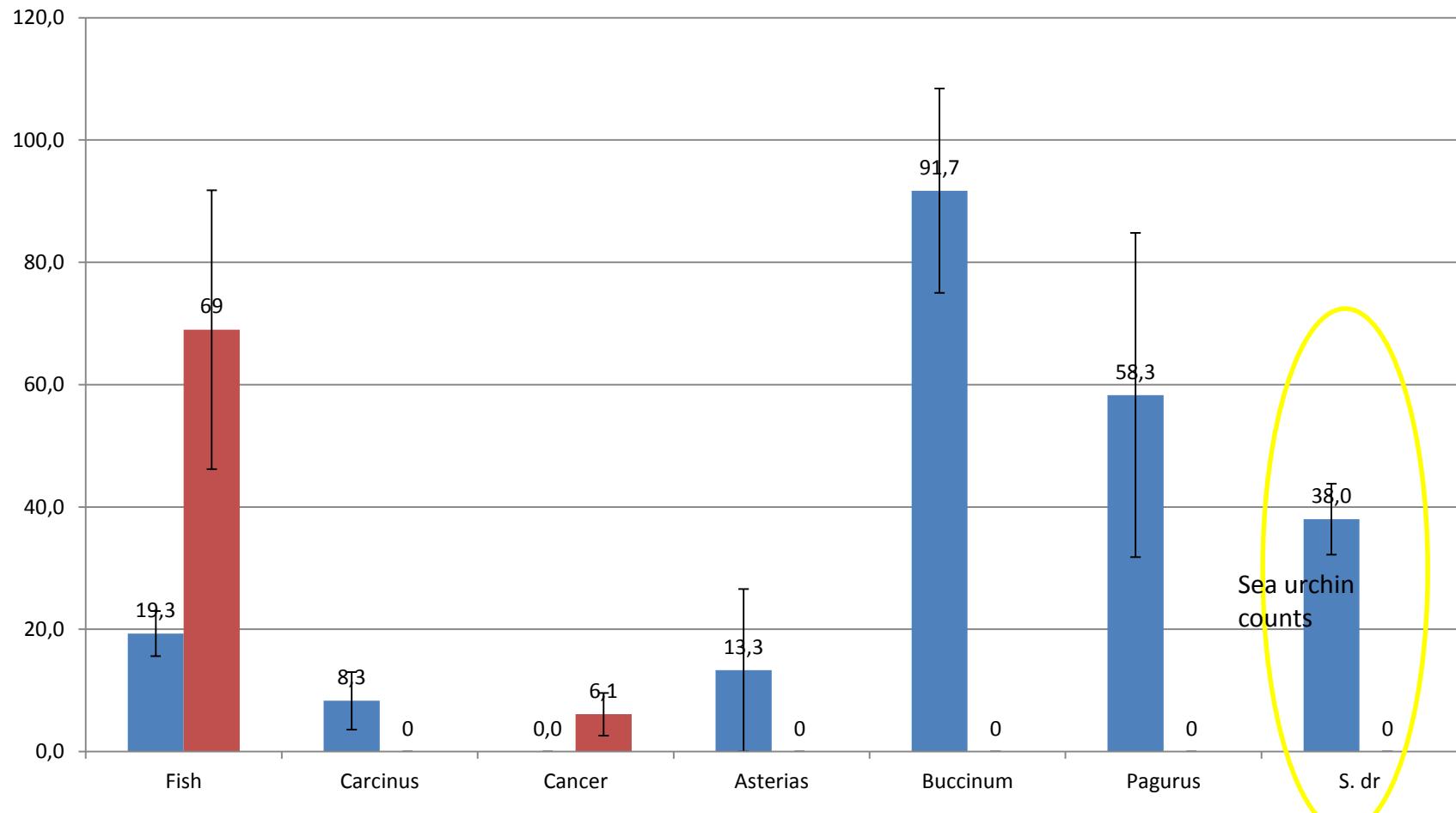
**Alltogether 74 species on 8 kelps**

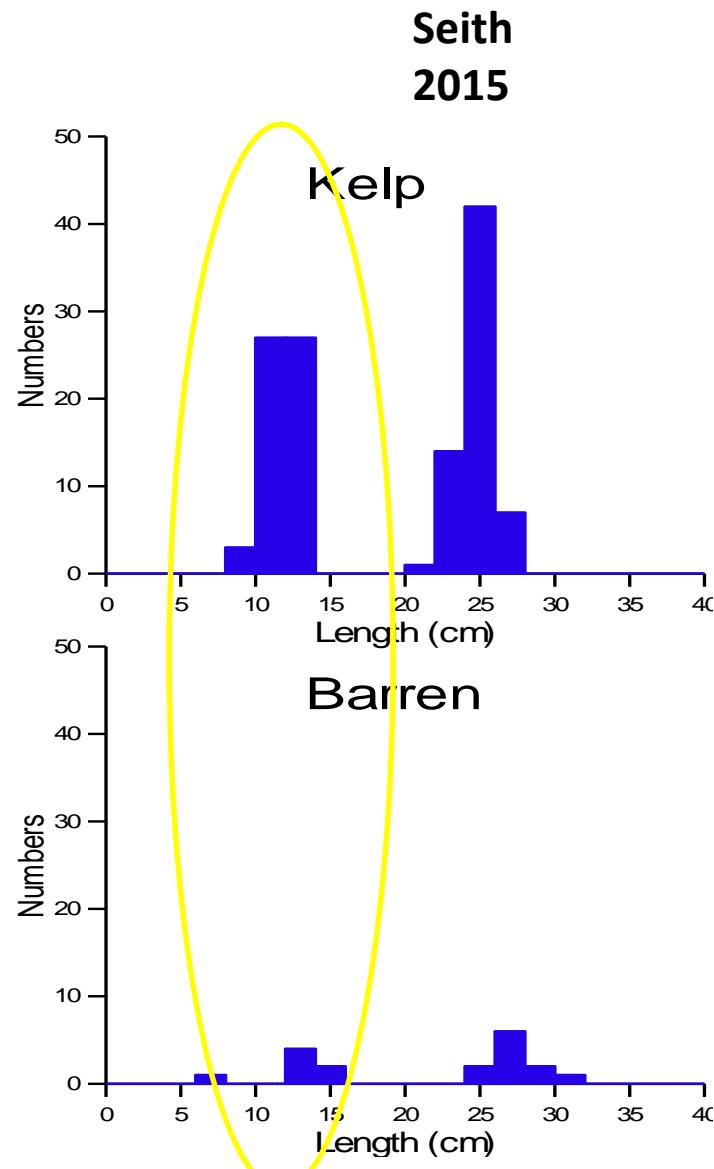
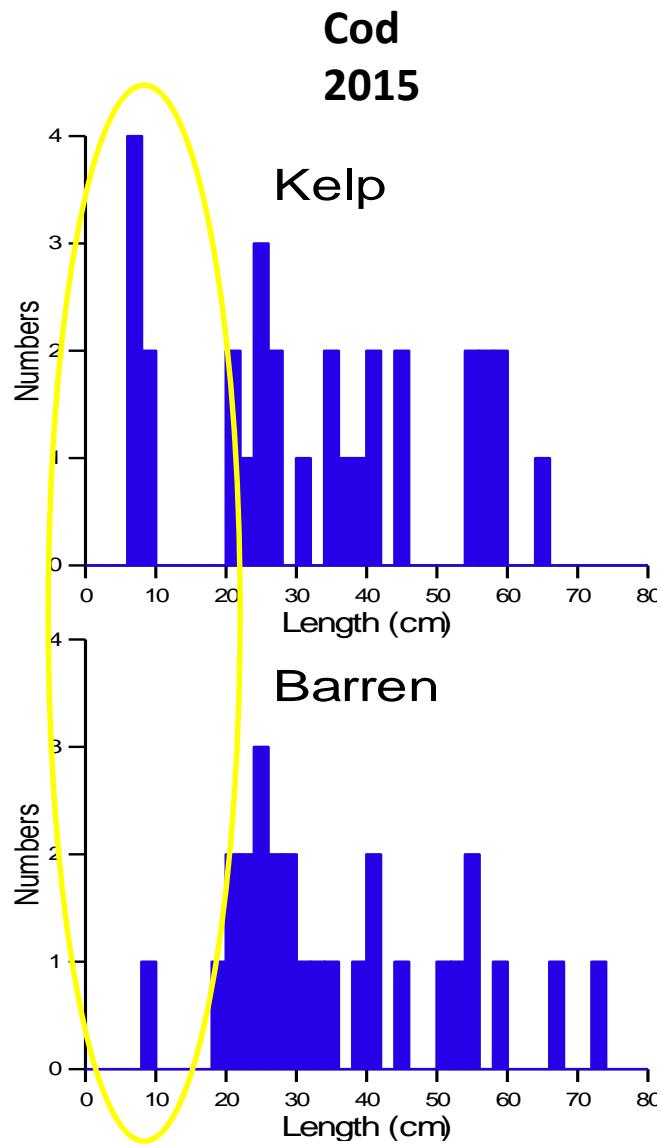
**Estimated 6000 animals per m<sup>2</sup>**

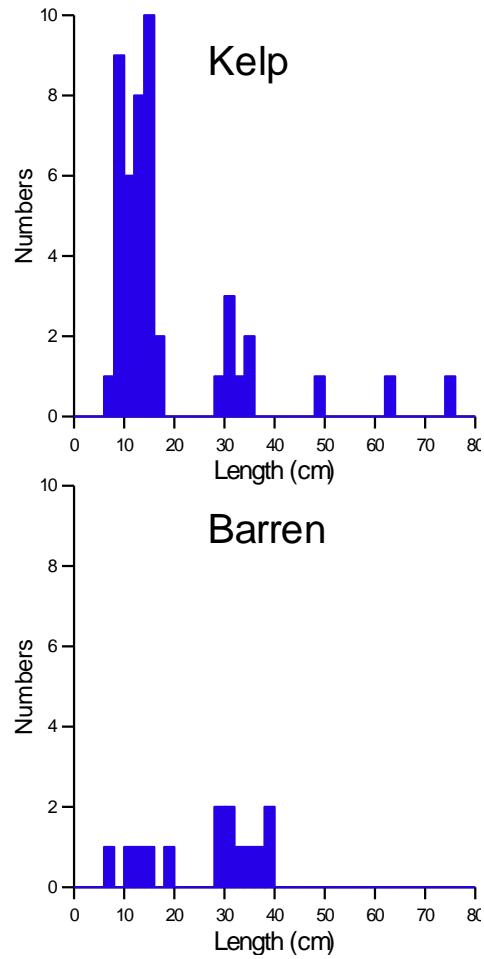
Less than (< 50%) of «natural» kelp beds  
(20-120 000 per m<sup>2</sup> in old kelp beds)

Gillnets Vega 2015 average per station

## Recovered kelp beds vs sea urchin barren grounds







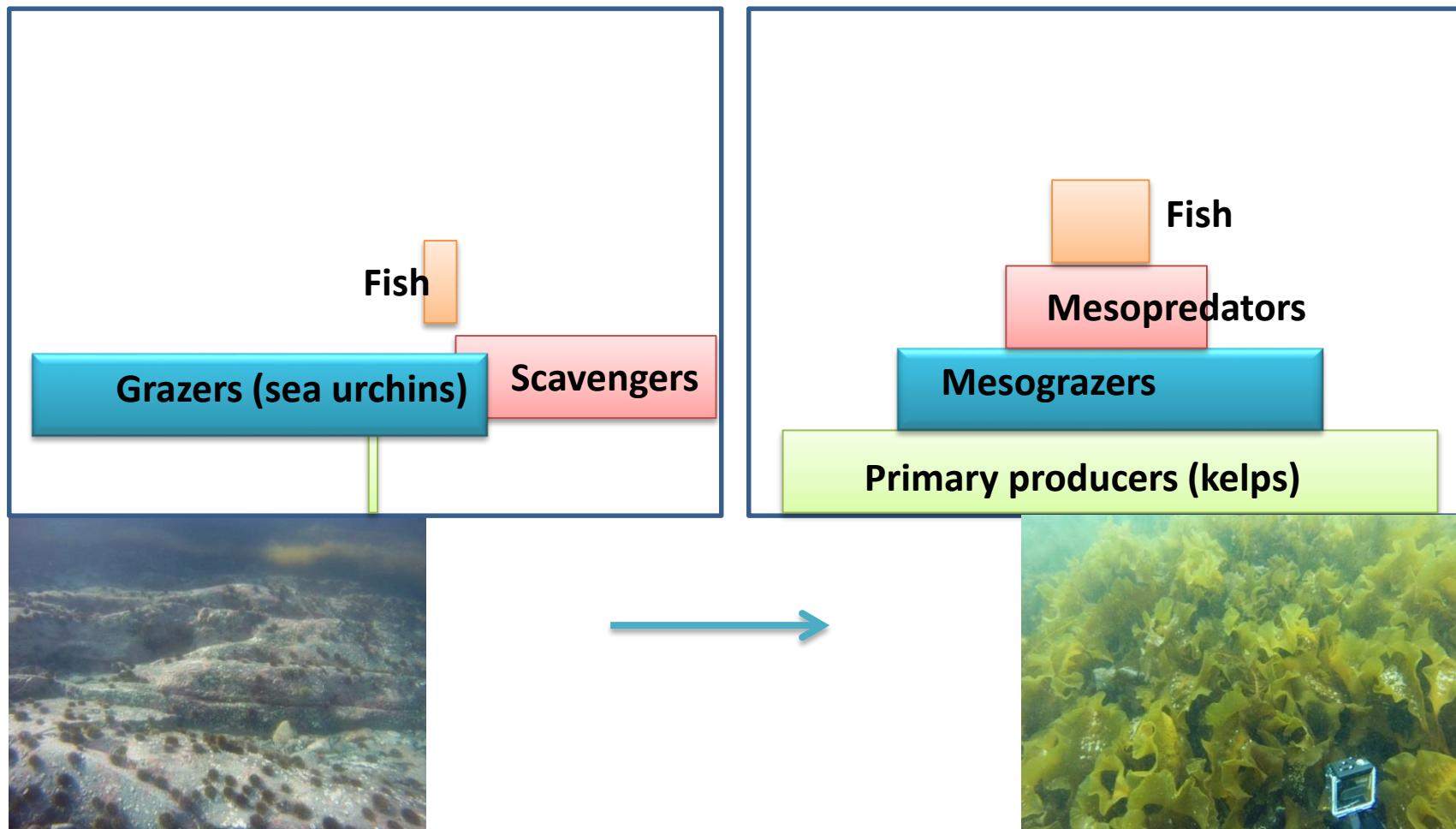
**Fish (cod) stomach content:**

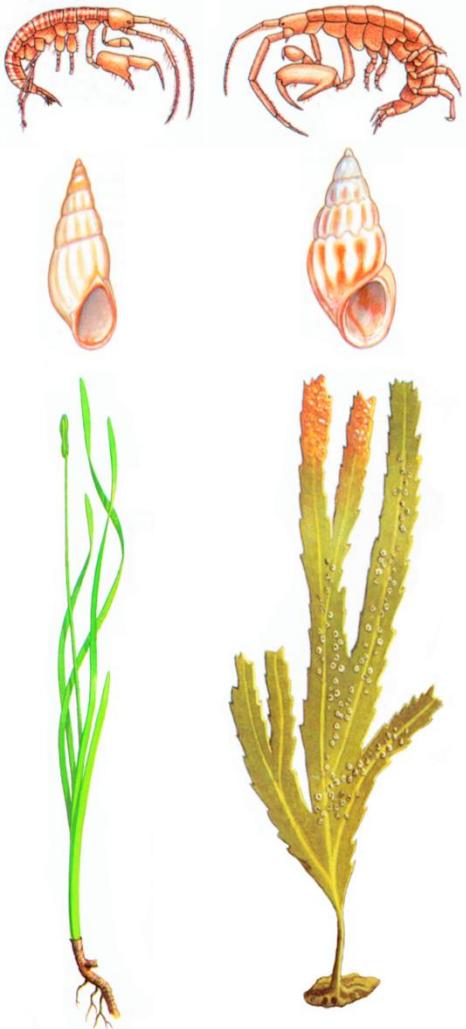
**Kelp: 32 species**

**Barren: 20 species**

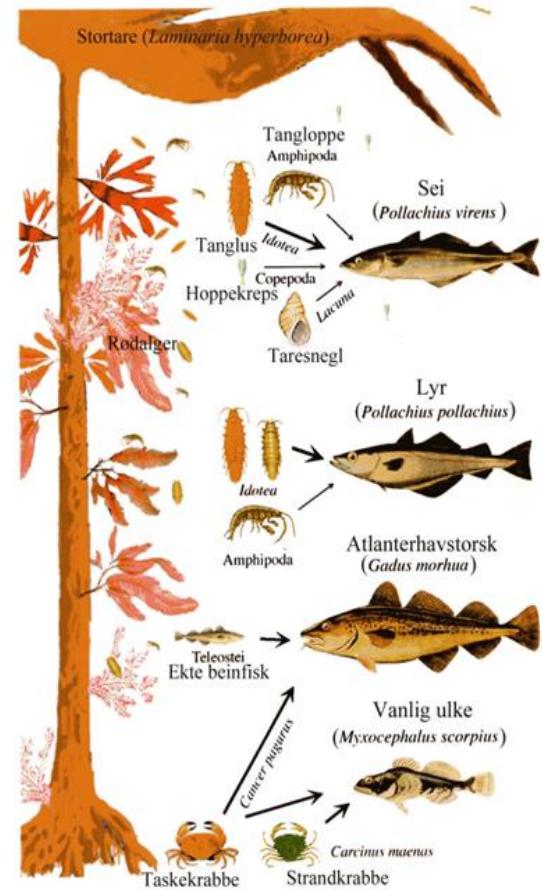
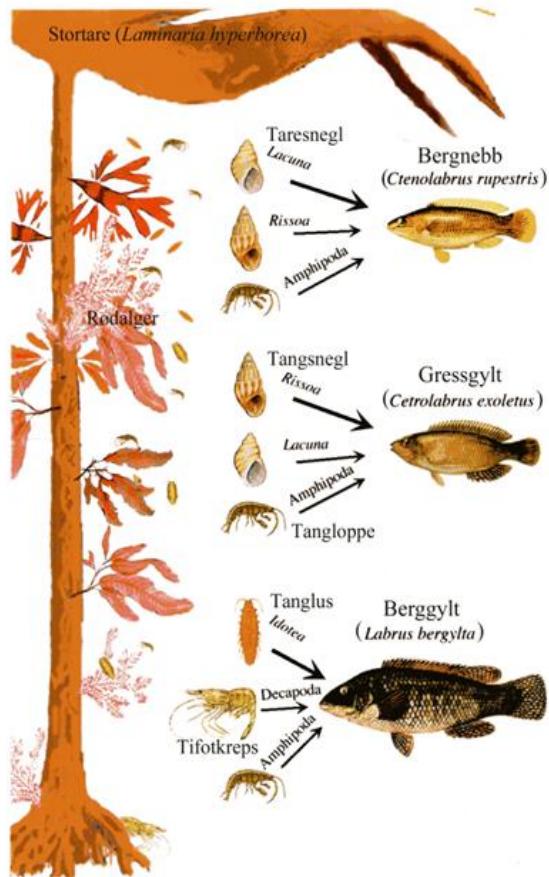
Length of other fish than cod and saithe.  
More fish species in kelp ( $n = 11$ ) than at barren grounds ( $n = 6$ ).

## Trophic structure organization (ecosystem function) when change from barren grounds to kelp beds



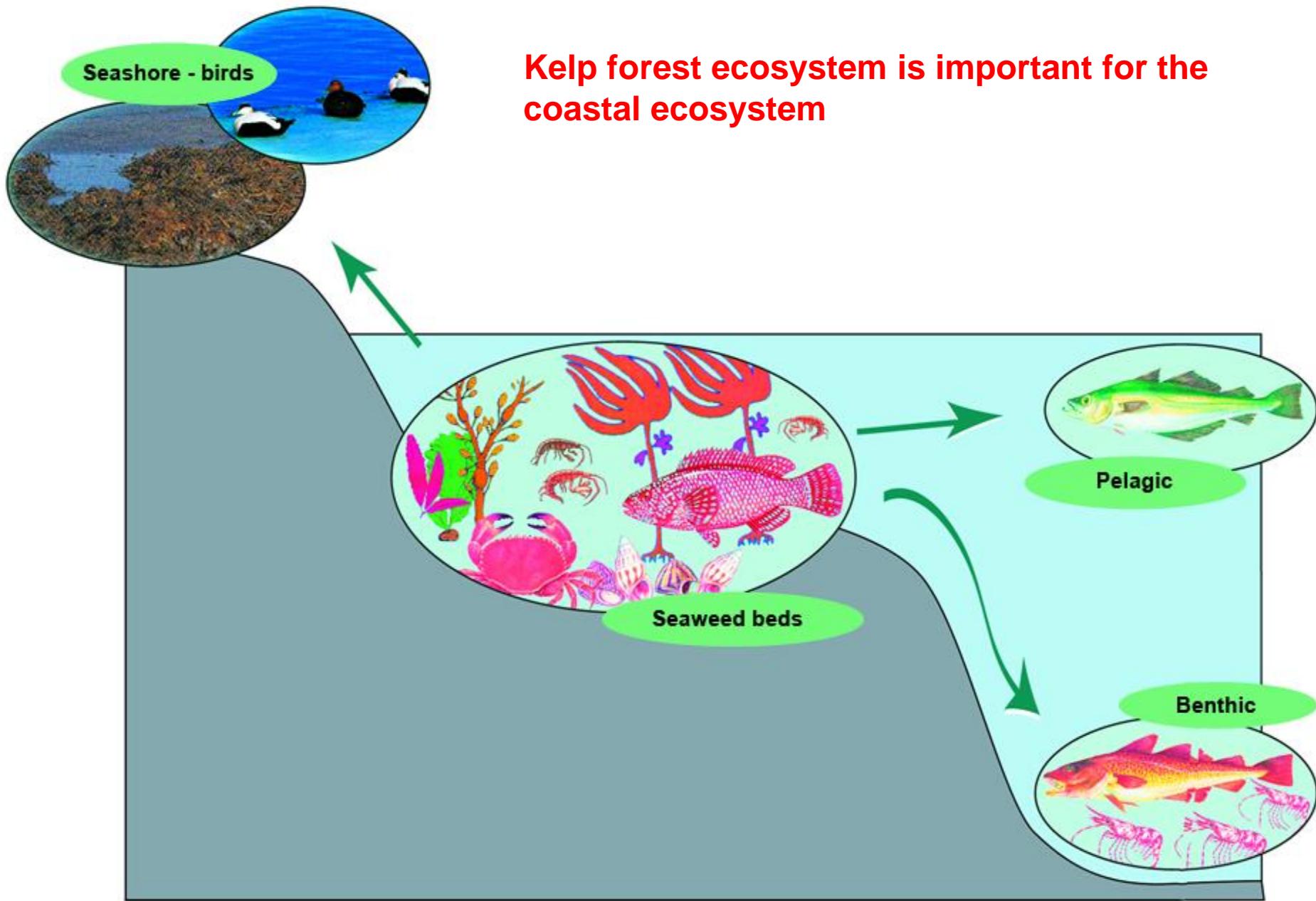


**Mobil fauna in vegetation**  
**> 100 000 per m<sup>2</sup>**  
**> 250 species**



## Kelp food chain organization

## Kelp forest ecosystem is important for the coastal ecosystem



## Benefit for the community (almost 10 000 km<sup>2</sup> new kelp may be gained)

- Increased annual primary production (biomass >10 kg/m<sup>2</sup>)
  - Increasing biodiversity and secondary production
  - Rapid colonization of small animals
  - Habitats for juvenile fish
  - More fish and edible crabs
  - More food for cod
  - CO<sub>2</sub> capture, bioremediation
  - Larger gonads on remaining urchins
- 
- Annual value (19000 US dollar/ha/yr) ca 15 mill pr km<sup>2</sup>

## What we found in the new kelp area



