

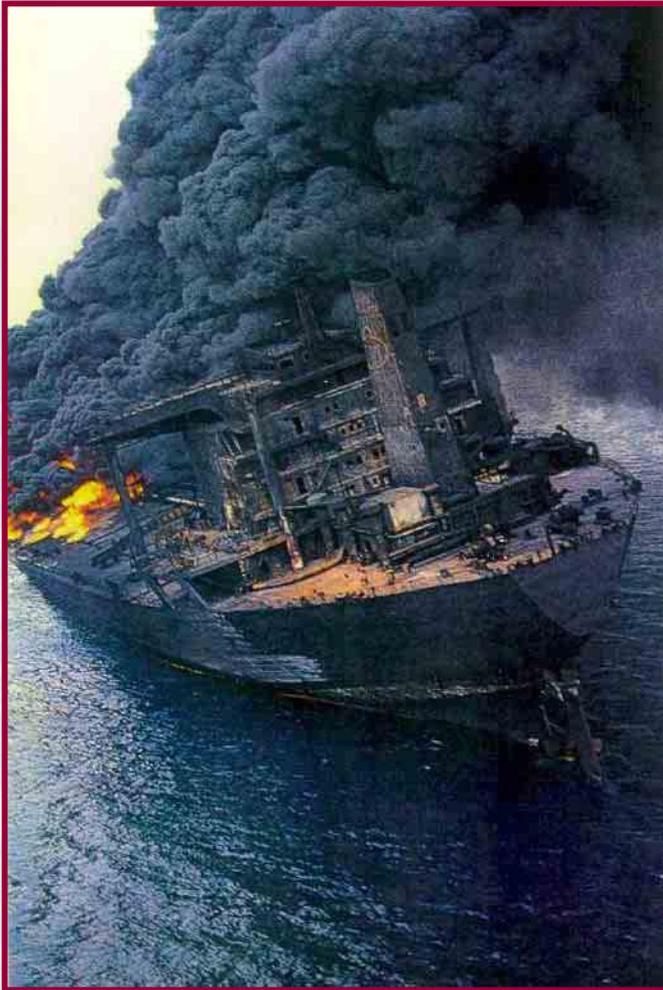
**8th Information day of Cedre / 8ème journée d'information du Cedre  
Paris, 17-10-2002**

**Impact et Réparation d'une Grande Marée  
Noire en Méditerranée : le Cas du Pétrolier  
Haven dans le golfe de Gênes**

**The Impact and Repair of a Major Black Tide in  
the Mediterranean : the HAVEN Incident in the  
gulf of Genoa**

# **VLCC HAVEN**

**(ex AMOCO MILFORD HAVEN)**



**Shipyard: Astilleros Españoles S.A.,  
Cadiz (Spain), 1973**

**Class: American Bureau of Shipping**

**Port of Registry: Limassol (Cyprus)**

§ **Overall length: 334 m**

§ **Beam: 51 m**

§ **Upper deck height: 26.19 m**

§ **Draught: 19.943 m**

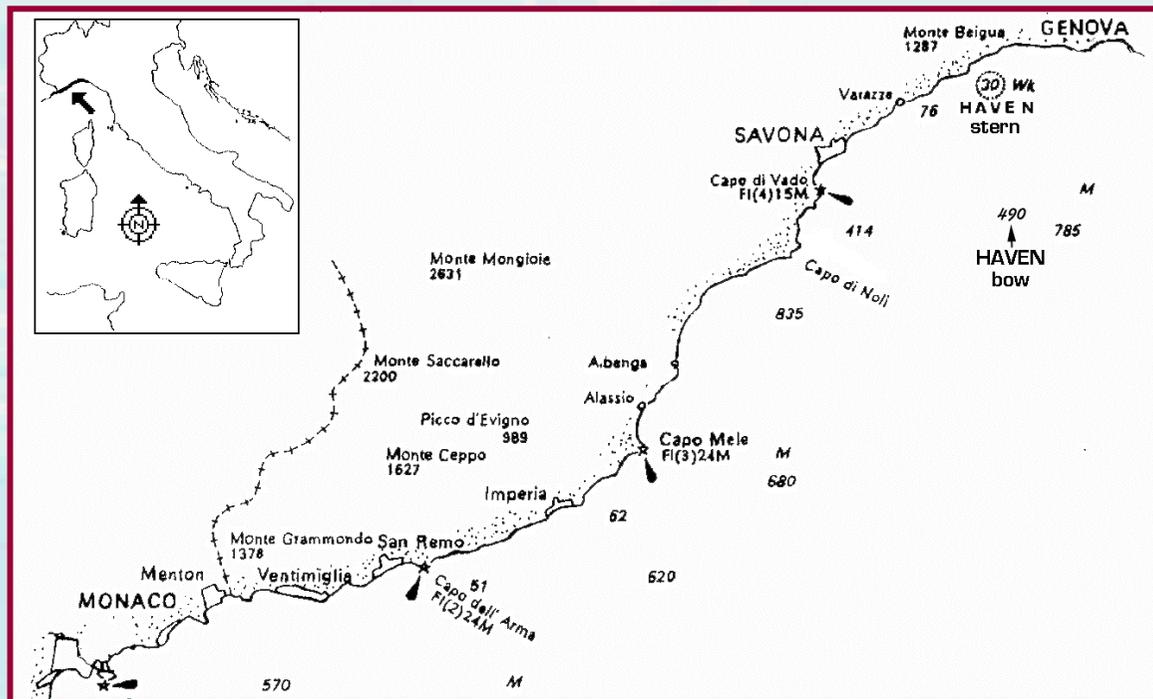
§ **Gross Tonnage: 109,700 t**

§ **Net Tonnage: 91,988 t**

§ **Capacity (d. w.): 232,164 t**

§ **Dead weight: 35,395 t**

At the moment of the accident, which killed five members of the crew, 144,000 tons of “heavy Iranian crude oil” and 1,223 tons of fuel oil and diesel were present on board. A large quantity of burnt oil rapidly sank in the form of bitumen while the rest of the cargo was dispersed by the Ligurian-Provençal current and the winds mainly west-south-westerly; according to the satellite images elaboration carried out by a team of experts, a few hours after the sinking of the HAVEN, the oil slicks had affected nearly 100 km<sup>2</sup> of the sea surface. According to REMPEC until April 25<sup>th</sup> the wreck released oil continuously at a rate of ten cubic metres per hour during the first two days and about one cubic metre per day by the end of the second week after the accident. The 70 hour burning determined the sinking, in a restricted area of the sea bottom, of an amount of oil estimated in the range 10,000÷50,000 tons. Due to the first explosion, the ship lost the deck of the central tank No 1 and part of the central tank No 2 and during the towage of the burning wreck coastward, it broke into two parts. The bow part with two tanks lies at 490 m depth, while the main part (220 m of length) is situated at 75-78 meters depth 1.5 nm offshore Arenzano. Once spilled at sea, the oil products were exposed to a series of physical and chemical processes that determined their fate at sea. Some of the spilled oil was collected directly from the sea surface, some was washed ashore, another part spread out from the intervention area, and the remaining part sunk. The total amount of petroleum hydrocarbons that burned during the 70 hours following the first explosion, was estimated in the range 95,500÷103,500 tons while 3,000 tons are still trapped inside the wreck.



# 11/4/ '91 Arenzano, gulf of Genoa

## Explosion + 70 hour burning

### On board:

- 144,000 t of Iranian Heavy crude oil
- 1,500 t of bunker, diesel and lubricating oils

### Fate:

- 100,000 t burnt
- 14,500 ÷ 17,000 t evaporated
- 10,000 ÷ 50,000 t sunk
- 3,000 t in the wreck
- 2,000 t collected at sea
- 1,000 ÷ 1,500 t collected on the coast

# Gulf of Genoa Main Oceanographical Features

Ligurian-provençal  
current

Narrow  
Continental Shelf

Upwelling



# Gulf of Genoa Main Environmental Features

- Mediterranean Cetaceans Sanctuary



- *Posidonia oceanica* and *Cymodocea nodosa* meadows

# Emergency Phase

**While the HAVEN was burning, two important decisions were taken:**

- to allow the burning of the greatest part of the oil spilt at sea



- to tow the wreck shorewards

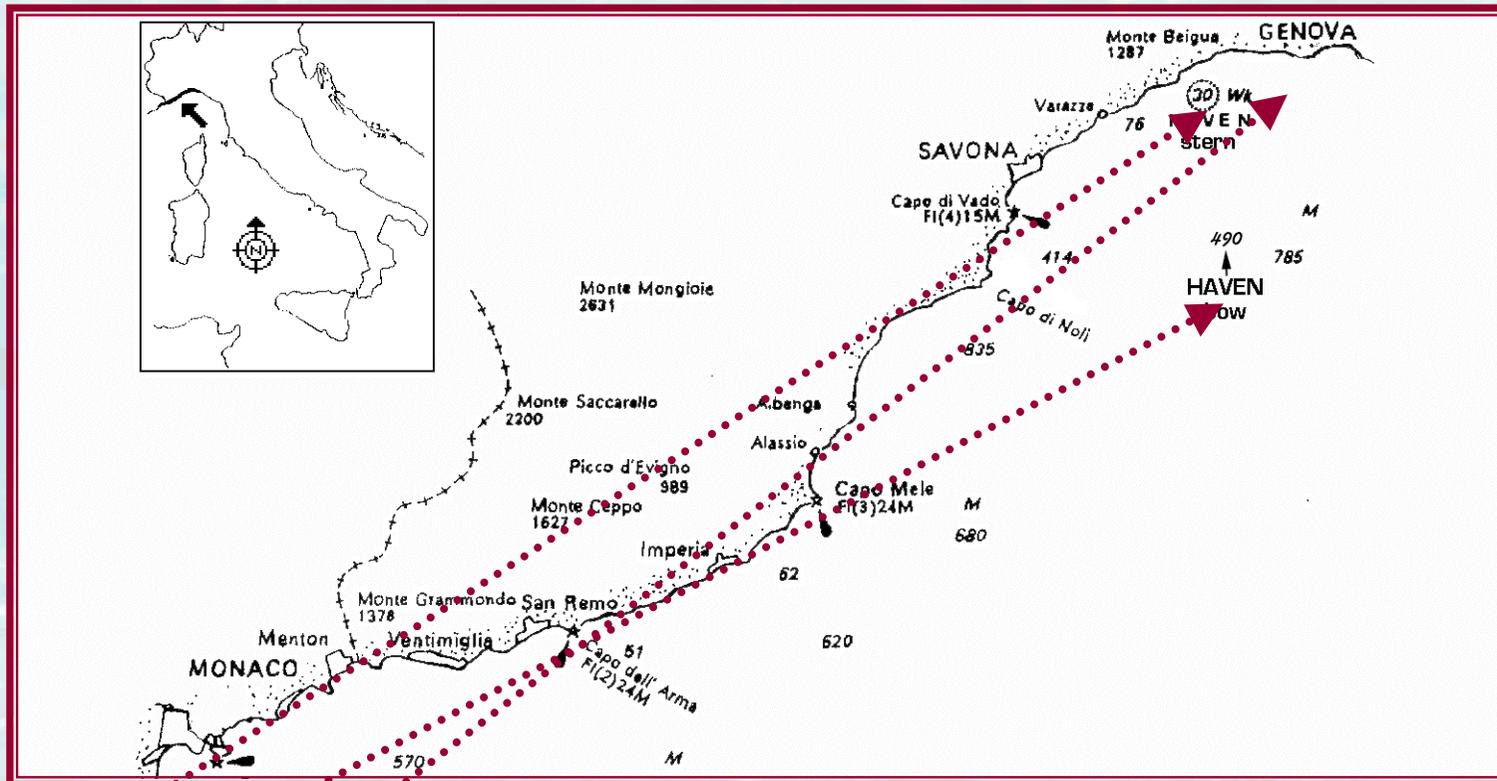
During the emergency phase, operations began in order to contain pollution. Many difficulties were encountered as most of the intervention teams were already involved in responding to the other accident occurred near Livorno twelve hours earlier. This phase of local emergency started at the moment of the accident and lasted until April 14<sup>th</sup> when the national emergency was declared.

In both phases, all the operations were co-ordinated by the commander of the *Capitaneria di Porto* (coast guard) of Genoa Adm. A. Alati; when the national emergency was declared, the National Emergency Committee appointed him as on-scene commander. Furthermore, a “crisis unit” was established at the Ministry of the Environment in order to take care, specifically, of the environmental aspects.

While the HAVEN was burning, two important decisions were taken:

- to allow the burning of the greatest part of the oil spilled at sea in order to contain the spreading of the product on the sea surface and the pollution on the coast. to tow the wreck shorewards, in order to prevent it from eventually sinking at depths where it would be extremely difficult to take any action and to contain pollution on the coast;
- to allow the burning of the greatest part of the oil spilled at sea in order to contain the spreading of the product on the sea surface and the pollution on the coast.

# The wreck broke into three parts



The stern sank at 75 m depth

The bow sank at 490 m depth

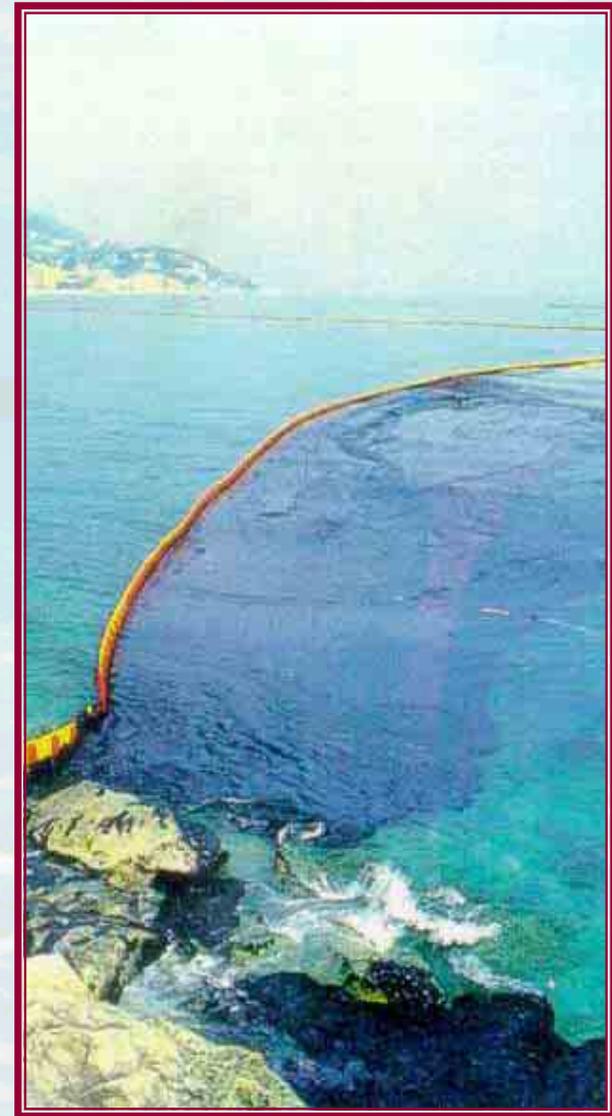
The deck of the central tank No 1 lies at 90 m depth

# Emergency Phase

The operations concerned:

- containment of the spilled products by means of booms;
- collection of the spilled products at sea by means of disc-oil skimmers;
- protection of harbours and of the coast from the black tide;
- waste disposal.

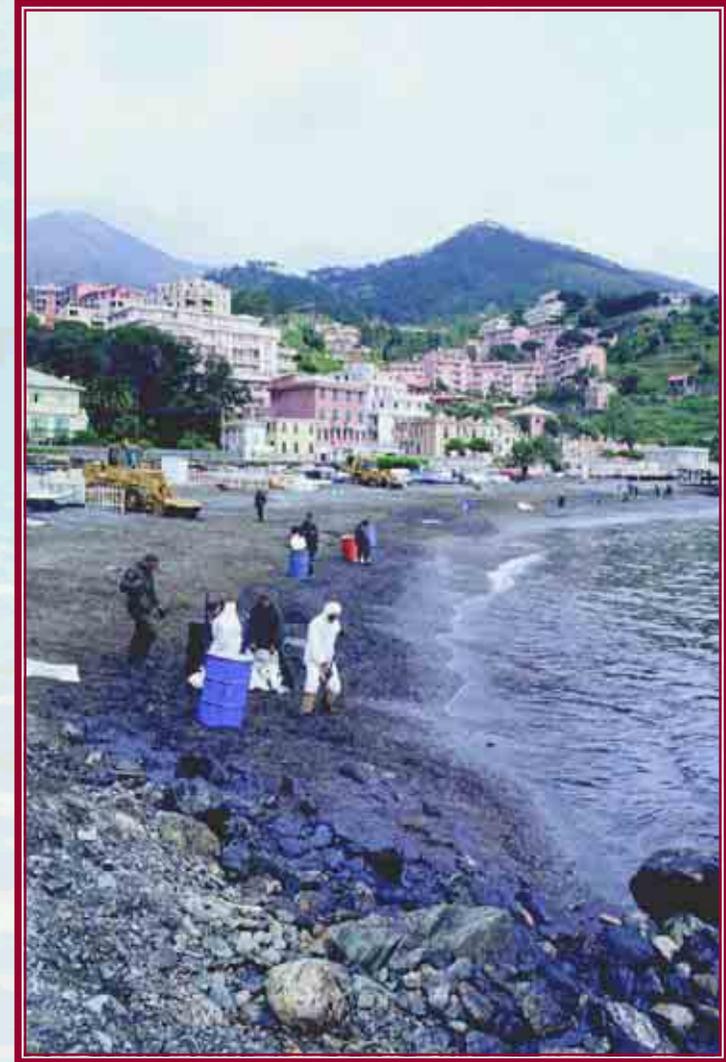
Dispersants were not utilised at all



# Emergency Phase

The operations concerned:

- collection of the spilled products on shore;
- recovery of oil residues from the near shore sea bottom;
- measures to stop the spilling of oil from the wreck (stern);
- removal of parts of the wreck.



## Safety measures

During the days following the accident a plan was elaborated in order to start the operations as soon as the emergency phase had ended (May the 22<sup>nd</sup>). The plan was divided into the following projects :

- Measures to safeguard the main part of the wreck. The wreck has been inspected and the liquid hydrocarbons leaking from it were collected by means of **suction skimmers** (this operation has been repeated three times until 1995, but the phenomenon has never been extinguished). The parts of the wreck that obstructed navigation were removed.
- Investigation of the seabottom near the “main” wreck by means of Side Scan Sonar, Sub Bottom Profiler and Remotely Operated Vehicle. The results indicated that the seabottom within 1,000-1,200 meters from the wreck was affected by tar depositions 10 cm thick, covering an area of 120,000 m<sup>2</sup>.
- Monitoring of air, sea water, sediments, beaches, rocky coasts, marine fauna and flora. A data base was set up for the information already available and for the information gathered by the control and monitoring plan.
- Clean up operations at sea. Oil residuals that were sunk within 10 meters depth were localised and removed. This operation resulted necessary as the depositions could have turned again into suspension and cause further pollution on land. Since there were no previous experiences for reclaiming such broad areas of the sea floor, several operative techniques were developed and tested to guarantee respect for the morphology of the sea floor and underwater flora and fauna. Manual recovery by divers was the most used method and the one that proved most flexible and successful, since it could be applied to all kinds of sea floor. Manual removal was supplemented by gathering with a specially adapted sort of steel “clam hook”. These activities were completed in August 1991 when 200 cubic meters of solid product were collected from the sea floor.
- Clean up operations on land. The stretches of coast interested by the presence of oil residuals were rather discontinuous. The work on beaches was mechanical with the pollutant oily layer removed with machinery and, in areas that were only slightly polluted, pollutant material was removed manually (tar balls, dirty stones, etc.). Along the rocky coast, breakwater and quays, the action was both mechanical and physical, with environmental temperature sea water cleaners. With this system the crude oil was removed by high pressure water jets, after protecting the working area with appropriate floating barriers. 91 km of sandy beaches, 5.7 km of rocky coast and 7.3 km of breakwater and quays were cleaned. Reclamation covered also 370 vessels anchored in the ports of Arenzano and Varazze. The operations started in May 25<sup>th</sup> and were substantially completed by the middle of July 1991. An emergency group worked until September 15, 1991 to meet cleaning needs for small re-deposits of hydrocarbon residues along the coast.
- Waste disposal. The material recovered offshore (an emulsion of crude oil residue and water) was stored in slop oil tanks. The processing consisted of separating the water from the hydrocarbon residues at Porto Petroli of Genoa Mulredo with a suitable mobile plant. The hydrocarbon residues were shipped to a refinery plant for additional processing, including dilution with crude oil, enhanced desalination, separation of pollutants, and finally recovered in the form of oil product.

The material from reclamation work on the coast and the sea floor was stored in a temporary storehouse located in Voltri and consisted essentially of stony material (sand, pebbles, gravel, etc.), bituminous residues, other material (including absorbent booms, wreckage, etc.). Most of the stony material was utilised as fill for the Voltri port while the other material was disposed in a landfill for special wastes or incinerated.

# Control and Monitoring

Control and monitoring of air, sea water, sediments, beaches, rocky coasts, marine fauna and flora

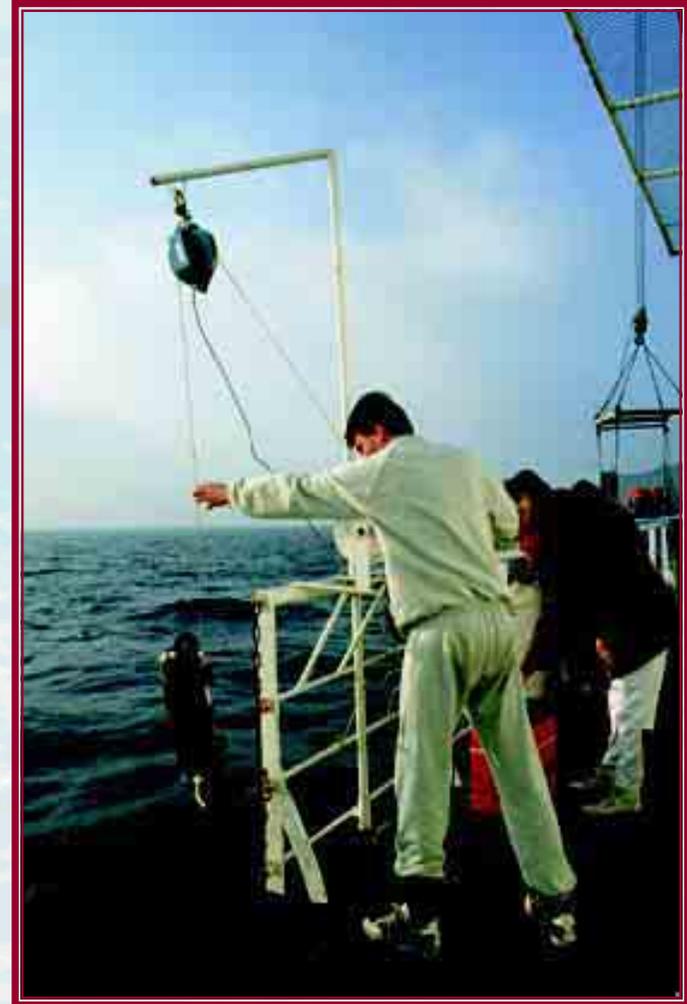
~ J Detection of burning products on land

~ J HAVECO: French-Italian control cruise

~ J Measurement of hydrological parameters (pH, salinity, O<sub>2</sub>, temperature, currents)

# Control and Monitoring

- ~ J Concentration of HC in water and of HC and PAHs in sediments and benthic organisms (filter feeders)
- ~ J Determination of chlorophyll "a", pheopigments and suspended matter
- ~ J Phytoplankton, mesozooplankton, benthos and demersal fauna assemblages



# Control and Monitoring

- J Mussel watch
- J Investigation of the sea-bottom near the wreck by means of S.S.S., S. B. P. and R. O. V.
- J Detection and fingerprinting of tar residuals
- J Socio-economic survey (tourism and commercial fishery)

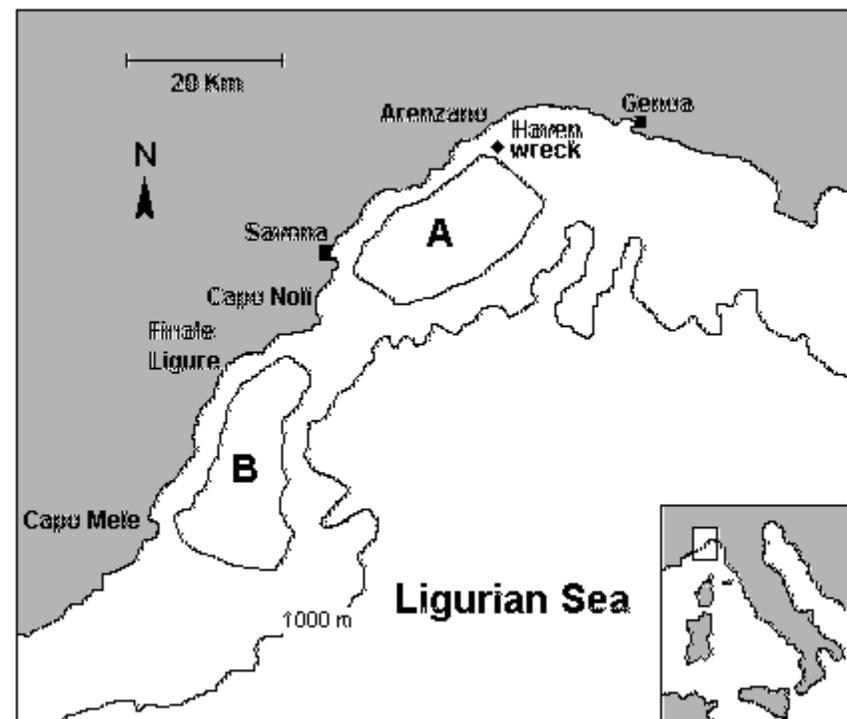
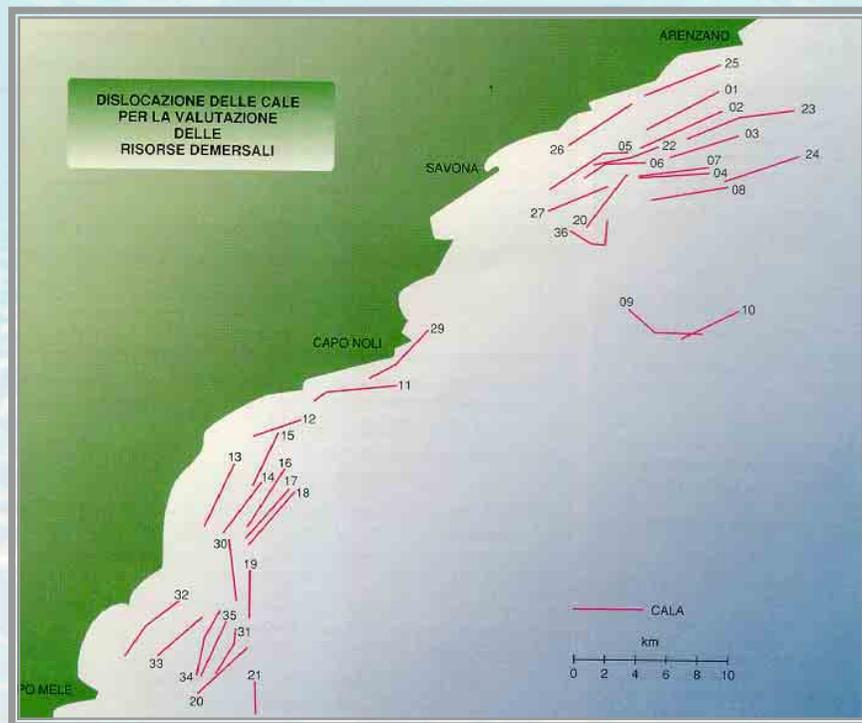
# Wreck Inspections



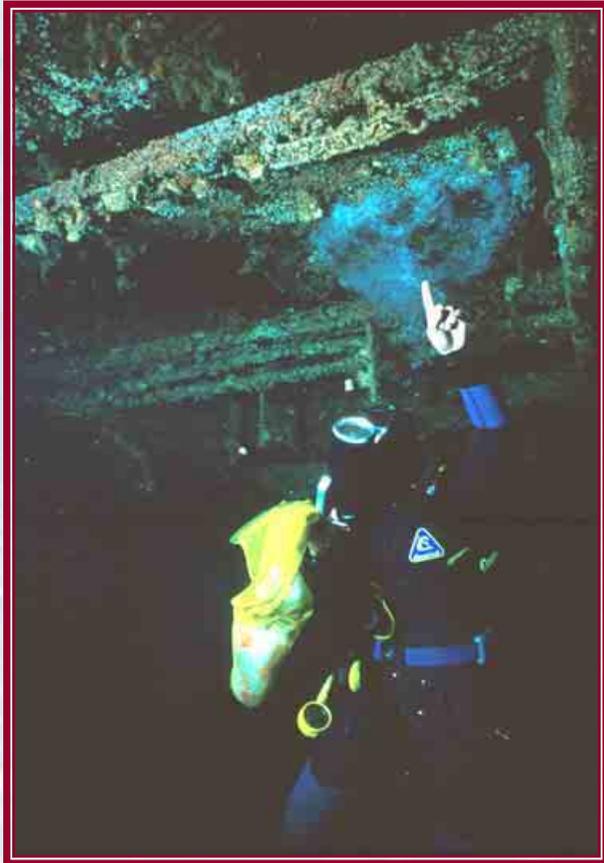
## Fouling Communities Monitoring



Demersal fauna was collected at 36 sampling stations by means of trawlers at depths in the range 50÷700m



# Long-term consequences



The oil residues into the wreck



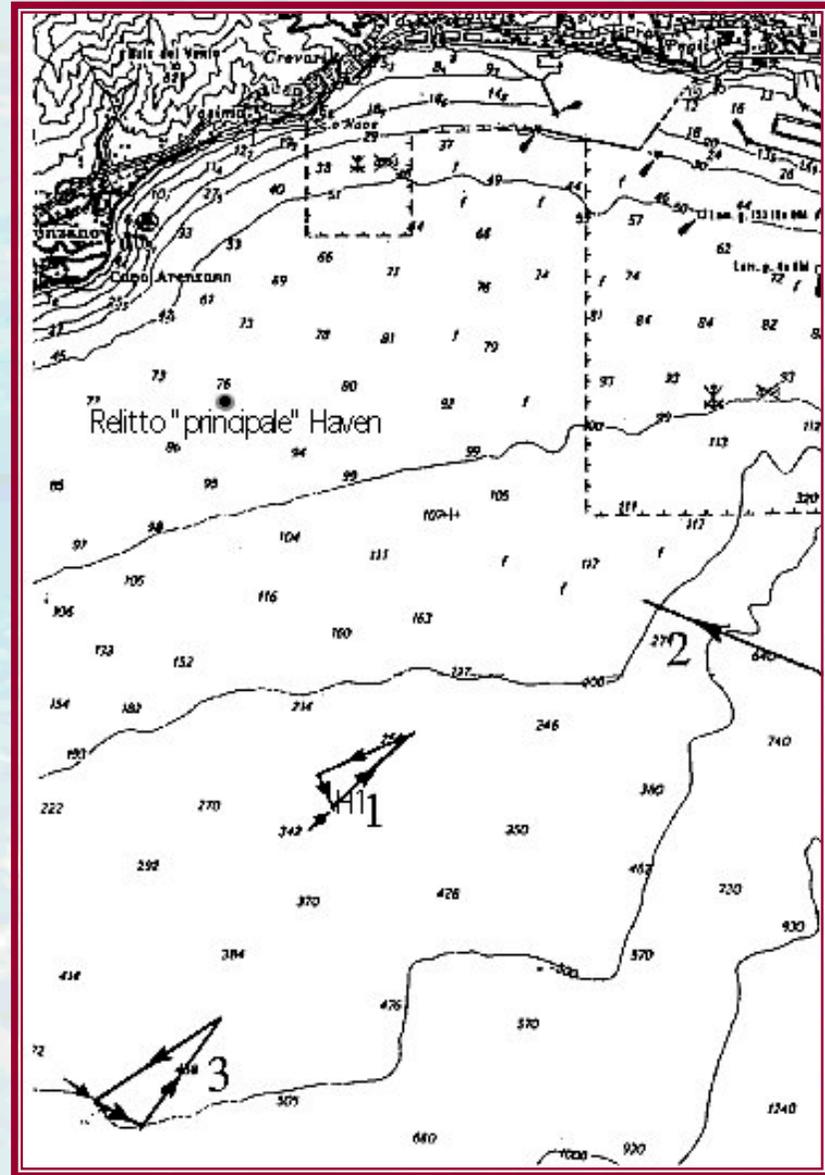
The burnt oil on the sea-bed



# Tar Depositions

Long-term consequence of the accident affecting fisheries and ecosystems



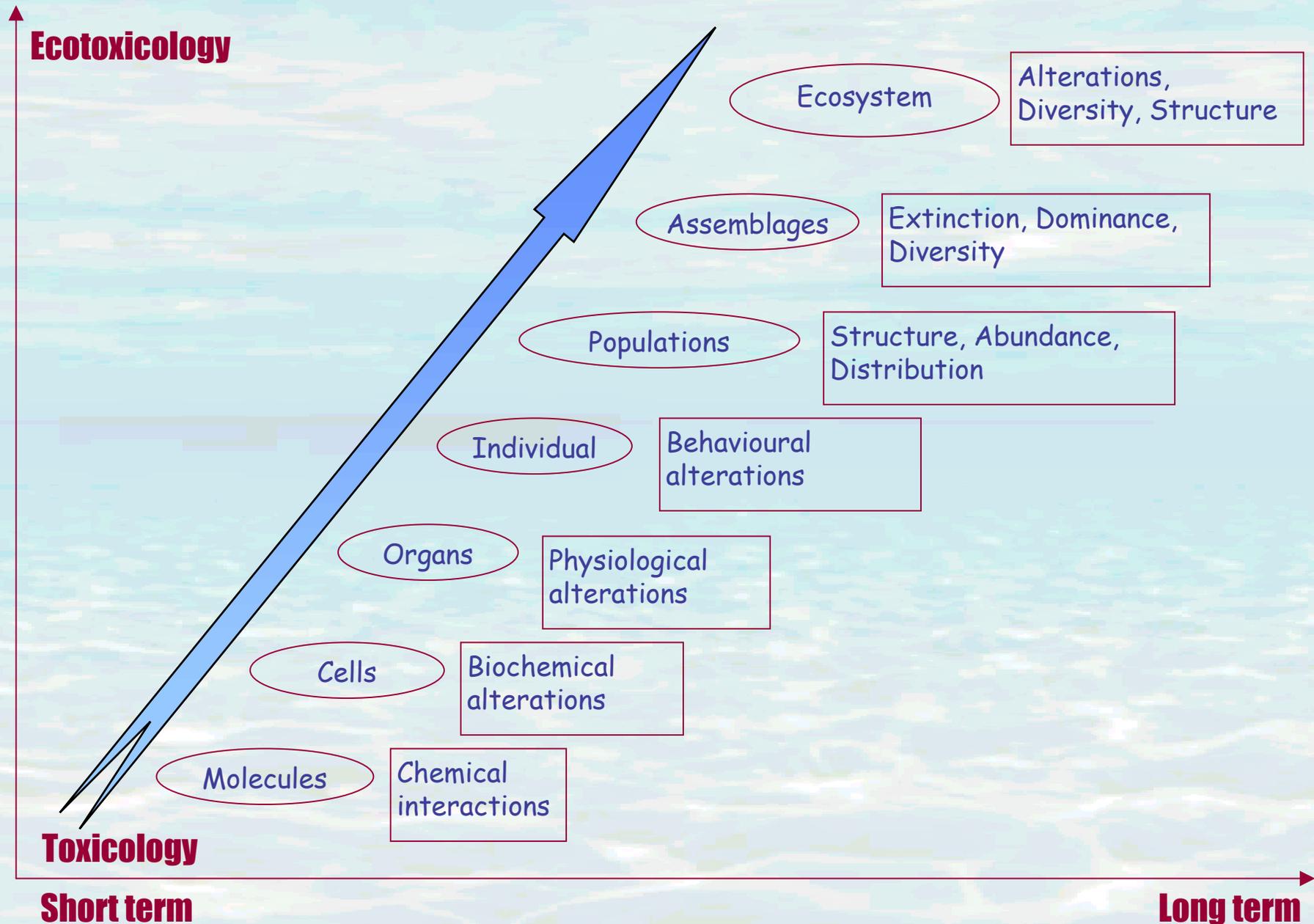


# Tar Depositions

10,000÷50,000 t of petroleum hydrocarbons have turned into tar deposition on the sea-bed

Need to assess: extension of the affected area, quantity, distribution, noxiousness, persistency

QuickTime™ and a Video decompressor are needed to see this picture.





# ECOLOGICAL EFFECTS

## Short-term

Immediate effects  
Generally cause the death of the organisms

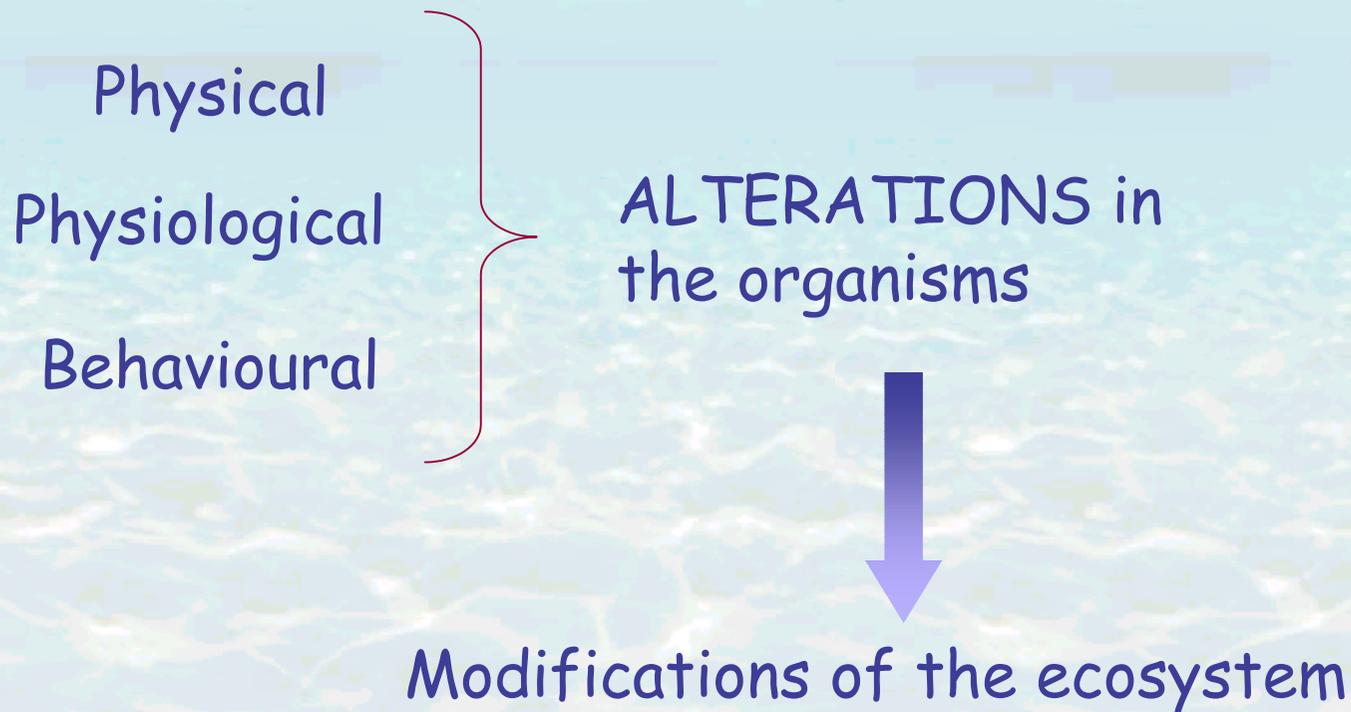


## Long-term

Delayed in time effects  
Chronic diseases  
Damage to genetic material  
Reproductive dysfunction  
Physiological alterations  
Decrease in biodiversity

# OIL SPILL

## Long-term effects





# Concentration of PAHs ( $\mu\text{g g}^{-1}$ d.w.) in four sub-samples (1= top) of a 30 cm sediment core taken during the CYACHUM '94 cruise (-350 m)

	1	2	3	4
Naphtalene	<0.001	<0.001	<0.001	<0.001
Acenaphtene	<0.001	<0.001	<0.001	<0.001
Phenanthrene	0.019	0.005	<0.001	<0.001
Anthracene	0.005	0.002	<0.001	<0.001
Fluoranthene	0.021	0.013	0.004	0.003
Pyrene	0.047	0.003	<0.001	0.001
Chrysene	0.079	0.014	<0.001	<0.001
Benzo[a]anthracene	0.037	0.005	0.004	0.003
Benzo[b]fluoranthene	0.087	0.019	0.005	0.004
Benzo[k]fluoranthene	0.027	0.004	<0.001	<0.001
Benzo[a]pyrene	0.041	0.006	<0.001	<0.001
Dibenzo[a,h]anthracene	0.003	<0.001	<0.001	<0.001
Benzo[g,h,i]perylene	<0.001	<0.001	<0.001	<0.001
Indeno[1,2,3 c,d]pyrene	<0.001	<0.001	<0.001	<0.001
<i>Total PAH's =</i>	<i>0.366</i>	<i>0.071</i>	<i>0.013</i>	<i>0.012</i>



**Concentration of PAHs ( $\mu\text{g g}^{-1}$  d.w.) in samples of tar deposition (H1) and contaminated sediments (“H3 1/2” and “H3 2/2”) collected, respectively, at 500 m and 340 m depth during the CYACHUM ‘94 cruise**

	<b>Carcinogenic properties</b>	<b>H1</b>	<b>H3 1/2</b>	<b>H3 2/2</b>
<b>Phenanthrene</b>	-	<b>6.0</b>	<b>2.8</b>	<b>0.5</b>
<b>Fluoranthene</b>	-	<b>8.0</b>	<b>1.7</b>	<b>0.3</b>
<b>Pyrene</b>	-	<b>15.8</b>	<b>3.1</b>	<b>0.6</b>
<b>Bz(b) Fluoranthene</b>	+	<b>4.7</b>	<b>0.6</b>	<b>0.1</b>
<b>Bz(k) Fluoranthene</b>	+	<b>4.6</b>	<b>0.4</b>	<b>0.1</b>
<b>Bz(ghi)perylene</b>	+	<b>2.6</b>	<b>0.1</b>	<b>0.0</b>
<b>Indeno(cd)Pyrene</b>	?	<b>3.3</b>	<b>0.2</b>	<b>0.1</b>

**In 1999, as a consequence of the agreement reached with the IOPCF (Law 239/'98), 16.4 M€ were made available to carry out studies, experiments and restoration interventions**

An agreement was signed among the Italian Ministry of the Environment, ICRAM and the Ligurian Region in order to carry out, through public call for tenders, a restoration and experimentation project worked out by ICRAM and validated by the main Italian scientific and technical institutions

# Environmental Restoration according to the Italian Law No 471/1999

“The activities aimed at to eliminate pollutant substances and sources or at to reduce pollutant concentration in soil, underground and superficial waters to levels equal or below the acceptable limits”.



# **The ICRAM project indicates the questions that need a response and the objectives to be reached on four topics:**

- **Removal of liquid oil residuals inside the wreck (1.5 M€)**
- **Experimental removal of tar depositions from deep sea-bottom (11.8 M€)**
- **Restoration of *P. oceanica* meadows (1.8 M€)**
- **Data base, control and monitoring (1.3 M€)**

**...because**

**«~~A~~the sea-bottom affected by the HAVEN accident are still polluted by thousands of tons of oil residuals that are likely to be a source of cancerogenic, mutagenic and teratogenic molecules... »**

**...knowing that**

**«the foreseen restoration and clean up activities  
imply the availability of knowledge,  
methodologies and instruments to be adapted  
or set-up»**

**...but also taking into account that**



**Environmental restoration will never lead the ecosystems back to the previous conditions**

The End