Defending Our Mediterranean

The Mediterranean:

From crimes to conservation

A call for protection



July 2007

GREENPEACE
MEDITERRANEAN

The Mediterranean:

From crimes to conservation

A call for protection

Prepared by:
David Santillo,
Greenpeace Research Laboratories,
University of Exeter-UK,
Ghalia Fayad,
Greenpeace Mediterranean- Lebanon.

"Greenpeace is committed to defending the health of the world's oceans and the plants, animals and people that depend upon them."

Defending Our Mediterranean

Content

© Greenpeace/Oerlemans

© Greenpeace/Gleizses

Executive Summary

The oil spill of July 26th 2006 from a power station oil storage facility at Jiyeh in Lebanon was on a large scale. It has been estimated that more than ten thousand tons of oil were released following damage inflicted between the 13th and 15th of July 2006. Subsequently, around two thirds of the Lebanese coastline was affected. Although clean-up operations have been ongoing since the spill, very little information exists concerning the lasting impacts of this spill on marine ecosystems in the area.

As part of the Greenpeace commitment to the Mediterranean Sea, this report presents data derived from a scientific research project designed to contribute to the evaluation of residual contamination of biological samples with oil and oil-related chemicals one year after the bombing of the Jiyeh facility. The study analyzed oysters from sites on the Lebanese coast known to have been contaminated by the spill as well as from sites which were not impacted by this particular spill.

One year on, seriously oil-contaminated sites can still be located, particularly between Jiyeh and Beirut. Data from Greenpeace's scientific study confirm that oysters from sites immediately to the north of Jiyeh, in the direction of the prevailing currents, contain higher levels of oil-derived chemicals than sites further north and, in particular, sites in the south, with the highest recorded levels at Ras Beirut. However, the overall concentrations (of total hydrocarbons and PAHs) found in this study are in the lower range of those reported for shellfish impacted by oil spills in other parts of the world, suggesting that the lasting impacts of the Jiyeh spill may not be as widespread and severe as it was feared they could be. Furthermore, although it is likely that the Jiyeh spill has contributed to the higher levels of contamination recorded in oysters from Ras Beirut, contribution from other, more localized and ongoing sources of oil pollution from both land and sea-based discharges cannot be ruled out and should be investigated further.

Despite the absence of very severe oil contamination of the oysters sampled in this study, the data provide only one part of the overall picture. Importantly, they do not on their own provide any assurance that Lebanese waters are generally of good quality, nor that marine resources from all locations along the affected coastline are safe for human consumption. More extensive scientific studies, investigating the wide variety of sources of chemical contamination along the Lebanese coastline, remain an urgent priority for the environmental protection authorities in Lebanon.

In the experience of Greenpeace and through the information provided in other studies across the Mediterranean region, it is clear that a wide range of human activities are contributing to pollution of the Mediterranean and overall environmental degradation. These include discharge of untreated or poorly treated industrial and municipal wastewaters, poorly managed solid waste, intensive coastal development, destructive fishing techniques, poorly managed or unmanaged fishing activities and introduction of alien species. In addition this picture is further complicated by the specter of future climate change.

Accordingly, although this current study provides a unique and valuable data set in its own right, it nonetheless points to the need for a wide ranging and comprehensive evaluation of marine pollution and polluting activities to be carried out for this area of the Mediterranean. In turn this would allow a scientific assessment of the state of the marine environment to be urgently carried out.

In order to protect the rich and diverse Mediterranean marine environment from further degradation and to allow recovery of degraded ecosystems, human activities need to be managed in a holistic way. This implies that the future management should be based on the whole ecosystem with designated marine reserves as a keystone of this ecosystem approach.

Greenpeace believes it is now essential that a network of marine reserves covering around 40% of the Mediterranean Sea is established, including Lebanese waters, protecting its marine life in all forms for the present and future generations to come.

1. Oil Spill in the Eastern Med

"Civilian casualties, the displaced and the dispossessed, will and should be the focus of our attention during and immediately after hostilities cease. But the environment, which has a key role in ensuring the stability of a country and its citizens, cannot be ignored. The world is slowly waking up to the powerful links between a healthy environment and national and regional stability, or to use the buzz phrase 'environmental security'."

Klaus Töpfer,
Executive Director of the United Nations Environment Program,
November 2003 (UNEP 2003).

A. Silent Victims of War

Ordinary people, wildlife and the environment are the witnesses to war, and are its silent victims

In 2001, the UN declared that 6th November of each year would be an International Day for Preventing the Exploitation of the Environment in War and Armed Conflict. This action taken by the UN highlights the fact that damage to the environment in times of armed conflict can impair ecosystems and natural resources long after the period of conflict, often extending beyond the limits of national territories and the present generation. There are many examples of severe damage to the environment as a consequence of war and this also often impacts on people's lives.

Unfortunately, the Gulf Region provides many examples of such damage, for example the 2 million barrels of oil that leaked into the Gulf and washed up along the shores of Saudi Arabia, Bahrain and Qatar during the Iran-Iraq War in 1983. Again during the 1991 Gulf war an estimated 1500 million liters of oil were released into Gulf waters (UNEP 2002) causing the world's largest oil spill (Price 1998). Much of the oil that wasn't recovered was washed ashore and contaminated over 700 km of coastline. The intertidal zone was heavily impacted (Abuzinda and Krupp 1994), including severe damage to mangroves and saltmarshes (Böer 1993), and it was estimated that at least 30,000 marine birds perished due to oil exposure (Gerges 1993). In addition to this ecological disaster, Iraqi troops also set fire to more than 600 oil wells in several of Kuwait's oil fields, fires which took up to 8 months to extinguish completely (UNEP 2002) leading to immediate respiratory problems within local populations (Greenpeace 2003). Finally during the 2003 War in Iraq, the Tuwaitha nuclear facility, 20 kilometers south of Baghdad, was bombed and subsequently looted. In the midst of armed conflict, barrels containing low-level uranium ore concentrate were stolen, emptied and sold to the local population for storage usage.

In response to this disaster, Greenpeace sent a mission to Iraq in June 2003 to evaluate the extent of radioactive contamination in the area and called for the US and UN to take immediate action to secure and clean up the site (Greenpeace 2004). A warning that resulted in action by the International Atomic Energy Agency only in 2006 to clean up the site within an area contaminated by radioactive residues and ruins (IAEA 2006).

On 12th July 2006, war broke out in the Middle East. The conflict persisted for 32 days until a

ceasefire came into force on the 14th August 2006 based on the UN Resolution 1701. The war claimed the lives of more than 1,100 people in Lebanon, mostly civilians, and more than 150 people in Israel, the majority of whom were soldiers (BBC News 2006a and 2006b).

In addition to human suffering and loss of life, in any armed conflict the environment is also a victim of war. Long after the bombing and gunfire have ceased, humans and wildlife continue to bear the consequences of the damage inflicted on both the natural and built environment, which in some instances may be practically irreversible.

Whether deliberately targeted or hit unintentionally by munitions, damage to infrastructure inevitably occurs, including to industrial facilities and utilities such as power stations, fuel storage depots, water treatment plants and waste storage or disposal facilities. Damage to such facilities can act as significant point sources of hazardous chemical pollution as a consequence of spills, leaks or fires. In this recent conflict, many factories and industrial facilities were damaged potentially exposing people in surrounding areas to hazardous chemicals. In addition to this infrastructural damage, there were widespread impacts on the natural environment, amongst others, a major oil spill on the Lebanese coast.

On the 20th of December 2006, the International community expressed its deep concern through the General Assembly Resolution 61/194, considering that "the oil slick has heavily polluted the shores of Lebanon and consequently has serious implications for human health, biodiversity, fisheries and tourism, all four of which in turn have serious implications for livelihoods and the economy of Lebanon".

The oil spill was probably the most visible environmental impact of the war, resulting in both short and long term threats to the coastal marine environment, and one the biggest environmental catastrophes in the Eastern Mediterranean Sea.

In addition, implications for society were enormous since tourism and recreation are some of the major economic activities for the country, as well as the deep impacts on fishing communities. Both the tourist industry and fishing communities have been badly affected by the oil spill.

In Lebanon, about 60% of the tourist industry depends on sea related activities. The conflict itself impacted the tourist industry due to cancellation of holidays by Lebanese and foreign tourists, but even after the conflict, oil contamination of beach resorts has led to a reduction in visitor numbers. The Lebanese ministry of tourism has estimated that the tourist sector lost 3 million US dollars because of the war (Heinrich Böll Foundation 2006).

The Food and Agriculture Organization of the United Nations revealed in its post-war assessment report (FAO 2006) that the fishing community suffered enormously from the effect of the war, both directly as a result of hostile action and indirectly from loss of income caused by the conflict and its after-effects since the war broke out during the peak fishing season, as 42% of the catches are in the summer, and impacts continued due to the subsequent reduction in demand. The same report has estimated the emergency assistance for the early recovery of the fishing communities at 1,344,750 USD.

A destroyed plastics factory near Tyr

B. The July 2006 Oil Spill

The spill occurred as a result of the bombing by Israeli missile attacks on fuel tanks at the Jiyeh power station 30 kilometers south of Beirut, causing the leakage of 12,000 to 15,000 tons of fuel oil into the Mediterranean Sea. Unfortunately, clean-up operations were delayed for five weeks due to the conflict, during which time the oil contamination spread over 150 km of the Lebanese coastline, reaching the Syrian coastline in the north (Heinrich Böll Foundation 2006, REMPEC 2006c).

On 13th July 2006 a fuel tank at the Jiyeh power plant was hit by munitions from the Israeli military and started burning. Fortunately, civil defense forces managed to contain the fire. However on 15th July, another fuel tank was hit resulting in about 2,000 tons of oil being burned during several days (releasing fumes to the atmosphere) and another 10,000 to 13,000 tons of oil being spilled into the sea. Another tank also caught fire and spilled 1,000 to 2,000 tons of oil. After that, the fires were contained and sand dune barriers were built around the tanks to prevent further losses of oil to the sea (REMPEC 2006a).

The type of oil spilled was medium/heavy oil that can be compared to IFO 150 (REMPEC 2006b). After the spill, the oil was partly carried out to sea and partly dispersed north east along the coast of Lebanon through the combined action of winds (blowing primarily from the south west) and water currents. By the 21st July, the area affected by the spill was reported to extend 20-30 km north of the spill site; three days later it had spread to 70 to 80 km north of the source. By the first week in August the Lebanese Ministry of the Environment reported that the spill had spread over at least 140 to 150 km of Lebanon's coastline (REMPEC 2006c).

A major fraction of the spilled oil emulsified and solidified along the shore, clinging to sand, rock and stone. Oil that remained on the water was more fluid, but it rapidly dried into a tarry residue once it was left on the beach (Greenpeace 2006d). Surveys of the coastline conducted between 18th July and 3rd August identified 21 sites impacted by oil, representing a total length of 19.2 km of coastline including sites comprised of sand, rocks, gravel and pebbles (REMPEC 2006d). An initial assessment of the contamination of the shoreline by IUCN (The World Conservation Union) found that some sandy beaches and rocky shorelines were extremely contaminated, others were moderately so, while others were contaminated lightly or

Oil at Byblos port

not at all. Over parts of the shoreline, the oil was reported to be up to 50cm deep (Steiner 2006). Aerial surveys conducted on the 28th and 29th of August confirmed oil pollution on the coast at Jiyeh, between Jiyeh and Beirut, from Beirut to Tripoli and at Palm Island (REMPEC 2006g) in the north.

In addition to contamination of the coastline, the seabed near to the Jiyeh power station was found to be smothered by sunken oil. Greenpeace alerted authorities and the public to the presence of this seabed oil contamination by releasing film footage taken by Mohamed El Sariji, chairman of the Professional Lebanese Divers Union, depicting the underwater slick in an area close to the Jiyeh power plant (Greenpeace 2006a, REMPEC 2006e). Subsequent underwater investigations by the team of Italian experts confirmed El Sariji's findings (conducted for the local NGO 'Bahr Loubnan') of large quantities of oil on the seabed around the Jiyeh power plant and in Byblos (REMPEC 2006f). Greenpeace worked with an Italian team of experts and Bahr Loubnan to help map the oil in preparation for clean-up operations (Greenpeace 2006b). At sea, aerial and boat surveys conducted on August 28th and 29th reported that there were no oil slicks floating at sea (REMPEC 2006g) and hence no oil recovery operations at sea were needed.

As part of the International mitigation efforts, Greenpeace took part in several operations upon the request of the Lebanese Ministry of Environment (MoE) until October 2006.

Sunken oil off Jiyeh

Greenpeace efforts were conducted in coordination with the Oil Spill Operations and Coordination Centre (OSOCC), the Lebanese Navy, French, German and Danish experts collaborating with the MoE, the Agency for Environmental Protection and Technical Services of Italy (APAT), the Central Institute of Marine Research (ICRAM) of Italy, the American University of Beirut (AUB) and local NGOs including Bahr Loubnan.

This collaboration involved beach clean up operations with Greenpeace volunteers, under the supervision of experts assigned by the MoE, as well as various operations conducted by Greenpeace's divers, crew and teams onboard the Rainbow Warrior for the monitoring of the seafloor and the collection of biological samples according to a plan agreed with experts of APAT/ARPA and ICRAM during the second half of September 2006 (APAT 2007).

On the coast, the initial impacts of the oil spill on wildlife were clearly evident. The IUCN reported after the spill that:

"thousands of fish and other living species are found dead on shores everyday" (IUCN 2006a).

In August, an IUCN mission to Lebanon noted that seabirds and early migrating bird species such as curlews and plovers had been contaminated with oil during the preceding few weeks (IUCN 2006b). Commenting on the disaster, the former Lebanese Environment Minister, Mr. Yaacoub Al Sarraf, said that:

"The turtles are hit, the dolphins are hit, the urchins are hit, the corals are hit. We are facing a major ecosystem failure" (McClatchy Newspapers 2006).

In Lebanon, on Palm Islands Nature Reserve off the coast of Tripoli, the IUCN reported that algae, and other organisms on which fish and turtles feed, had been killed. The reserve provides habitat for 156 bird species, including migratory species that depend on the waters that had been contaminated by the spill. The IUCN commented that the oil film on the seawater at the reserve site put endangered loggerhead turtles at risk as they come up to the surface to breathe. Their nesting beaches were also contaminated (IUCN 2006b). Exposure of hatching baby turtles to oil on beaches could kill them as well as having longer-term impacts on their health such as cancers and physiological and reproductive impairment (Steiner 2006).

The Rainbow Warrior facing the Jiyeh Power Plant

Generally, marine ecosystems in Lebanese waters have a high biodiversity and there is a particular concern for the impact on reef communities. It is also possible that much of the mortality of marine animals may have gone undetected due to the conflict and air/sea blockade in operation at the time. In most spills it is generally accepted that only about 12-20% of the true mortality of sea birds is known, the remainder being lost at sea. After the oil spill and based on the fact that there is a yearly north-south migration of about 300 bird species through the coastal zone of Lebanon in September/October, Dr. Rick Steiner, an IUCN expert, estimated that some of them might been exposed to oil residues remaining on the shoreline (Steiner 2006).

Sunken oil on the seabed was found near the Jiyeh power station and in Byblos. Commenting on this seabed pollution around Jiyeh at that time, Mohamed El-Sariji, chairman of the Professional Lebanese Divers Union, said:

"The scenery down there is terrifying, everything is covered by this black slick, and it will threaten maritime life over years to come" (Heinrich Böll Foundation 2006).

Lebanese divers collecting underwater oil

2. Many threats to our Sea

A. The impact of the oil spill

Given the scale of the oil spill resulting from the bombing of the power plant at Jiyeh in July 2006, there is a clear interest in determining the levels of pollution of Lebanon's coastal marine environment with oil-related chemicals. For this reason, in addition to gathering video and photographic documentary evidence for the persistence of the spill in some areas, Greenpeace conducted a scientific study to determine levels of oil and related chemical contamination in oysters collected from six key locations (two to the south of Jiyeh and four to the north) approximately one year after the spill.

Initial screening analyses conducted by researchers at the American University of Beirut (AUB) using ELISA (enzyme-linked immunosorbent assay) techniques indicated that oysters may have accumulated higher levels of oil-related contaminants than some common fish species in the region (Barbour et al. 2007, unpublished), perhaps a consequence of their sedentary and filter-feeding habit. Similar findings have been reported previously for bivalves in areas impacted by oil spills (e.g. Law et al. 1999). Given their widespread presence along the length of the coast of Lebanon, oysters may therefore provide valuable indications of the distribution of contaminants which may have arisen from the oil spill.

In addition to hydrocarbons (including the toxic and persistent polycyclic aromatic hydrocarbons, or PAHs) which may be most commonly associated with spills and/or discharges of oil, there are concerns that the destruction of electrical transformers on the Jiyeh site could have resulted in the release of significant quantities of the chlorinated chemicals PCBs (polychlorinated biphenyls) to the marine environment. These highly toxic, persistent and bioaccumulative chemicals have been phased out of production and use worldwide for many years, but there is some evidence to suggest that they may still be present in certain

© Greenpeace

Collecting oyster samples - Ras Beirut

older pieces of electrical equipment which remain in use in some countries. In addition to analysis for total hydrocarbon content and a range of PAHs, therefore, the oysters collected in this study were also analysed for the presence of PCBs.

In addition, separate samples of oysters were collected from each location for analysis by AUB to determine concentrations of certain heavy metals which can be associated with oil spills (vanadium, nickel and lead). These results are noted below but are expected to be published elsewhere in more detail.

Materials and methods

A total of six sampling locations along the coast of Lebanon were selected for this study, based on those investigated in the screening study conducted by AUB and spanning a distance from 48km south to 78 km north of Jiyeh. These locations are described in Table 1 below.

Location	Sampling date	Sampling coordinates	Approx. distance from jiyeh (km)	Sample codes
Sour/Tyr	10/05/07	33° 17.438' N 35° 12.469' E	48 km South	LB07007-009
Sarafand	10/05/07	33° 28.388' N 35° 16.242' E	24 km South	LB07013-015
Ras Beirut	11/05/07	33° 53.579' N 35° 27.855' E	30 km North	LB07004-006
Tabarja	11/05/07	34° 01.093' N 35° 37.277' E	58 km North	LB07016-018
Amchit	12/05/07	34° 07.729' N 35° 38.209' E	72 km North	LB07001-003
Barbara	12/05/07	34° 12.181' N 35° 38.060' E	78 km North	LB07010-012

Table 1: Locations of the six sites from which triplicate samples of oysters were collected

During 10-12th May 2007, approximately 300 days after the spill, a total of 15 wild oysters (Ostrea edulis) were collected from each of these locations, comprising three distinct replicate samples of five individual oysters from each of the six sites. All samples were wrapped in clean aluminium foil, placed in polyethylene bags and frozen within a few hours of collection, before being shipped by courier to the Greenpeace Research Laboratories at the University of Exeter (UK).

On receipt at the Greenpeace laboratories, the samples were checked, each replicate of five oysters assigned a unique sample code, and all samples dispatched to the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in Burnham on Crouch (UK) for total hydrocarbon, PAH and PCB analyses.

The soft tissues of the five individual oysters representing each sampling location were combined to make a single homogenous composite sample in each case (i.e. a total of 18 composite samples, representing triplicate samples from each of the six sample sites). For hydrocarbon analyses, homogenised composites were subjected to alkaline saponification followed by solvent extraction and alumina chromatography column clean-up before concentration of extracts to 1ml and instrumental analysis. Sub-samples were prepared for PCB analysis by mixing with anhydrous sodium sulphate and Soxhlet extraction with n-hexane/acetone, before clean-up and fractionation using partially deactivated alumina and silica column chromatography using. Total hydrocarbon (THC) concentrations were determined using UV-fluorescence spectrometry (a semi-quantitative measure, Law et al. 1999), while PAH and PCB concentrations were determined using coupled gas chromatography/mass spectrometry (GC/MS) and gas chromatography/electron capture detection (GC/ECD). Further details of the analytical methods employed can be provided on request.

Results and discussion

Total hydrocarbon concentrations for oysters at all six sites are presented in Table 2 (4th column). THC levels were higher in oysters from Ras Beirut (30km north of Jiyeh, 58-66 mg/kg fresh weight) than at all three sample sites further north (Tabarja, Amchit and Barbara, between 57 and 78km north of Jiyeh, and with concentrations in the range of 16-26 mg/kg). However, lowest levels of hydrocarbon contamination were found in oysters collected from the two sites sampled to the south of Jiyeh, at Sarafand (24 km south, 6.6-9.9 mg/kg) and Tyr (48 km south, 4.8-6.0 mg/kg). Given the prevailing northerly current along the Lebanese coast, it seems likely that the Jiyeh spill has at least contributed to the observed patterns of hydrocarbon contamination, though

Location	Approx. distance from Jiyeh (km)	Sample codes	Total Hydrocarbones (THC),mg/kg fresh weight (parts per million)	Sum EP A 16 PAH's, ug/kg fresh weight (parts per billion)
Sour/Tyr	48 km South	LB07007	6.0	8.4
		LB07008	4.8	8.9
		LB07009	5.1	9.3
Sarafand	24 km South	LB07013	6.6	10.5
		LB07014	9.9	13.8
		LB07015	9.5	14.6
Ras Beirut	30 km North	LB07004	66	39.4
		LB07005	58	50.1
		LB07006	62	55.6
Tabarja	58 km North	LB07016	19	27.7
		LB07017	24	18.4
		LB07018	19	22.4
Amchit	72 km North	LB07001	16	15.0
		LB07002	16	13.6
		LB07003	26	23.1
Barbara	78 km North	LB07010	21	15.6
		LB07011	22	10.6
		LB07012	12	15.4

Table 2: Concentrations of total hydrocarbons (THC, mg/kg or parts per million) and key PAHs (EPA 16, ug/kg or parts per billion) in the soft tissues of oysters

the potential significance of more localized and perhaps ongoing sources of oil pollution, especially regular discharges and spills from shipping in the vicinity of Beirut, cannot be ruled out. Bivalves such as oysters and mussels are capable of accumulating far higher (10 to 100 times) body burdens of oil than those recorded here during and immediately after major oil spills (e.g. Law et al. 1999), but these levels can reduce quite rapidly over time (weeks to months) if the source of oil inputs to surrounding waters is removed.

Initial data on the presence of the most toxic and persistent hydrocarbons, the PAHs (polycyclic aromatic hydrocarbons, final column of Table 2), also point to greater contamination in oysters from Ras Beirut (39-55 ug/kg fresh weight, calculated as the sum of the so-called EPA 16 PAHs) than at stations further north or south. PAHs can arise from a variety of sources, especially from oil spills (petrogenic) and from combustion processes (pyrogenic). Overall concentrations recorded at all sites in this study are at the lower end of the range relative to those measured in other parts of the world impacted by major oil spills (Webster et al. 1997, Law et al. 1999) or industrial sources (Law et al. 2002, McIntosh et al. 2004), which can sometimes reach several thousand ug/kg fresh weight. Even at Ras Beirut, concentrations of the most toxic PAHs, such as benzo[a]pyrene, were consistently lower than the 15 ug/kg fresh weight 'pragmatic guideline limit' value assumed to provide protection for the health of consumers in the UK and elsewhere (McIntosh et al. 2004).

Nevertheless, the pattern of PAHs present in these oysters from Lebanon (with a predominance of low molecular weight and, especially, alkylated forms, see e.g. Devier et al. 2005) do strongly suggest contamination from petrogenic sources in this case. Indeed, if the alkylated PAHs typical of crude or partially refined oils (such as dimethyl naphthalene, dimethyl phenanthrene and methyl chrysene) are included in the calculations, the total PAH levels would be somewhere between 2 and 10 times higher than the values reported in Table 2. More detailed 'fingerprinting' of samples of the oil spilled from Jiyeh and comparison with the PAH profiles recorded in the oysters would be necessary in order to distinguish for certain between the contribution to overall tissue contamination from the Jiyeh spill and that arising from a more localized background of oil pollution from shipping and other Tissue concentrations of PCBs are presented for all six sites in Table 3, reported as the sum of the so-called ICES 7 PCBs (CB congeners 28, 52, 101, 118, 153, 138 and 180).

A waste dump in the sea off Akkar

Overall, analysis for PCBs reveals levels of contamination more typical of background sources of these pollutants (Devier et al. 2005), rather than a substantial localized point source. Sampling sites north of Jiyeh (especially Ras Beirut and Tabarja) showed generally higher levels of PCBs than those to the south, but these differences cannot be linked definitively to any release of PCBs from the Jiyeh facility. Further work would be needed if possible ongoing point or diffuse sources of PCBs and other persistent organic pollutants to the coastal waters of Lebanon were to be identified.

Analysis conducted by AUB of oysters collected from the same six locations for the heavy metals lead, nickel and vanadium reveal some interesting, but so far unexplained, spatial and temporal trends in contamination (Barbour et al. 2007, unpublished), trends which warrant further investigation in order to determine the significance of both point and diffuse sources of pollution. These results are expected to be reported elsewhere in due course.activities, especially in the vicinity of Beirut itself.

Location	Approx. distance from Jiyeh (km)	Sample codes	Sum Ices 7 PCBs, mg/kg fresh weight
Sour/Tyr	48 km South	LB07007	0.50
		LB07008	0.50
		LB07009	0.44
Sarafand	24 km South	LB07013	0.89
		LB07014	2.97
		LB07015	1.87
Ras Beirut	30 km North	LB07004	4.84
		LB07005	6.09
		LB07006	4.64
Tabarja	58 km North	LB07016	6.66
		LB07017	5.01
		LB07018	5.18
Amchit	72 km North	LB07001	2.91
		LB07002	2.36
		LB07003	3.30
Barbara	78 km North	LB07010	3.44
		LB07011	3.14
		LB07012	2.68

Table 3: Concentrations of PCBs, expressed as the sum of the ICES 7 PCB congeners, in the soft tissues of oysters

Conclusions

This current study, although providing a unique and valuable data set in its own right, is just one small part of the overall picture of levels of marine pollution in Lebanon. More detailed data on the presence of PAHs and PCBs will emerge from the study in due course. It is important to remember, however, that while focusing on one sentinel species at six locations can give a very useful picture of the distribution of the contaminant groups studied, these data alone do not give assurances that Lebanon's waters are relatively free from all types of contamination and therefore safe to swim in and eat fish and shellfish from. Since there is a lack of baseline information, this study cannot provide a picture of the extent to which levels of contamination may have changed since before the July 2006 bombing or in the weeks immediately after the spill. Relationships between exposure to oil in water following the spill and concentrations accumulating in the soft tissues of oysters almost a year later may well have been complicated by gradual elimination of oil-related compounds post exposure (Hwang et al. 2004) and by behavioural responses such as cessation of feeding and associated valve closure during periods of very high oil exposures (Huckins et al. 2004).

Moreover, there are many potential sources of chemical pollution along the coast, and many types of contaminants (both chemical and biological). Even if this study does not cover the broader questions related to point and diffuse sources of marine pollution in Lebanon, it may bring some reassurance that the Jiyeh spill is not still causing as severe contamination of the marine environment with oil-related chemicals and PCBs as may have been feared, at least at locations tens of kilometres from the power plant itself. This does not imply that the Jiyeh spill had no significant impact on the marine and coastal environment along the Lebanese coast, but rather indicates that the most severe long-term impacts may have been relatively localised, perhaps by the weather conditions prevailing at the time.

B. Same old chronic problems

It is beyond dispute that our marine environment faces a variety of grave man made threats, undermining the very livelihood of millions of people. Lebanon is no exception as the 2006 UNEP post-war assessment report pointed out.

Solid waste

The Mediterranean suffers from pollution from industry, agriculture and urban centers and these pollution sources are regarded as major environmental problems in a large majority of countries in the region (EEA. 2005). Limited water exchange makes the Mediterranean very sensitive to the build-up of pollutants. In addition to coastal point sources, other sources are situated inland and the pollutants are carried by the many rivers that drain into the Mediterranean. The multitude of chemicals used to create a vast range of household and industrial products, including plastics, plasticizers; packaging materials, pesticides, fertilizers, solvents, and a vast number of other hazardous products are posing a serious threat to the region. A large number of industries located along the coast regularly pump thousands of tons of toxic waste directly into the water. As a result, the Mediterranean basin has now arguably become one of the most polluted semi-enclosed basins in the world.

Generation of sewage effluents from coastal cities, which are then discharged untreated or partially treated into the sea is a major problem along Mediterranean coastlines. Of the 70% of cities with sewage treatment plants none treat wastewater above secondary treatment plant level. Hence these discharges are significant sources not only of nutrients, but also metals and organic chemicals. There are today over 53 network pipelines of wastewater on the coast of Lebanon (MoE 2001). It should be noted that most of the coastline and up to 8-10 Km of width is constructed habitat & factories. The coastal population is nearly 2, 5 million, who produce nearly 950000 cubic meters of waste water, which ends up in the sea (CDR/ECODIT-IAURIF. 1997), which leads the Center of Water Resources to consider the level of pollution of most beaches to be above the permissible level set by the World Health Organization (WHO). Every year there are consistent media reports of outbreaks of Skin rachis but unfortunately there is no referenced studies that measure the percentage and the ratio of sea-swimming causes, unlike the studies on (drinking) water transmitted disease in Lebanon (typhoid, Hepatitis A).

Industrial and coastal development are a common plague along the lebanese shore

Solid waste dumping continues in sites in Tripoli and Saida, which are on the coast, while Normandy and Dora no longer as official dumps. But illegal or semi-legal dumping continues in coastal areas in unsuited sites and in unsafe ways, which leads to the contamination of ground water and sea water, leading to organic and non-organic pollution. An earlier study done by the CDR in 1997 covered only three sites (the Saida site was not included):

	Normandy site	Bourj Hammoud	Tripoli site	Total
Surface (hectare)	10	15	3	28
Million tonnes per year	80000	120000	24000	224000
Polluante (concentration in leakage)				
Biological need for oxygen	24 million ton per year	36 million ton per year	7,2 million ton per year	67,2 million ton per year
Heavy Metals (3 milligrams per Liter)	240 million ton per year	260 million ton per year	72 million ton per year	670 million ton per year

Solid waste dumping continues in sites in Tripoli and Saida, which are on the coast, while Normandy and Dora no longer as official dumps. But illegal or semi-legal dumping continues in coastal areas in unsuited sites and in unsafe ways, which leads to the contamination of ground water and sea water, leading to organic and non-organic pollution. An earlier study done by the CDR in 1997 covered only three sites (the Saida site was not included):aThe untreated sewage waste and solid waste dumping are not the only polluting threats to the Lebanese shore, for there are power plants and factories. The Center of Water Resources of the American University of Beirut (AUB) did an initial field study in the year 2000 on coastal waters taking 30 water samples from 30 sites all across the coast (from Tyr in the South to Akkar in the North). The study found high levels of pesticides and a high concentration of nickel, copper, chrome, lead and mercury on different sites. Samples were taken near 7 industrial sites and compared to a base-line sample taken from a site 2 km off of Shekka. The results were alarming:

Main Industrial sites	Heavy Metals Concentrations M1/Li				°C (Temperature)
	Mercury	Lead	Zinc	Chrome	
Base-line	5.1	2	3.8	2	2808
Al-Gazia	14	2	32	35	2907
Jiyeh Power Plant	707	17	19	24	3103
Dora Industrial Zone	51	2	24	100	2901
Zouk Power Plant	47	2	17	81	3003
Salaata Chemical Plant	10	2	9.6	36	2807
Shekka Cement Plant	13	2	26	23	29.5
Akkar Future pipes Ind.	13	2	23	33	29

Intensive coastal urbanization

The Lebanese coastline, which is 225 km long, is mostly urbanized. In the Beirut area and to the north, numerous cities and towns occupy the narrow coastal strip, which stretches between the Mediterranean Sea and Mount Lebanon. South of Beirut, the coastline is flatter and densely populated. It should be reminded that more than half of the Lebanese population lives in the coastal urban centers. Intensive coastal urbanization is not a sustainable way of life from an environmental point of view. Intensive coastal urbanization causes severe marine pollution in the following ways:

1. Massive release of untreated waste water into the sea. As we have seen in the previous paragraphs, untreated waste water is a prime polluting factor all along the Lebanese coast.
2. Massive dumping in the sea of solid waste, considering that the involved (both official and actual) dumping sites are mainly open air land fills by the sea.
3. Unsustainable use of ground water, as these urban centers extract water faster than it can regenerate, thus increasing the mineral concentration (chloride) in the remaining ground water, which contaminates both remaining ground water and coastal sea water.
4. Coastal urbanization involves concentration of industrial activity along the coast and therefore, the release of untreated chemical waste into the marine environment increases substantially.

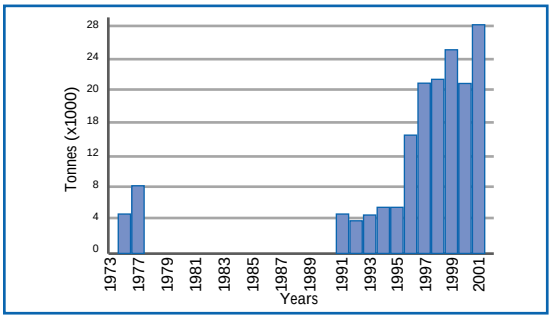
Unsustainable fishing practices & destructive fishing techniques:

Worldwide, over fishing is considered to be the biggest environmental threat to the oceans. Many stocks have been over fished and some of them collapsed. Recent studies have shown a strong decline of many fish species all over the world, particularly of top predators, which were abundant before industrial fisheries started (Myers & al. 2005).

Profound changes are being experienced in all parts of the world's oceans. In November 2006, new data brought the extent of marine degradation into stark relief. An international group of scientists, led by Professor Boris Worm, showed that the loss of marine biodiversity is drastically reducing the ocean's ability to produce seafood, resist diseases, and filter pollutants and rebound from stresses such as over-fishing and climate change (Worm & al.2006).

The Mediterranean Sea is no exception to this global trend. Total catches in both the Mediterranean and Black Sea total about 1,500,000 tons in recent years. That's more than double the 700,000 tons landed in 1950, but is far below the maximum 2 million tons reached between 1982 and 1988. Catches of many species reached peaks between the late 80's and the early 90's, but have decreased since (FAO 2005). Food and Agriculture Organization (FAO) data suggest that in the Mediterranean and Black Sea together, around 20% of resources are depleted, 15% are overexploited and 50% are fully exploited (FAO 2004). A European Environment Agency (EEA) evaluation paints an even starker picture for the Mediterranean region (Streftaris 2004). For the majority (80%) of commercially exploited stocks in the Mediterranean, no robust assessment of their status exists. Where the status of stocks has been assessed, it indicates that around 60% of commercially important stocks are being fished in excess of safe biological limits. Earlier EEA data suggested that between 65% and 79% of stocks were being fished in excess of safe biological limits, dependent on region (EEA 2003).

The reported marine production of Lebanon for 2004 was 7800 tons, to which must be added an annual aquaculture production of 800–1000 ton, while an estimated 16200 tons of fish is imported (FAO 2006). The following is the statistic given by FAO (FAO 2001) on the annual production in Lebanon of fishery commodities and its import and export (including re-export) of fishery commodities in terms of volume and value since 1976:



The figure for marine production could not and does not take into account the very significant catches taken by 'amateurs'. The lower volume for 2004 seems to indicate that Lebanese native fish reserves are being depleted, especially since there is no indication either of a decrease of the number of fishermen or of a decrease of fish consumption. Moreover there is definitely no

decrease in fish import (imported fish are sold in the market at cheaper prices than locally caught fish).

The fisheries of Lebanon are small-scale, and are traditionally based on bottom-set stationary gear (trammel nets and longlines), purse seine nets and beach seines. They are almost exclusively conducted within six nautical miles of the coast; in recent years mostly for security. Fishing operations, with the exception of longlines, are mostly carried out at depths of up to 50 m. A considerable proportion of the nets (purse seines, gillnets and beach seines) have a mesh size of less than 2 x 2 cm, which is the government-mandated minimum.

The previously extensive fishing with explosives has been significantly reduced (but not eradicated) during the past few years because of stricter control by the military.

Finally, introduced or "alien" species can have serious impacts in the marine environment, competing with native species for food and for space, and altering the structure of communities and habitats. Alien species may be introduced from one marine area to another either by intentional release or by accident. In a broad sense, degraded habitats are more vulnerable to the establishment of new species than healthy ecosystems. In the case of Lebanon, introduced species from the Rea Sea have been monitored.

Thus, Lebanese coastal waters are relatively intensively fished, which in addition to destructive fishing practices, such as very small mesh size, the use of explosives and fishing during egg laying season, create a situation of over-fishing. Overall, despite its artisan structure, the Lebanese fishing sector does not practice sustainable fishing.

Shipping

Some of the world's busiest shipping routes are to be found in the Mediterranean. On an annual basis, it is estimated that 200,000 vessels ply their trade in the Mediterranean, And large numbers of them will visit one or more of the 305 Mediterranean ports (one per 150 kilometers of coastline). It is estimated that the Mediterranean accounts for around one third of the world's total merchant shipping (EEA 1999). The discharge of chemical tank washings and oily wastes including oil contaminated ballast and wash waters represent a significant source of marine pollution.

As a defined "Special Sea Area" under the MARPOL 73/78 Convention (Annex 1 Regulation 10) the discharge of oil or oily mixtures into the Mediterranean from ships is entirely prohibited with only minor and well-defined exceptions. The Convention appears to be regularly flouted however, and operational discharges from ships make up a major proportion of the hydrocarbon input to this regional sea. In Lebanon, there is no monitoring infrastructure of such practices. A study conducted under the auspices of the European Community using remote sensing data identified in excess of 1600 spills in 1999 alone. None of these coincided with any reported spills or accidents. The volume of oil involved in the detected slicks was estimated at around 13,000 tons. Estimates of the true extent of illicit oil discharges from vessels in the Mediterranean vary widely. UNEP (2002) suggest that inputs amount to some 250,000 tons per annum, but note that earlier estimates of 500,000 tonnes were regarded as plausible by the International Maritime Organization (IMO).

Climate change:

The consequences of our unsustainable use of the oceans, are worsened by climate change (Greenpeace 2007b). The United Nations Intergovernmental Panel on Climate Change (IPCC) warned in 2001 that climate change will "affect the physical, biological, and biochemical characteristics of the oceans and coasts", and warned of "significant feedback on the climate system" of such changes (IPCC 2001). Organisms in coastal zones and enclosed seas are most at risk from climate change, it warned. In short, experts warn that we have eroded the ocean's ability to cope with and mitigate the consequences of global warming. They recommend that we reduce our exploitation levels of marine fish and other maritime activities in order to improve the resilience of our seas and oceans and ultimately safeguard their role in stabilizing the climate. Simply aiming at the sustainable use of sea-life is no longer a sufficient management strategy. Proper marine protection will help to deal with an unpredictable future, one which will be hotter, stormier and more hostile.

It is beyond dispute that the health of our seas has first and foremost been compromised by the overexploitation of marine resources and marine pollution. In addition, however, we must consider the impacts of climate change as a result of the greenhouse gasses already emitted into the planet's atmosphere.

C. Main Recommendations

1. In conducting this study, the near absence of baseline data for environmental quality and levels of contaminants against which the impacts of pollution incidents can be determined has been a particular problem. We therefore recommend that greater research emphasis is placed on determining such baseline (current) conditions in terms of both species and contaminant distributions. It is only with such a baseline of data that the impacts of accidents and longer-term trends in levels of pollution can be determined and timely action taken to ensure protection not just of biodiversity, but also of human health.

2. Although the results obtained in this study suggest a role for the Jiyeh spill in explaining the distribution of oil-related contaminants in oysters one year on, determining the contribution of this relative to that from ongoing, chronic pollution from shipping and other industrial activities requires more detailed 'fingerprinting' of those different contaminant sources. We therefore recommend a targeted scientific programme to characterise discharges, emissions and unintentional losses of hazardous chemicals to Lebanese coastal waters, especially from major urban and industrial sites, in order that sources of pollution can be more readily traced and addressed.

3. As a further contribution to the process of identifying and, as far as possible, eliminating sources of chemical and biological pollution to the marine environment (and thereby increasing protection for human health and those marine resources vital to the culture and economy of Lebanon), we recommend the development of an inventory of industries and of the hazardous substances and wastes they generate and release to the environment.

4. Clearly the threats faced by Lebanon's coastal and marine environment are far from limited to chemical pollution, but include also unsustainable coastal development, overfishing and destructive fishing practices, problems in the management of municipal solid waste and medical waste, etc. In addition to the measures above, we therefore recommend the preparation of an holistic and sustainable management plan for those human activities which impact on natural systems. Given the capacity for different stressors to interact and for responses of ecosystems to such stresses to be unpredictable and potentially irreversible, there is a need for such a plan to be precautionary in nature. A key element will be the establishment of reserve areas fully protected from all extractive and potentially destructive human activities, including a contribution to a Mediterranean-wide network of marine reserves. Such an approach would, in turn, allow greater resilience to the changes likely to occur as a result of ongoing climate change.

Sewage at sea off Shekka

3. Time for Change

A. Recovery and Protection for the Eastern Mediterranean

The impacts of war and human activities are both harming our marine environment. It is time to acknowledge the harm being caused and to move forward and take action.

Recovery and protection of our Sea should be a priority for Lebanon, since caring about the environment is caring about the people that depend on it. In a time where communities are suffering the after-effects of the conflict and environmental damage of war, it is important to address the threats facing our environment, and develop a new system to recover and protect important species and habitats. In a tense region like ours, working for a better environment is working for a better future, leaving behind the lack of security and channeling our efforts into improving the environmental situation.

Sustainable Peace is not only about the absence of war and the lack of political stability; it also includes quality of life; socio-economical and environmental sustainability.

Amongst the numerous environmental concerns we are facing, the marine environment is one of the top priorities that must be addressed.

Overall Solution

Greenpeace's Oceans Campaign is about caring for our Sea, seeking its recovery, by calling for protection and sustainable management of its wealth. That means establishing a network of fully-protected marine reserves covering 40% of our Sea, to protect its health and productivity – for now and for the future.

In order to reverse the current decline in the health of our Oceans and Seas, Greenpeace is calling for protecting 40% of the seas and oceans – including the Mediterranean Sea - through a network of marine reserves. This figure is firmly based on science. A review (Gell and Roberts 2003) of forty previous studies into what area coverage is required to achieve conservation and fisheries management goals concluded that 20-50% is required. In its 2004 report "Turning the tide: addressing the impact of fisheries on the marine environment" the UK's Royal Commission on Environmental Pollution (RCEP 2003) similarly recommended that 30% of the UK's Exclusive Economic Zone be designated as no-take zones in order to reverse the trend of declining fish stocks. Greenpeace's demand is also consistent with that of the World Parks Congress, which said, "Networks should be extensive and include strictly protected areas that amount to at least 20-30% of each habitat." Meanwhile, the United Nations Millennium Project (UN Millennium Project 2000) calls for 10% of the oceans to be covered by Marine Reserves in the short to medium-term, with a long-term goal of 30%.

It is worth remembering that in the past, vast tracts of our seas were simply inaccessible to fishing and other human activities and so those areas were de facto marine reserves, providing natural refuges for marine species. Creating networks of marine reserves is in fact re-creating the system of refuge areas that marine life once benefited from.

Marine Reserves are an essential part of the solution to the crisis facing our seas and oceans. But we cannot forget that in establishing marine reserves, countries have to commit to ensuring that the reserves boundaries are respected and that those areas, covering the other 60% of the waters, falling outside of the protected areas are sustainably managed so that the benefits of the reserves are experienced well beyond their boundaries.

Marine Reserves are one type of MPA, and in terms of protecting the marine environment, they offer the highest level of protection. Marine reserves are areas of the sea that are fully protected from damaging human activities - much like national parks in the sea. In its 2004 report on Rescuing the North and Baltic Seas, Greenpeace adopted the following definition of marine reserves:

Large-scale marine reserves are areas that are closed to all extractive uses, such as fishing and mining, as well as to disposal activities. Within these areas there may be core zones where no human activities are allowed, for instance areas that act as scientific reference areas or areas where there are particularly sensitive habitats or species.

Some areas within the coastal zone may be opened to small-scale, non-destructive fisheries, provided that they are sustainable, within ecological limits, and have been decided upon with the full participation of affected local communities.

In 2006, Greenpeace presented a proposal for a network of marine reserves to protect the Mediterranean's "high seas" – the 80% of the Mediterranean Sea which falls beyond the jurisdiction of any one country (Greenpeace 2006c). The proposed reserves are large-scale, protecting key areas of the Mediterranean such as vulnerable habitats, fish spawning and nursery grounds, and areas important for whales and dolphins. Within the coastal zone, Mediterranean countries must develop similar networks of smaller marine reserves. A network of marine reserves in Lebanese waters would protect important coastal values such as hydrothermal vents and turtle migration and nesting areas. The network would allow Lebanon to manage the marine environment and resources according to the precautionary principle and the ecosystem approach (Greenpeace 2007).

B. ...Marine Reserves Now!

"Over the years, going back to Phoenician times, the peoples of the Mediterranean have managed to overcome various threats to their survival as a result of major conflicts in the region. A new threat is now endangering their well-being and those of future generations, primarily from activities that are causing pollution to the marine environment, which is the source of life for both human beings and a large variety of marine living resources in the region. Compounding this danger is the fact that apart from the flow of surface water through the Straight of Gibraltar, the Dardanelles and river run-off, the Mediterranean is an almost enclosed sea taking over a century to be fully renewed". Paul Mifsud, Coordinator, Mediterranean Action Plan (MAP 2005).

This case study about Lebanon shows the reality of human activities harming the marine environment, but the same could easily be applied to many of the Mediterranean Arab countries surrounding Lebanon. The European Environment Agency 2006 report on the major environmental problems facing the Mediterranean Sea show that the Arab Mediterranean coastline suffers from common major threats as untreated sewage discharges, intensive coastal development, oil pollution, chemical pollution from industrial sites as well as a lack of solid waste management (PNUE/AEE 2006).

In addition, 2006 UNEP's "State of the Marine Environment" report highlighted sewage discharges as top cause of destruction of coastal habitats and reporting that over half of the wastewater entering the Mediterranean Sea is untreated and that on balance, it is perhaps the most serious of all problems about which the least progress has been achieved (UNEP 2006).

It is also worth reminding that all of the Arab Mediterranean countries are parties to the Convention for the Protection of the Mediterranean Sea against Pollution - better know as the Barcelona Convention - which aims at the elimination of pollution from land-based sources and the protection of the Mediterranean Sea through the establishment of marine protected areas (MAP 2005).

Therefore the creation of marine reserves should be carried out throughout the region, increasing the overall protection and benefits from those reserves.

Protection of the high seas has been identified by regional and international bodies and conventions to be a priority, however coastal protection is nonetheless as urgent, and steps can be taken now to begin establishing a marine reserve network. Lebanon' s coastline – as well as the rest of the Arab Mediterranean coastline – needs the urgent establishment of coastal marine reserves in order to ensure recovery, protection and a healthier environment for people and marine life.

What do we protect in a marine reserve?

Establishing a marine reserve network in the coastal zone follows a number of ecological criteria. These are:

- Covering an adequate proportion of the marine area. Greenpeace considers 40% protection with marine reserves to be an appropriate level.
- Protection for each habitat type; not only rare, unique or pristine sites, but also examples of common habitats – which are often degraded, but are also often critical habitat for marine species.
- Protection of each type of habitat must cover an adequate proportion of that habitat, and include numerous sites.

Local and political support for marine reserves

On the high seas, marine reserves protecting international waters must be implemented within regional agreements, whereas coastal marine reserves may be established through national legislation. Many countries have already established marine reserves in their coastal waters, and studies of fully-protected marine reserves show increased number, diversity and size of marine life within the reserve (American Association for the Advancement of Science (2001).

The success of marine reserves depends not only on their establishment and enforcement, but also about the local communities' involvement and feeling of ownership. Their belief in the advantages of marine protection will make local communities the leading voice calling for the desired change. Around the world, marine reserves have been created through pressure by many local communities and groups such as conservation organisations, fishers' associations, universities and schools, native communities and diving organisations. This movement for change must be reflected in the political will of decision-makers, who are the key actors in establishing coastal marine reserves by law. A coastal marine reserve network for Lebanon needs to be established in consultation with local communities and in association with well-managed, sustainable fishing areas within coastal waters. This will ensure that small-scale features are protected, while equitable

Thermal vents of the coast of Tyr

access to fishing resources is maintained. The benefits that marine reserves bring for education, research, leisure and tourism will also be shared between coastal communities.
They can also benefit small-scale fisheries in surrounding areas. Fishing and other local communities benefiting from those reserves become important in ensuring that the rules are followed to enable their success in restoring and protecting marine biodiversity.

Benefits for all

Parties at the Convention on Biological Diversity (CBD) had agreed on that "marine and coastal protected areas have been proven to contribute to: Protecting biodiversity; Sustainable use of components of biodiversity; Managing conflict, enhancing economic well-being and improving the quality of life." (COP 7.2004)

In a study of two Mediterranean marine reserves, one had a biomass of commercial species 4 times higher after 10 years, while the other had only 0.2 times more - this was attributed to poaching from that reserve. The realization of benefits from marine reserves, including to the productivity of surrounding fisheries, makes coastal communities a powerful ally in ensuring that marine reserves are well managed and their rules enforced. A series of marine reserves in Egypt's Red Sea were established in 1995, giving an increase of over 60% in the catch per unit effort of a surrounding fishery after only five years of protection (Greenpeace 2006c).

Marine Reserves are tools for conservation, for fisheries management, scientific research as well as an important source of economic income:

Conservation is about protecting the diversity and abundance of life on earth. Internationally, countries have committed to create protected areas under the Convention on Biological Diversity (CBD) – including in the marine environment. Regionally, the Barcelona Convention, to which Lebanon is also a party, addresses the protection of specially protected areas and biodiversity in the Mediterranean Sea.

Fishing sustainability results from managing fisheries based on both the precautionary principle and the ecosystem approach. Fundamental to the ecosystem approach is the creation of a network of fully protected marine reserves. Marine reserves can also benefit local fisheries through migration and breeding of fish from within reserves, building surrounding populations. Reserves help provide a more predictable catch from year to year, hence enhancing fisheries stability. Finally, they serve as a form of insurance against uncertainty and reduce the probability of overfishing and fishery collapse.

Scientific research is enhanced by Marine Reserves, which provide an undisturbed habitat that can supply invaluable information for scientific investigation. Monitoring and Assessing environmental change occurring during the recovery of damaged ecosystems is necessary in order to obtain a better understanding of the complexities of marine life. Marine Reserves provide a unique source of long-term data, giving researchers the opportunity to monitor species and their habitats – which is essential in order to supply reliable information for future conservation and management policies. Marine reserves provide a benchmark or a baseline showing what the sea is supposed to be like.

Economic value is generated by marine reserves through increases in fish populations within and surrounding the reserves. In addition to fisheries benefits described above; the abundant and diverse marine communities within reserves provide an economic advantage in the domain of tourism (ecotourism). This can in turn contribute to the management of the reserves, increasing their viability. Activities such as diving, snorkeling or underwater photography all benefit from the marine life of reserves.

© Greenpeace/Åslund

Conclusions

Crimes on the environment, whether due to war or man made activities are drastically harming our Mediterranean Sea and only protection could ensure the recovery of its health, productivity and marine life for the sake of the environment but also for the millions of people who rely on it.

This Greenpeace report provided a scientific study assessing, on year after the Jiyeh power plant bombing, residual impacts of the consequent oil spill.

The scientific study which objective was to determine the levels of oil and related chemical contamination in the marine environment. It has shows that if the oil spill impacts were not as catastrophic as feared, serious impacts were nonetheless still traced in the collected oyster samples.

The study has also revealed that the traced oil pollution could also be related to regular discharges from land and sea-based activities, therefore stressing on the fact that further research is needed to fingerprint this serious chemical pollution that an oil spill couldn't explain on its own.

Although providing a unique and valuable data set in its own right, this study is just one small part of the overall picture of levels of marine pollution in Lebanon. It is also a contribution to the extensive scientific assessment of the status of the marine environment that should take place in order to determine the reality of the long list of chronic threats degrading our Mediterranean sea such as untreated domestic sewage discharges, lack of solid waste management, intensive coastal development, destructive fishing techniques, unsustainable fishing practices amongst others.

Greenpeace believes it's not too late to reverse the degrading process and is calling for the establishment of a network of marine reserves covering 40% of the Mediterranean Sea as the path towards recovery for our Mediterranean and for the millions of people who rely on it for their health and wellbeing.

For that what is lacking is the political will to make this a reality. This must change, and Greenpeace believes that people can play a crucial role in bringing this about. We need laws to make it possible. We need laws to ensure protection and a sustainable management of the environment surrounding the reserves in order to maximize their benefits both for coastal and high seas marine reserves.

Promising steps towards a network of marine reserves have already been taken in the Mediterranean since the Barcelona Convention creates a regional agreement under which marine protected areas can be created within and beyond national jurisdiction.

In addition, all Arab Mediterranean countries are parties to the Convention for Biological Diversity (CBD), which highlights the fact that "marine and coastal protected areas should be part of a wider marine and coastal management framework" and "urges Parties and other Governments to make efforts to adopt, as a matter of high priority (…) such a framework" (CBD 2007,COP 7.2004).

Greenpeace believes that the best pathway to honor the CBD commitment to protect marine biodiversity is to create an implementing system under the United Nations Convention on the Law of the Sea, UNCLOS. The laws created must allow for full protection from damaging activities, and provide enforcement mechanisms. It all depends on our belief that it's not too late, that change is possible!

Taking action is about believing in the importance of enjoying a better environment. Taking action is pushing for change.

It's our sea, let's defend it!

© Greenpeace/Newman

References

Abuzinda A. and Krupp F. (1994). What happened to the GULF two years after the world's greatest oil-slick. [http://www.arabianwildlife.com/archive/vol2.1/oilglf.htm].

American Association for the Advancement of Science (2001). Scientific consensus statement on Marine Reserves and Marine Protected Areas.

APAT (2007). Libano: una missione ambientale.

BBC News (2006a). UN hails Israel's Lebanon pullout [http://news.bbc.co.uk/1/hi/world/middle_east/5396966.stm]

BBC News (2006b). Middle East crisis: facts and figures. [http://news.bbc.co.uk/1/hi/world/middle_east/5257128.stm].

Böer B. (1993). Anomalous pneumatophores and adventitious roots of Avicennia marina (forssk.) vierh. Mangroves two years after the 1991 Gulf War oil spill in Saudi Arabia. Marine Pollution Bulletin 27: 207-211.

CBD (2007). Parties to the Convention on Biological Diversity http://www.cbd.int/world/parties.asp

COP 7 (2004). Seventh Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity Kuala Lumpur, Malaysia, 9 - 20 February 2004. www.cbd.int/convention/cops.shtml

EEA. 1999. State and Pressures of the Marine and Coastal Mediterranean Environment. Environmental Issues Series (5). European Environment Agency, Copenhagen.

EEA. 2003. Fisheries and Aquaculture. In Europe's Environment: The Third Assessment. Environmental Assessment Report (10).

EEA. 2005. Priority issues in the Mediterranean environment. European Environment Agency Report 5/2005. Copenhagen

FAO: Fisheries and Aquaculture Department's Fishery Trade Statistics. 2001

FAO. 2004. The State of World Aquaculture and Fisheries 2004.

FAO Newsroom. July 2005. Mediterranean fisheries: as stocks decline, management improves

FAO (2006). Damage and Early Recovery Needs Assessment of Agriculture, Fisheries and Forestry.

Gell, F.R. and C.M. Roberts (2003). Benefits beyond boundaries: the fishery effects of marine reserves and fishery closures. Trends in Ecology and Evolution 18: 448-455.

Gerges M.A. (1993). On the impacts of the 1991 Gulf War on the environment of the region: general observations. Marine Pollution Bulletin 27: 305-314.

Greenpeace (2003). Lessons from the last Gulf War. February 2003. [http://www.greenpeace.org/raw/content/international/press/reports/lessons-from-the-gulf-war-the.pdf].

Greenpeace (2004). One year on, UN takes up Greenpeace Iraq warnings. [http://www.greenpeace.org/international/news/vanishing-nukes-in-iraq].

Greenpeace (2006a). Greenpeace exposes oil slick on the seabed off the Lebanese coast. August 22, 2006. [http://www.greenpeace.org/mediterranean/news/greenpeace-exposes-oil-slick-o].

Greenpeace (2006b). Rainbow Warrior aiding Lebanon oil spill clean up plans. September 27, 2006. [http://www.greenpeace.org/mediterranean/news/rainbow-warrior-aiding-lebanon].

Greenpeace (2006c). Marine Reserves for the Mediterranean Sea.

Greenpeace (2006d). Witnessing War: a preliminary post conflict environmental assessment by Greenpeace. [http://www.oilspilllebanon.org/articles/Witnessing%20War.pdf].

Greenpeace (2007). The Eco System Approach: protecting marine life in all its forms

Heinrich Böll Foundation (2006). Environmental impact of the 2006 Lebanon War. Beirut, October 16, 2006. [http://www.boell.org/news/documents/Environmental%20Impact%20of%20War.pdf]

IAEA (2006). International Atomic Energy Agency. Tackling Tuwaitha's radioactive ruins. IAEA asked to help to clean Iraq "hot" spots. 24 April 2006. [http://www.iaea.org/NewsCenter/News/2006/tuwaitha.html].
IPCC (2001) Climate Change 2001: Impacts, Adaptation and Vulnerability; Chapter 6 Coastal Zones and Marine Ecosystems

IUCN (2006a). Mediterranean environment affected by armed conflict. [http://www.iucn.org/places/medoffice/noticias/armed_conflict.html].

IUCN (2006b). Lebanon oil spill threatens migrant birds and marine life. [http://www.iucn.org/en/news/archive/2006/08/pr_lebanon_oil_spill.htm].

MAP (2005). Mediterranean Action Plan: an introduction http://www.unep.ch/regionalseas/regions/med/medint.htm

McClatchy Newspapers (2006). Huge oil spill off Lebanon threatens to ravage life in the sea. [http://www.commondreams.org/headlines06/0812-01.htm].

Ministry of Environment (MoE) State of the Environment in Lebanon 2001. Beirut
PNUE/AEE (2006). Problemes prioritaires pour l'environement mediterraneen.

Myers, R.A. and Worm, B. Extinction, survival or recovery of large predatory fishes. The Royal Society, UK, 2005

PNUE/AEE (2006). Problemes prioritaires pour l'environement mediterraneen.

Price A.R.G (1998). Impact of the 1991 Gulf War on the coastal environment and ecosystems: current status and future prospects. Environment International 24 (1/2): 91-96.

RCEP (2003). Twenty-fifth Report. Turning the Tide - Addressing the impact of Fisheries on the Marine Environment.

REMPEC (2006a). Sitrep 8. Spill in Lebanon, 14/08/2006. [http://www.rempec.org/news.asp].

REMPEC (2006b). Sitrep 1. Spill in Lebanon, 31/07/2006. [http://www.rempec.org/news.asp].

REMPEC (2006c). Sitrep 5. Spill in Lebanon, 07/08/2006. [http://www.rempec.org/news.asp].

REMPEC (2006d). Sitrep 9. Spill in Lebanon, 17/08/2006. [http://www.rempec.org/news.asp].

REMPEC (2006e). Sitrep 12. Spill in Lebanon, 25/08/2006. [http://www.rempec.org/news.asp].

REMPEC (2006f). Sitrep 15. Spill in Lebanon, 28/09/2006. [http://www.rempec.org/news.asp].

REMPEC (2006g). Sitrep 13. Spill in Lebanon, 31/08/2006. [http://www.rempec.org/news.asp].

Streftaris, N. 2004. Fish stocks outside Safe Biological Limits in 2002. Indicator Fact Sheet: FISH1a, European Environment Agency, Copenhagen

Steiner R. (2006). Lebanon oil spill rapid assessment and response mission. Final Report, September 11, 2006. IUCN, CEESP, Greenline.

UN Millennium Project (2000). Environment and human well-being: a practical strategy.

UNEP (2002). GEO-3. Global Environment Outlook. Chapter 2. State of the Environment and Policy Retrospective: 1972-2002. page 292. [http://www.unep.org/geo/geo3/pdfs/Chapter2disasters.pdf].

UNEP (2003). If there must be war, there must be environmental law. 6 Nov 2003. [http://www.unep.org/Documents.Multilingual/Default.asp?ArticleID=4286&DocumentID=355&l=en].

UNEP (2006). State of the Marine Environment.

UNEP (2007). Lebanon Post-Conflict Environmental Assessment.

Worm B, Barbier EB, Beaumont N, Duffy JE, Folke C, Halpern BS, Jackson JBC, Lotze HK, Micheli F, Palumbi SR, Sala E, Selkoe K, Stachowicz JJ, Watson R (2006) Impacts of biodiversity loss on ocean ecosystem services. Science 314:787-790
http://myweb.dal.ca/bworm/Worm_etal_2006Science.pdf

References of scientific study section:

Barbour, E.K., Sabra, A.H. & Shaib, H.A. (2007, unpublished). Oil spill contaminants in selected vertebrates and invertebrates of the Eastern Mediterranean Sea.

Devier, M.H., Augagneur, S., Budzinski, H., le Menach, K., Mora, P., Narbonne, J.F. & Garrigues, P. (2005) One-year monitoring survey of organic compounds (PAHs, PCBs, TBT), heavy metals and biomarkers in blue mussels from the Arcachon Bay, France. Journal of Environmental Monitoring 7(3): 224-240

Huckins, J.N., Prest, H.F., Petty, J.D., Lebo, J.A., Hodgins, M.M., Clark, R.C., Alvarez, D.A., Gala, W.R., Steen, A., Gale, R. & Ingersol, C.G. (2004). Overview and comparison of lipid-containing semipermeable membrane devices and oysters (Crassostrea gigas) for assessing organic chemical exposure. Environmental Toxicology & Chemistry 23(7): 1617-1628

Hwang, H.M., Wade, T.L. & Sericano, J.L. (2004). Destabilized lysosomes and elimination of polycyclic aromatic hydrocarbons and polychlorinated biphenyls in eastern oysters (Crassostrea virginica). Environmental Toxicology & Chemistry 23(8): 1991-1995

Law, R. J., Kelly, C. A. & Nicholson, M. D. (1999). Polycyclic Aromatic Hydrocarbons (PAH) in Shellfish Affected by the Sea Empress Oil Spill in Wales in 1996. Polycyclic Aromatic Compounds 17(1): 229-239

Law, R.J., Kelly, C.A., Baker, K.L., Langford, K.H. & Bartlett, T. (2002). Polycyclic aromatic hydrocarbons in sediments, mussels and crustacean around a former gasworks site in Shoreham-by-Sea, UK. Marine Pollution Bulletin 44(9): 903-911

McIntosh, A.D., Moffat, C.F., Packer, G. & Webster, L. (2004). Polycyclic aromatic hydrocarbon (PAH) concentration and composition determined in farmed blue mussels (Mytilus edulis) in a sea loch pre- and post-closure of an aluminium smelter. Journal of Environmental Monitoring 6(3): 209-218

Webster, L., Angus, L., Topping, G., Dalgarno, E.J. & Moffat, C.F. (1997). Long-term monitoring of polycyclic aromatic hydrocarbons in mussels (Mytilus edulis) following the Braer oil spill. Analyst 122(12): 1491-1495

The Mediterranean:

From crimes to conservation

A call for protection

"Greenpeace is committed to defending the health of the world's oceans and the plants, animals and people that depend upon them."

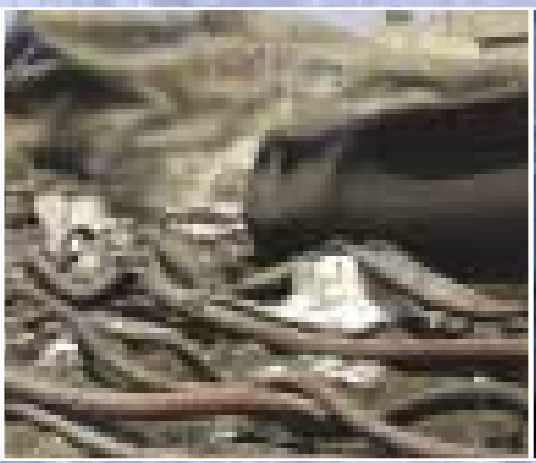
Defending Our Mediterranean

Defending Our Mediterranean

The Mediterranean:
From crimes to conservation
A call for protection

Greenpeace is an independent, campaigning organisation which uses non-violent, creative confrontation to expose global environmental problems and to force solutions essential to a green and peaceful future.

Greenpeace Mediterranean Caracas, Kuwait Street, Yaacoubian Bldg. Block B, 10th Floor.
P.O.Box: 13-6590 Beirut, Lebanon. Tel: + 961 1 755 665. Fax: +961 1 755 664.
www.greenpeace.org.lb


GREENPEACE
MEDITERRANEAN