



Israel Oceanographic & Limnological Research, Ltd
The National Institute of Oceanography

An Overview of Seaweed Research & Cultivation Practices in Israel

Alvaro Israel
MOBI, Porter School, Tel Aviv, May 2017

Marine Macroalgae (Seaweeds)

Divisions:

Chlorophyta (“green”, 15,000 spp.)

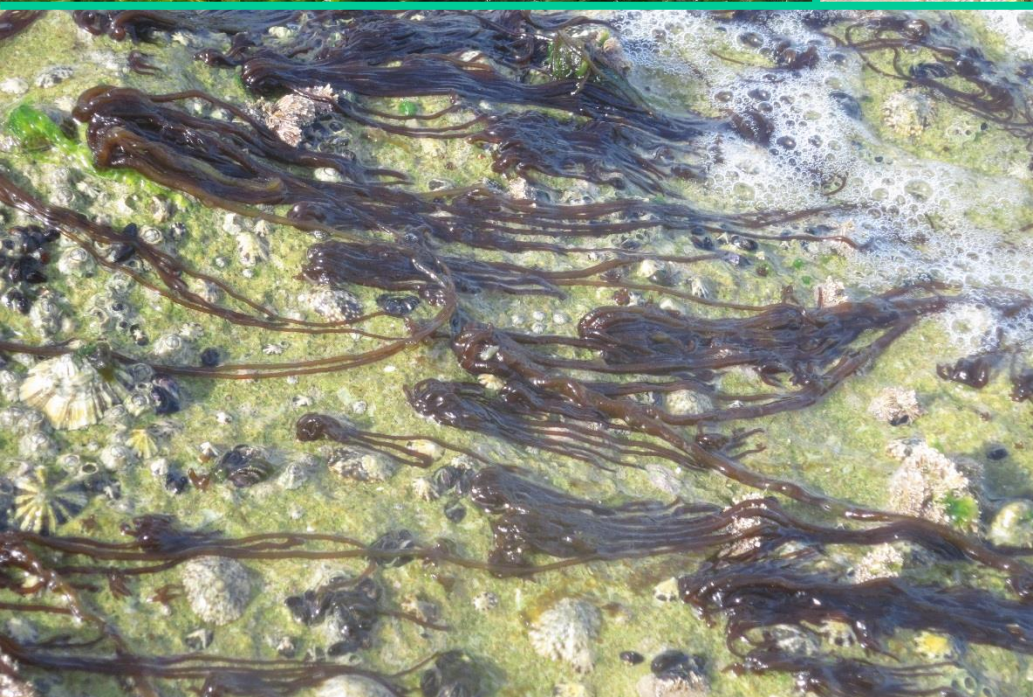
Rhodophyta (“red”, 4,500 spp.)

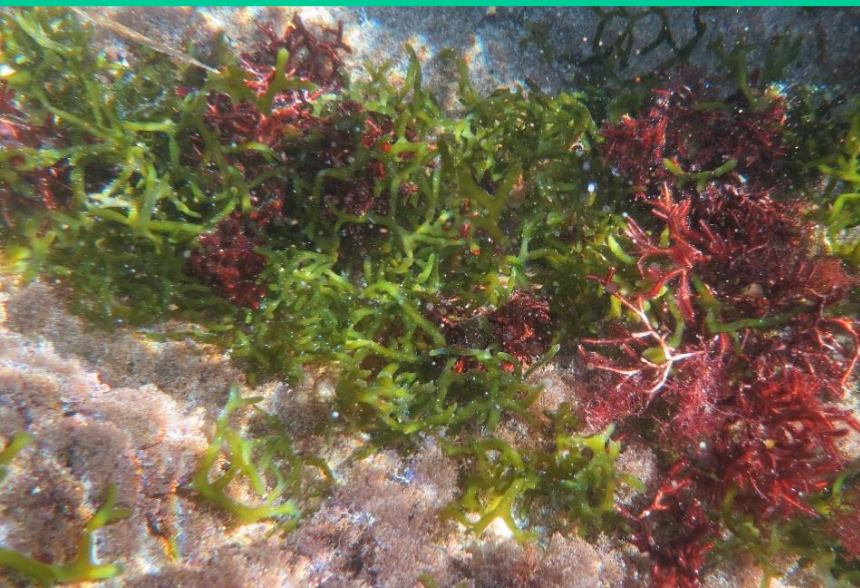
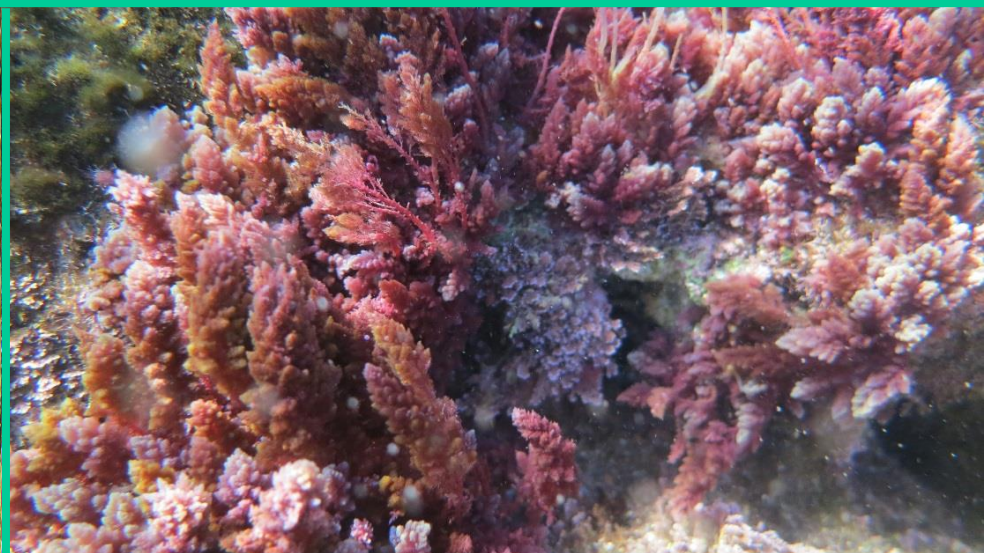
Ochrophyta (formerly Phaeophyta (“brown”, 1,500 spp.))

*representatives of cyanophyta

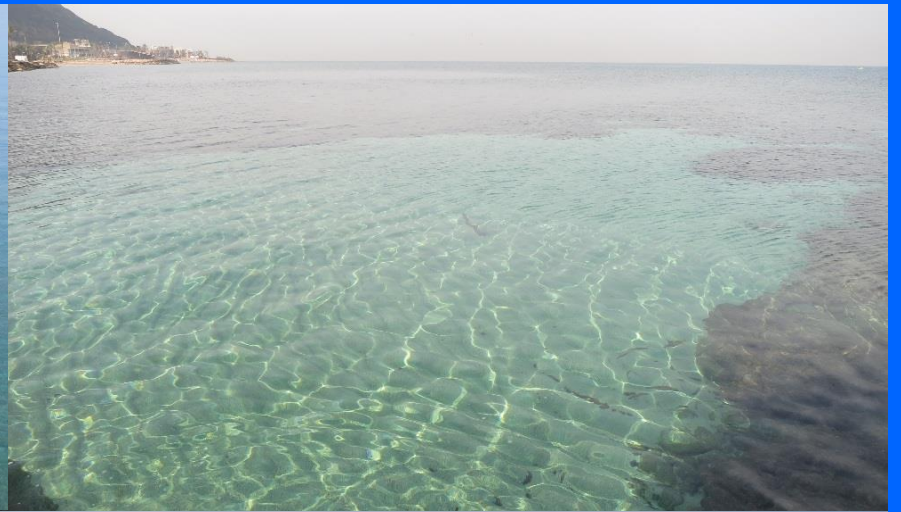
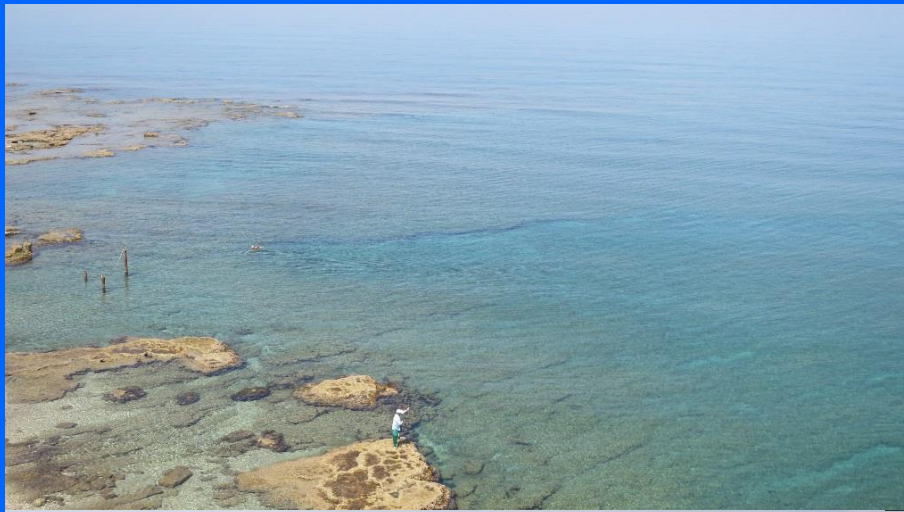


Photo: Galit Zellermayer











Gil Rilov's lab, 2012



From 1960

Checklist of seaweeds from the Israeli Mediterranean: Taxonomical and ecological approaches

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ABSTRACT

The present work presents a checklist of marine macroalgal species described for the Israeli Mediterranean shores, based on literature records published within the last century. The eastern Mediterranean (Levant Basin) offers a peculiar macro-habitat, which is radically unique within the Mediterranean Sea. The list includes more than 300 species of red (Rhodophyta), brown (Phaeophyta), and green (Chlorophyta) marine macroalgae found primarily in the intertidal zone, with at least one endemic species (*Cystoclema rayssiae*, Phaeophyta) described for this area.

Keywords: checklist, seaweeds, Israel, macroalgae, Mediterranean, Levant Basin

2008,
300 described species....

All refs

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Alien seaweeds from the Levant basin (Eastern Mediterranean Sea), with emphasis to the Israeli shores

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ABSTRACT

The link of the Mediterranean Sea to the Indian and Pacific Oceans was artificially created with the opening of the first Suez Canal in 1897, and the second in 2015, allowing the direct passage of marine organisms into the Eastern Mediterranean Sea. About 307 macroalgae (seaweeds) exist in the Israeli Mediterranean shores. The current study lists marine macroalgae within the Levant basin described after the year 1900, with special focus on species from Israeli shores. We identified 86 species for the whole Levant area regarded as exotic, namely, introduced by artificial vectors derived from human activities, including arrivals via the Suez Canal (Lessepsian invasion). Of those 86 species, 42 are Rhodophyta, 23 are Chlorophyta and 21 are Ochrophyta. Further, about 68% are of Indo-Pacific origin, 20% of Atlantic origin, with 12% of the species of uncertain origin. With precaution we suggest that about 16% of the marine flora in the Israeli Mediterranean shores are

ARTICLE HISTORY

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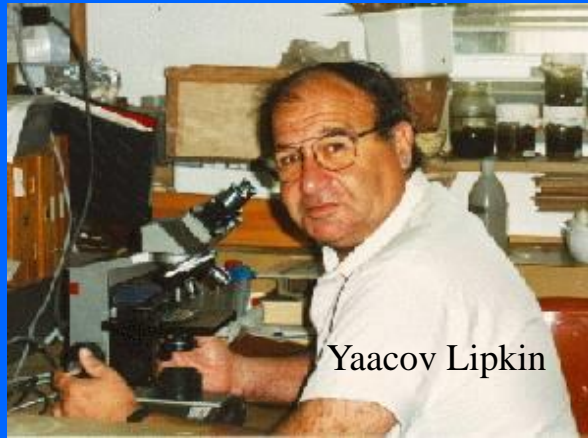
KEYWORDS

Alien; exotic; invasive seaweeds; Israel; Lessepsian invasion; Levant Basin; marine macroalgae; Mediterranean Sea

2017,
86 alien (= Invasive)
species...



Barbro Lundberg



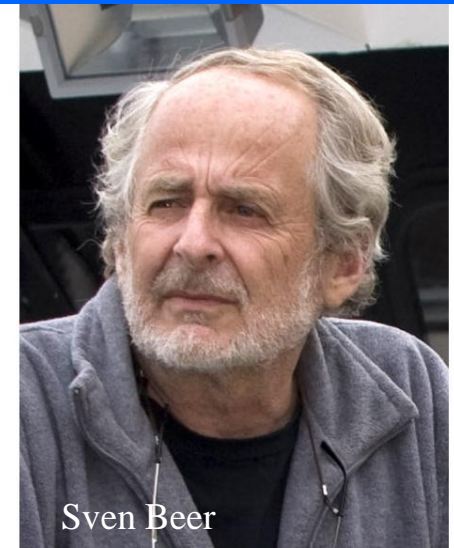
Yaacov Lipkin



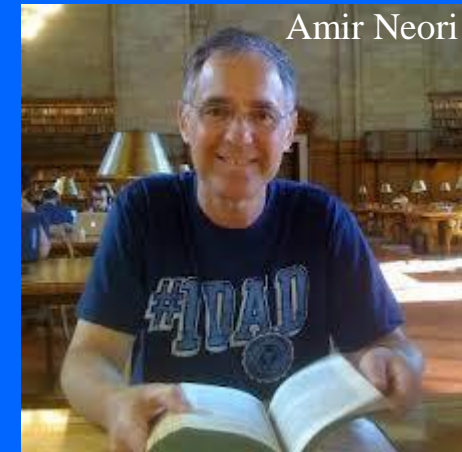
Rachel Einav



Michael Friedlander



Sven Beer



Amir Neori

But also others..... I. Levy, E. Ramon, T. Rayss, T. Edelstein, C. Nemlich, Z. Danin

Z. Dubinzky
R. Hoffman
A. Kaplan



Muki Shpigel

*Physiology, biochemistry,
clas. taxonomy, mol.
taxonomy, ecology,
monitoring, IMTA, cultivation
land- and sea-based*

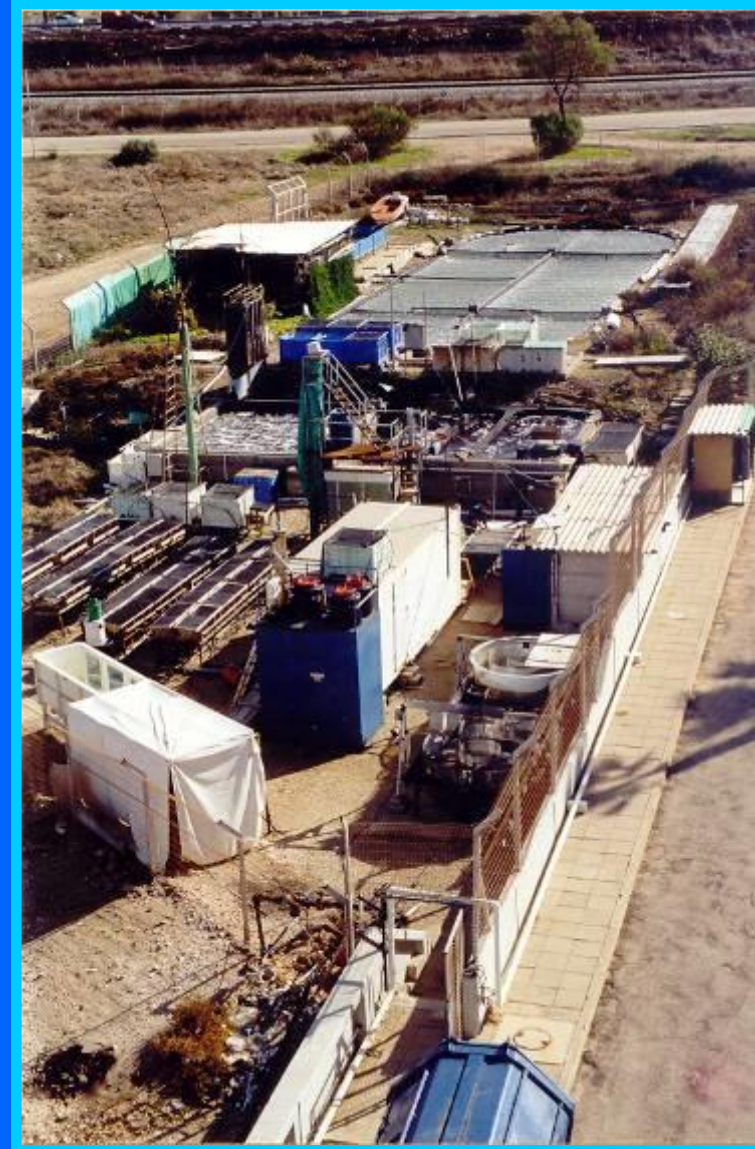


Laminaria sp. at low-tide..... this will never occur in Israel!! (low productivities, harsh conditions, topography, etc....)





Tanks and ponds experimental site at IOLR, Haifa, Israel (since 1985)





.....land-based cultivation



Porphyra (Tel-Baruk ; 3/2/98)

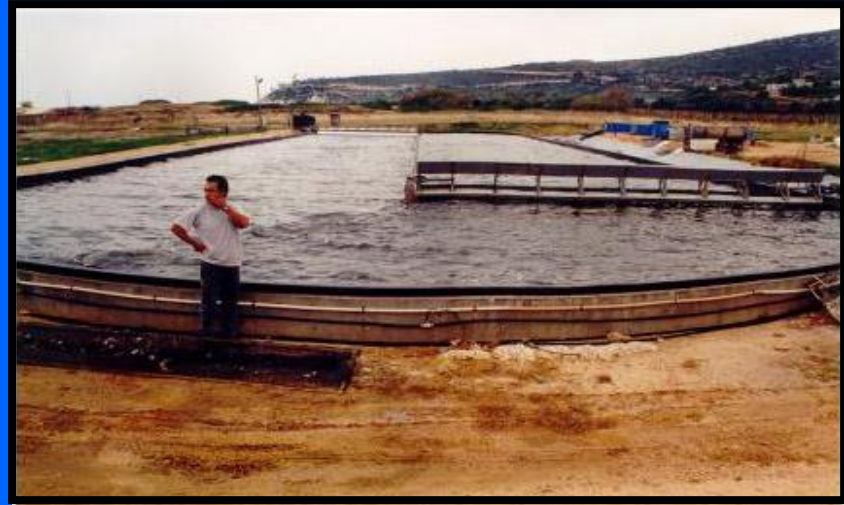
Porphyra = *Pyropia*



Large pond (120 m³, 300 m²)



Two-compartments circular ponds (1000 m²)

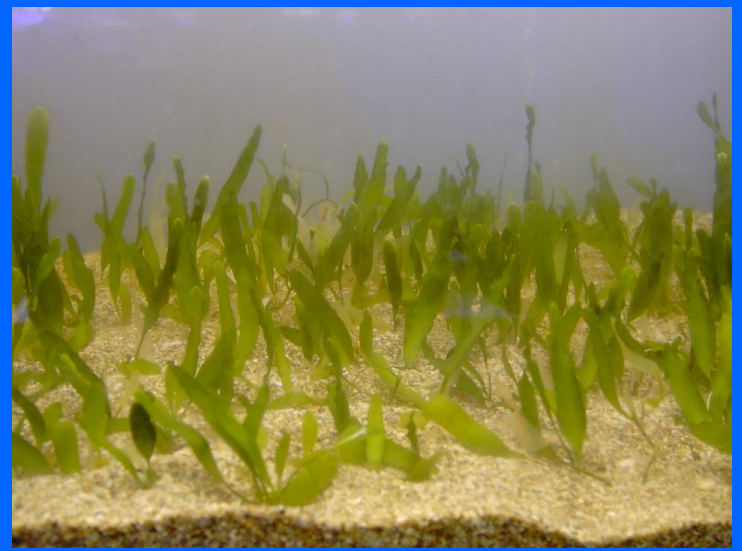
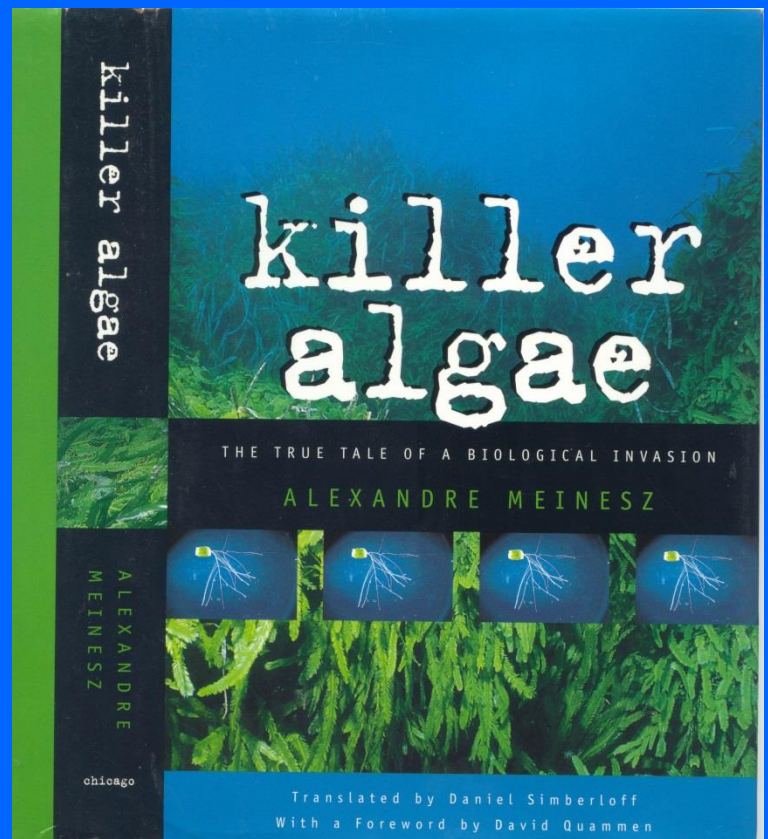


1000 m² *Gracilaria* paddle-wheel pond





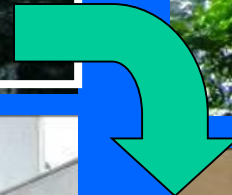
Agar



Bio-adhesive

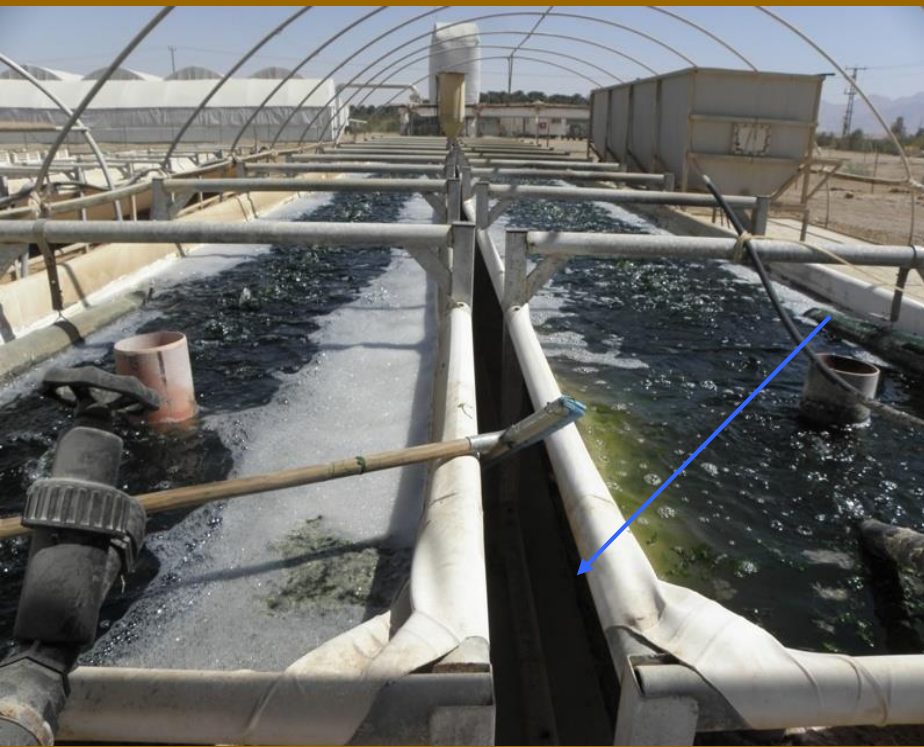
Alginates





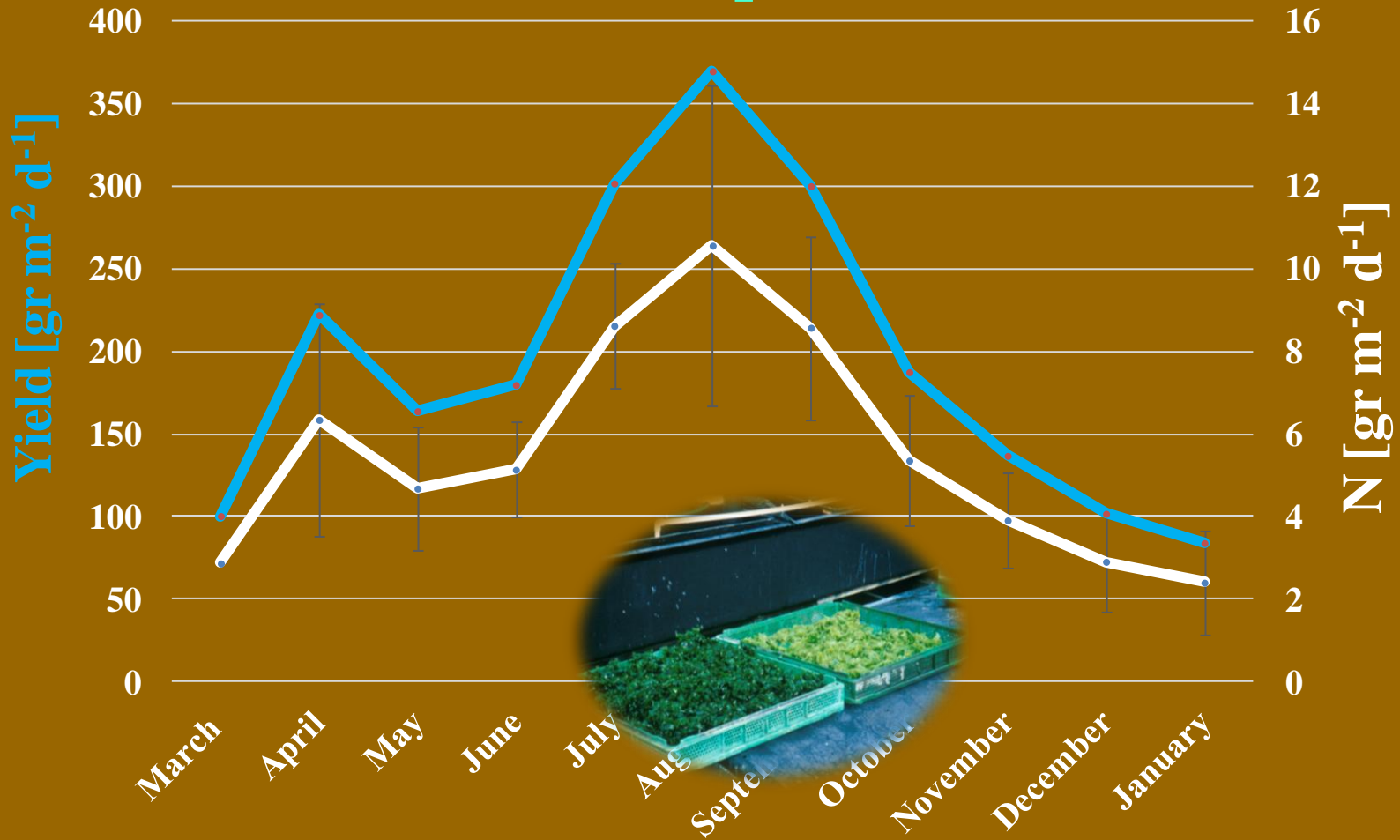
Ulva tumble cultivation,
sold fresh (salted) or dry
pellets





**IMTA Department at NCM,
IOLR-Eilat**

Ulva lactuca performance



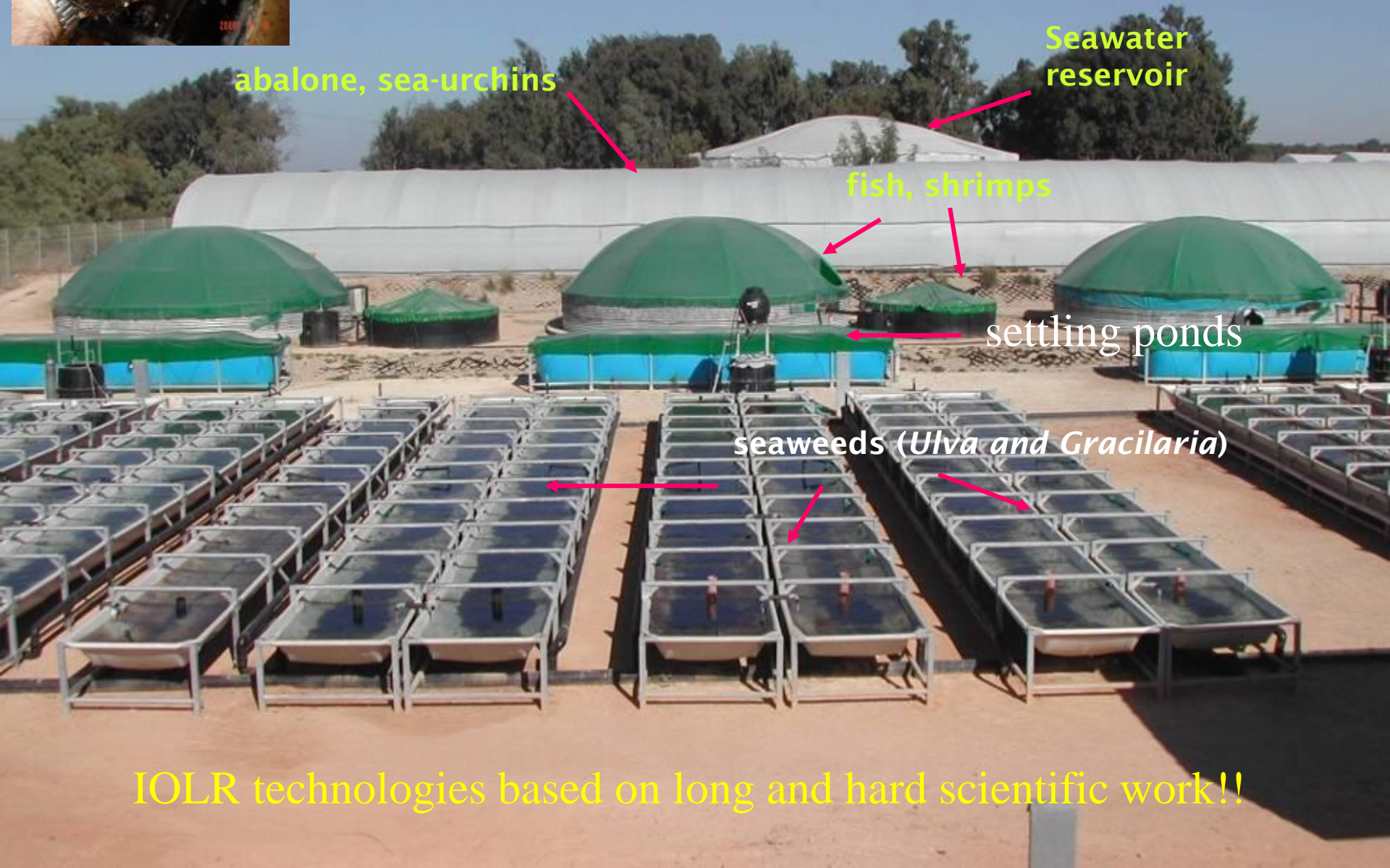
	Ash (% DW)	Protein (% DW)	Lipid (% D)	Carbohyd. (% DW)	Phosphate (% DW)
	19.9 ± 3.05	34.1 ± 2.35	1.5 ± 0.75	43.9 ± 3.05	0.44 ± 0.03

Ben Ari et al., 2014;

Neori and Shpigel, 1998;

Schuenhoff et al., 2003

Integrated Aquaculture (= Integrated Multi-trophic Aquaculture – IMTA = Polyculture)



abalone, sea-urchins

Seawater reservoir

fish, shrimps

settling ponds

seaweeds (*Ulva* and *Gracilaria*)

IOLR technologies based on long and hard scientific work!!

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- + Vitamin C 21.9mg
- + Iodine 23mg
- + Lysine 1.19g
- + Potassium 2163mg
- + beta-Carotene 5.83mg
- + Zinc 3.51mg
- + Vitamins B-1,2,3,5,6

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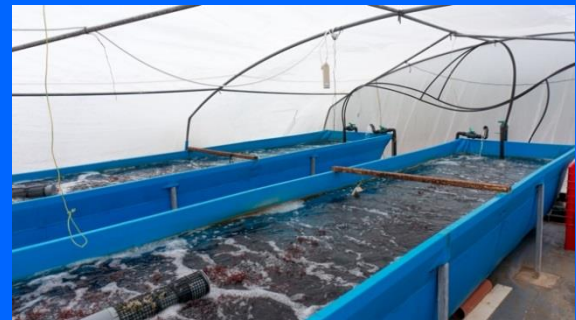
- Operating seaweed cultivation farms: Seakura (*Ulva*)
Sealaria (*Gracilaria*)
- R&D: Blue Nori (*Pyropia*, *Gracilaria*)

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Natural Hydrogel is a unique body care agent that preserves the wellness of *Gracilaria* red seaweed from the sea.



Annual growth pattern and reserves in seaweeds (strongly species dependent!!!)

- Carbohydrates
- Growth
- Reserve N



Bioethanol from seaweeds? (Min of Science & Technology, Israel)



..... involving various groups from

Tel Aviv University
Technion
Bar Ilan University
IOLR

and more.....

Table 1: Ethanol yield in various crops and a red seaweed (*Gracilaria*) and a green seaweed (*Ulva*). Numbers were converted from gallon/acre to liter/1000 m² of land.

Crop	Ethanol Yield (liter/1000 m ²)
Sugar beet (France)	667
Sugarcane (Brazil)	618
Cassava (Nigeria)	381
Sweet Sorghum (India)	348
Corn (U.S.)	329
Wheat (France)	258
<i>Gracilaria</i> starch (Hawaii)	353 ^c
<i>Ulva</i> starch (Israel)	727 ^a
<i>Ulva</i> carbohydrates (Israel)	4360 ^b



^a Our estimation assuming 50% starch to ethanol conversion yield. ^b Our estimation assuming 50% carbohydrates to ethanol conversion yield. ^c Our estimation with data from Glenn et al. (1991). Data from Brown (2006)

Effects of Global Changes (CO₂, UV, Temp. nutrients) enhanced photosynthesis/growth?



Temperature rise:

0.03 °C per year

Sea Level Rise:

10.5 cm in the past 18 years

up to 1 m by the end of the century

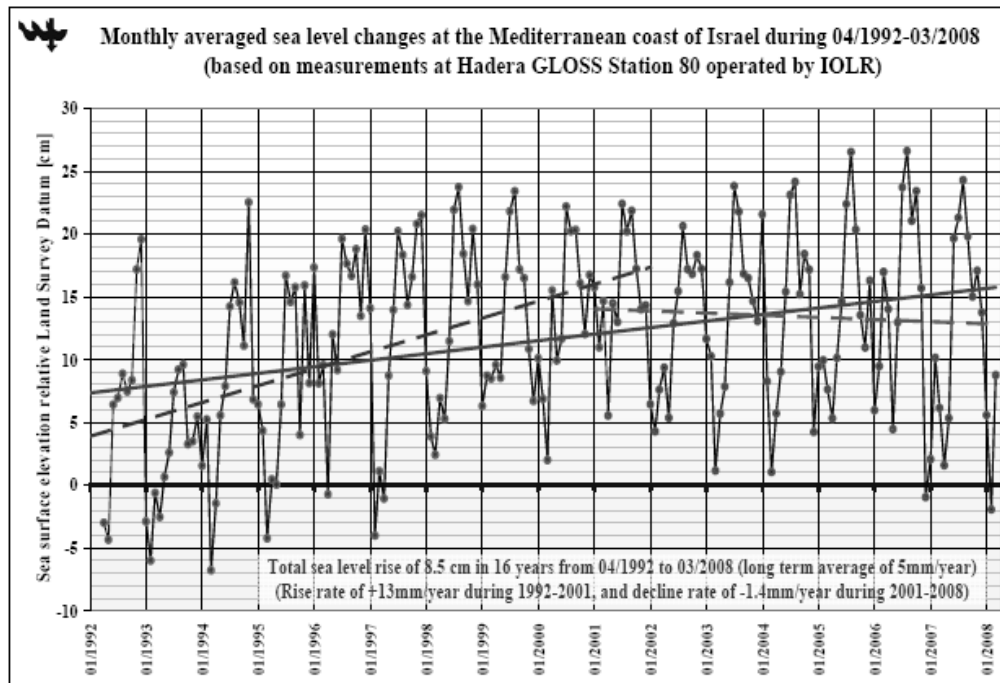


Fig. 2. Sea level rise changing rates at Hadera, Israel (Rosen et al., 2007).



2005-2013





Haifa, November 2007

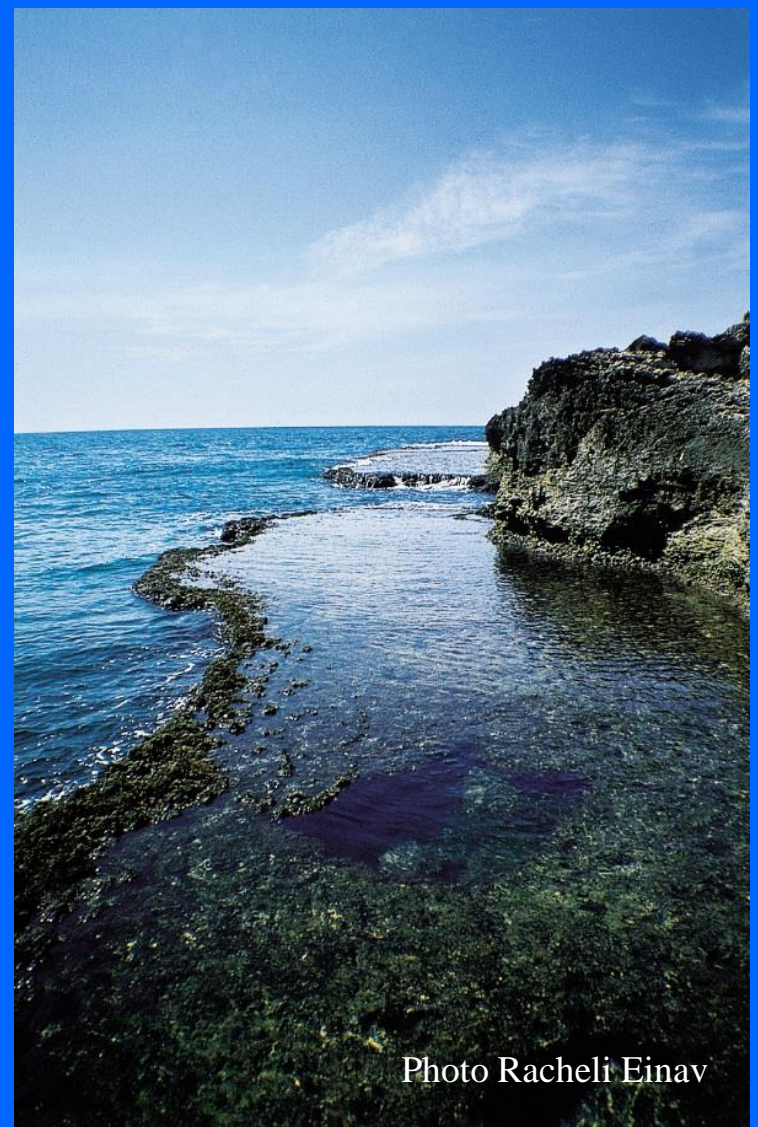
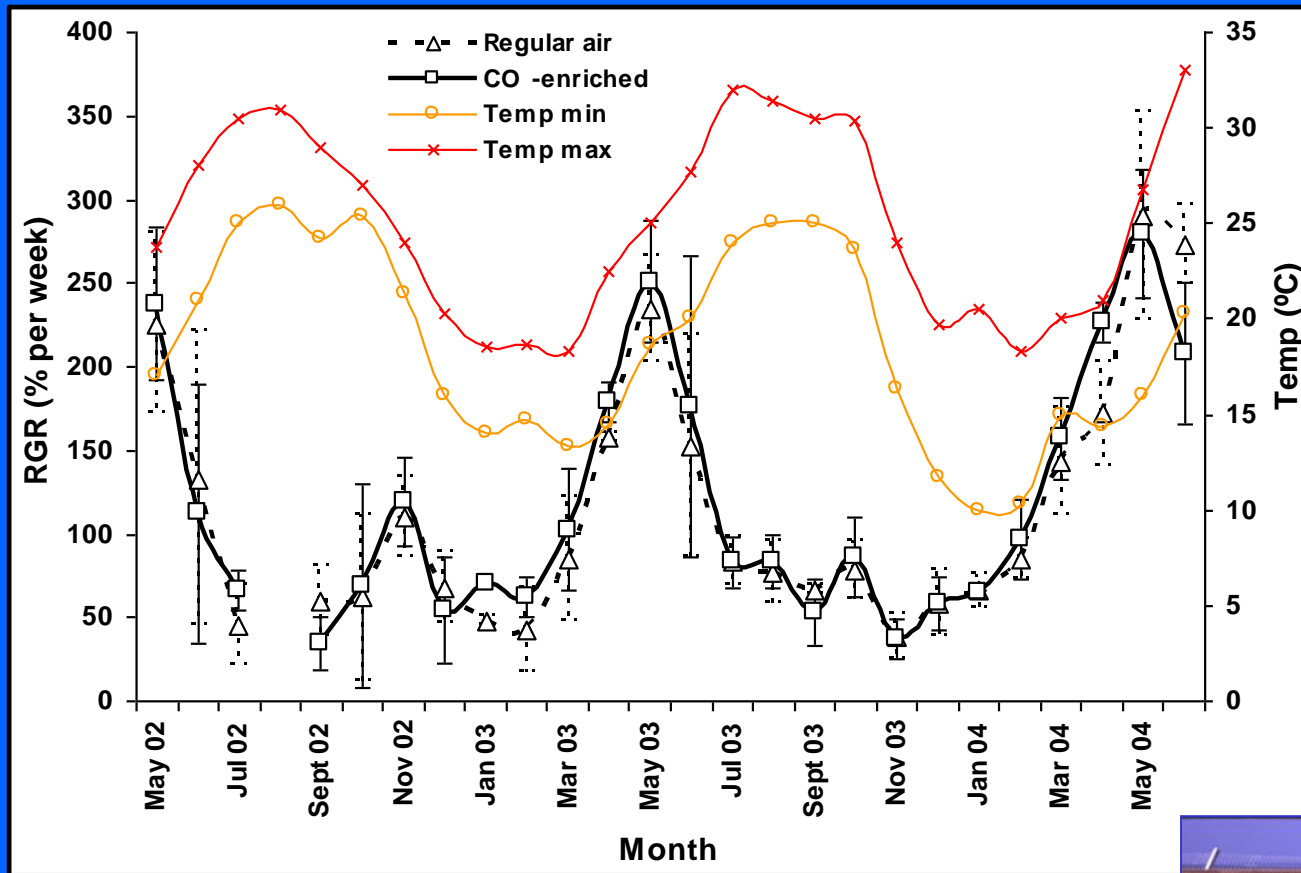


Photo Racheli Einav

Strong seasonality and local weather
(also associated to prevailing seasons)

- Sea level
- Temps
- Acidification

Long-term growth rates *Ulva rigida* under CO₂ enrichment

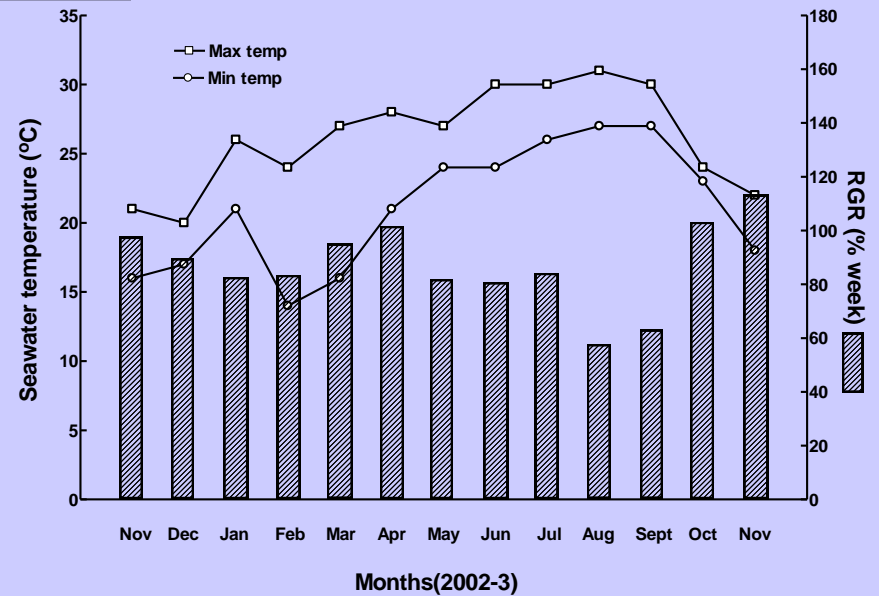




Israel Electric Corporation (Hedera site, 2002-2004)

flue gas (CO₂)
high temp seawater

“New trials sea-based cultivation
(Golberg et al).



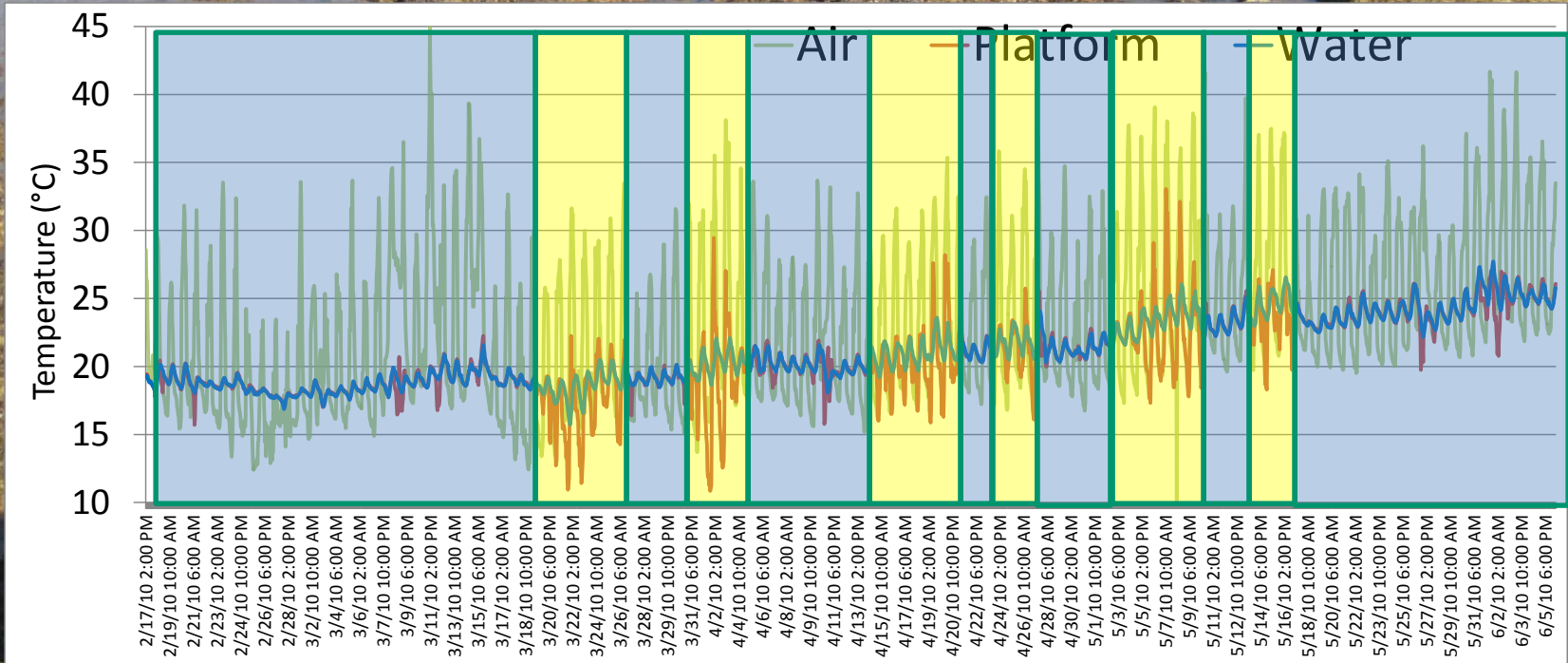
Monitoring strategies

Gathering of biological and oceanographic data

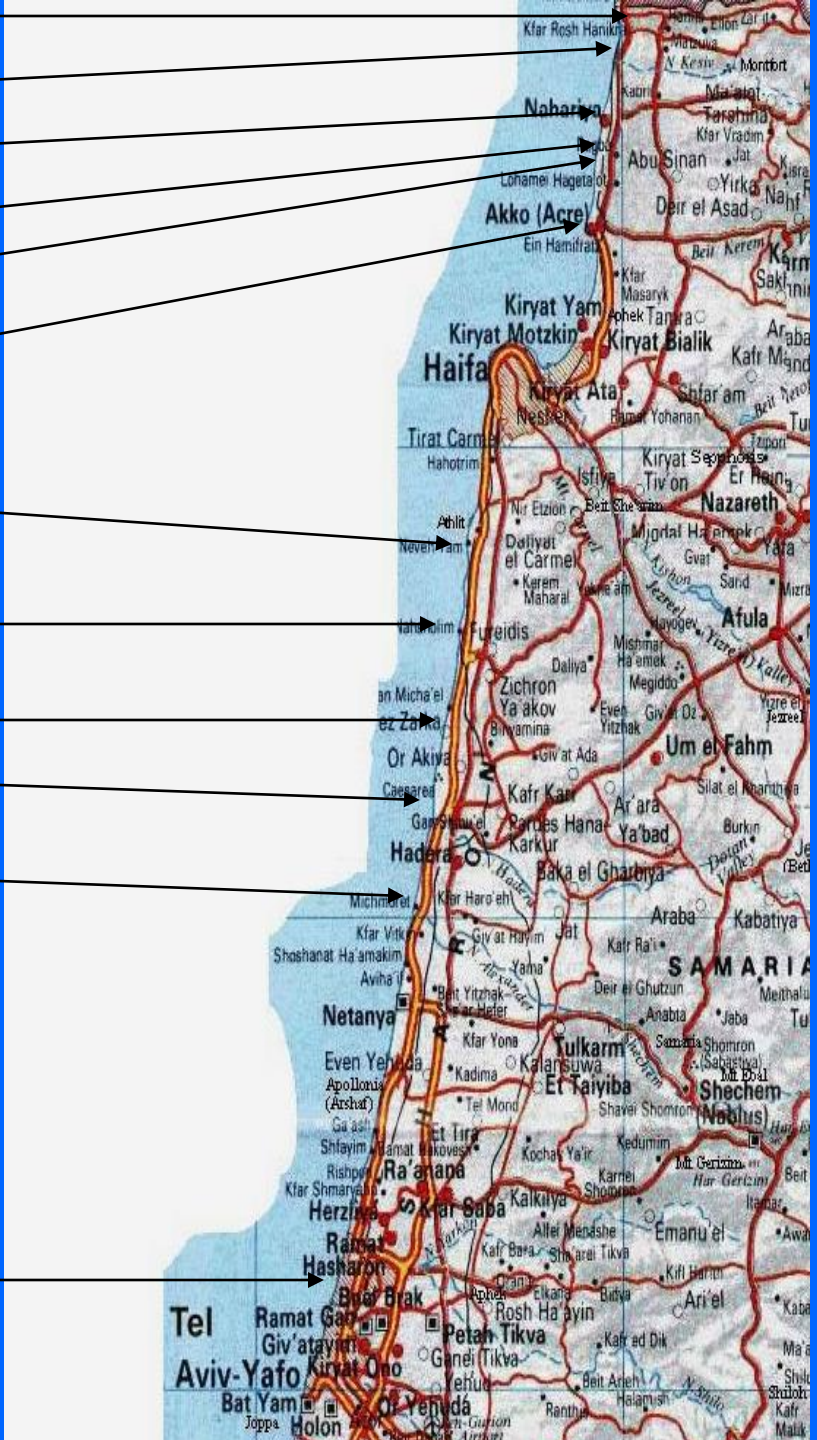
NMP – National Monitoring Program



Temperature time-series



- Bezet**
- Akhziv**
- Naharyia**
- Shave-Ziyon (site b)**
- Shave-Ziyon (site a)**
- Akko**
- Neve-Yam**
- Nachsholim**
- Jisr-ez-Zarqa**
- Sedot-Yam**
- Michmoret**
- Tel-Baruch beach**



Kfar Rosh Hanikra

Nahariya

Akko (Acre)

Haifa

Neve-Yam

Nachsholim

Jisr-ez-Zarqa

Sedot-Yam

Michmoret

Tel-Baruch beach

Intertidal seaweed survey vs. nutrients and heavy metals (from 2006)

