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STUDY TITLE: USNM Panama Oil Spill Recovery Study

REPORT TITLE: Long-term Assessment of the Oil Spill at Bahía Las Minas, Panama, Synthesis Report, Volume I: Executive Summary and Volume II: Technical Report Part 1 of 2 and Part 2 of 2

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SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREAS: Eastern Gulf of Mexico; South Atlantic

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COSTS: FY 1987: $661,066; FY 1988: $2,271,250; FY 1989: 1,400,000; FY 1991: $100,024

CUMULATIVE PROJECT COST: $4,432,340

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KEY WORDS: Panama; oil spill; ecology; long-term; monitoring; assessment; recovery; intertidal; reef flat; algae; invertebrates; gastropods; stomatopods; mangrove; roots; epibiota; subtidal; coral seagrass; petroleum; hydrocarbons; meteorology; hydrography

BACKGROUND: In April 1987 at least 9.6-16.0 million L (60,000-100,000 bbl) of medium-weight crude oil spilled from a refinery at Bahía Las Minas on the Caribbean coast of Panama. Affected habitats along more than 80 km of oiled shore included intertidal reef flats and mangroves, and subtidal coral reefs and seagrass beds. Study areas near the Galeta Marine Laboratory, Smithsonian Tropical Research Institute, were heavily oiled. Long-term environmental and biological studies of the reef flat at Punta Galeta provided extensive prespill data. Also, reef flat stomatopods had been studied for several years and there were prespill surveys of reef flat gastropods, epibiota on mangrove roots, and coral reefs. Pre- and postspill aerial photography enabled measurements of the distribution and area of mangrove deforestation, including a previously undocumented die-off after a 1968 tanker spill in the same bay. This was

an unprecedented opportunity to study the fate of spilled oil and its biological effects in tropical Atlantic coastal environments. This report presents the findings of the biological studies conducted in Panama, and chemical analyses of petroleum hydrocarbons in environmental and biological samples.

OBJECTIVES: (1) to monitor the long-term changes that may occur in the distribution and abundance of marine organisms as a result of the 1986 oil spill at Bahía Las Minas and (2) to understand the ecological processes causing any observed changes.

DESCRIPTION: Petroleum hydrocarbons were measured and characterized in samples of organisms and sediments collected 5 mos, 2 yr, and 4 yr after the spill. There also were quarterly collections of bivalve molluscs 2.5-5 yr postspill. Hydrographic and meteorological plarameters were monitored at Punta Galeta and other sites. Long-term ecological data on reef flat organisms (some span 20 yr) continued to be collected at Punta Galeta (oiled); a second oiled site and two unoiled sites were established after the spill. Percent cover of algae and sessile invertebrates, densities of sea urchins, and densities of invertebrates in algal turf were monitored. Reef flat gastropods were surveyed in 1982-1983 near Punta Galeta; gastropods were counted and measured for 3 yr after the spill at this site (oiled) and two unoiled sites. Populations of reef flat stomatopods were studied from 1979 to 1983. After the spill, stomatopod density, size, sex, growth, injuries, and cavity volume were monitored at tow heavily oiled and two unoiled to lightly oiled reef flats that had been studied previously. Two unoiled sites were added after the spill. Coral reefs were monitored at six heavily oiled, two moderately oiled, and four unoiled sites for abundance and size of corals, and frequency and size of patches of recent tissue lesions. Six of the monitored reefs were surveyed the year before the spill. Growth bands of corals were compared at oiled and unoiled sites using x-radiographs of slabs cut along the growth axis of skeletons. Regeneration of experimentally induced injuries was measured, reproductive activity was monitored, and juvenile recruitment was surveyed. The extent of mangrove deforestation, forest condition where oiling was sublethal, and recruitment and seedling growth in deforested areas were investigated. Percent cover, community development, and recruitment of organisms attached to mangrove roots were monitored at replicate oiled and unoiled sites in three habitats. Surveys of percent cover were conducted 4 yr prior to the spill. Abundance of infauna, epifauna, and plants were monitored in replicate oiled and unoiled seagrass beds for 3 yr after the spill.

SIGNIFICANT CONCLUSIONS: The oil spill had widespread lethal and sublethal effects on organisms in all intertidal and subtidal environments examined. These included both epifaunal and infaunal populations at all trophic levels, including primary producers, epifaunal and infaunal populations at all trophic levels, including primary producers, herbivores, carnivores, and detritivores. There were extensive mortalities of subtidal reef corals and some taxa in subtidal seagrass beds. Certain species of algae and invertebrates in environments exposed to the open sea regained prespill abundance or an abundance similar to unoiled controls less than 2 yr after the spill. Such recovery generally did not occur for organisms in more sheltered environments after 5 yr. There were some instances of unexplainable declines in populations at

control sites, resulting in similar abundances at oiled and unoiled sites. Oil slicks were persistent for over 5 yr, originating mainly from areas of deforestation. Extensive replication was necessary to detect differences related to oiling among sites and through time because of high spatial and temproal variability.

STUDY RESULTS: Chemical analyses showed concentrations of the spilled crude oil in mangrove sediments as high as 25% (by dry weight) 4 yr after the spill; concentrations were as high as 39% 5 mo postspill. The spilled oil also contaminated subtidal reef and seagrass sediments, and was still detectable in reef sediments 4 yr postspill. Oil was detected in coral tissues 5 mo postspill, was present in trace amounts after 2 yr, and was just detectable after 4 yr; oil was accumulated by bivalve molluscs up to 5 yr postspill. The oil degraded considerably within 5 mo, but one sample from mangrove sediments 4 yr postspill still had toxic fractions. Oiling caused extensive mortaility of plants, sessile animals, and sea urchins along the heavily oiled seaward margin of the Punta Galeta reef flat relative to seasonal dieoffs. The dominant turf-forming alga regenerated within 5 mo of the spill and the dominant sea urchin soon returned to its prespill abundance. Invertebrates in algal turf were about as abundance and diverse at oiled sites as at unoiled controls within 15 mo of the spill, with the possible exception of tanaid crustaceans. Die-offs from extreme low-tide exposures of the reef flat 2 yr after the spill were not distributed the same as those from the spill. Gastropods from approximately mean low water to mean high water, where oiling was heaviest, were less abundant at an oiled reef flat compated to a control. Changes in gastropod populations in other zones were not persistent or may not have been related to the spill. Densities of gonodactylid stomatopods declined both at oiled and reference sites due to unusually sparse postlarval recruitment; it is not known whether this was related to the oil spill. Competition for cavities and injuries from intraspecific aggression remained relatively low at a heavily oiled site as long as stomatopod density was low. Seagrasses died at a heavily oiled site, resulting in erosion and loss of the coral-rubble habitat occupied by these crustaceans. There was a general decline in percent cover of corals at control reefs 2 yr after the spill, causing coral cover to become almost as low at unoiled reefs as at oiled reefs. Both the frequency and size of tissue lesions for certain species of corals increased with oiling, particularly in water less than 1 m deep. Such injuries persisted a year after the spill and recurred after other spills. Sclerochronological measurements of three coral species revealed significant reductions in growth during the year of the oil spill on oiled reefs compared to unoiled reefs; this was not seen for a fourth species. Reproductive activity of the dominant coral species was reduced at oiled reefs more than 3 yr after the spill, and recruitment rates were significantly lower 5 yr postspill. Aerial photographs showed a total of 64 ha of mangrove deforestation, 7% of the total area of mangroves in the bay. Sublethal oiling caused deterioration of canopies, with 23-33% less leaf biomass 3-4 yr postspill. Mangrove seedlings recruited vaiably and grew slower where oil concentrations were high. On mangrove roots, common or dominant organisms, including erect algae (open coast), an edible oyster (channel), and a species of false mussel (stream), all were much less abundant at oiled sites than at unoiled sites after the spill. The mussel-dominated assemblage in streams was most severly affected by oiling, and there was virtually no recovery at oiled streams 5 yr after the spill. Some recovery

occured in channels and on open coasts. Habitat destruction ranged from 33% on the open coast to 63% in oiled streams. The abundances of different taxa of infauna and epifauna in seagrass beds ranged from no significant difference between oiled and unoiled sites, to an initial differnce followed by converegence, to a persistent difference.

STUDY PRODUCTS: Keller, B.D., and J.B.C. Jackson, eds. 1993. Long-term assessment of the oil spill at Bahía Las Minas, Panama, synthesis report, Vol. I: executive summary. OCS Study MMS 93-0047. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA. 138 pp.

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MMS Interim Report (1991). Publications in scientific journals and books: 12; in press: 3; in review: 5. Contributions in workshop or symposium proceedings, including MMS IMTs: 35.

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