SKYTRUTH

A Non-Profit 501(c)(3) Organization

Testimony to the United States Senate
Committee on Energy & Natural Resources
November 19, 2009

Offshore Oil and Gas Development Still Poses Major Risks

John F. Amos
President, SkyTruth

Good morning, Mr. Chairman and members of the committee. Thank you for this opportunity to present information about some of the ongoing risks posed by offshore oil and gas drilling. This is an important issue for our nation as we face increasing political, strategic, environmental and economic consequences resulting from our dependence on fossil fuels as the primary energy source driving our economy. As the nation embarks on a new marine spatial planning process to help us make better-informed management decisions governing our nation's coastal and marine resources, and as we debate the merits of opening new offshore areas to energy development, it is important to understand and carefully evaluate the risks of offshore drilling when considering the benefits. The critical first step is acknowledging the potential risks of offshore oil and gas development to the environment, and to communities that depend on healthy marine and coastal ecosystems for their economic well-being.

I received degrees in geology from Cornell University (B.S.) and the University of Wyoming (M.S.), and spent nearly a decade working as an exploration geologist for two Washington, D.C.-area consulting firms, Earth Satellite Corporation (now MDA Federal Inc.) and Advanced Resources International. During that time I developed expertise in remote sensing and digital mapping: processing and analyzing satellite images as a tool to explore for oil and gas, minerals, and ground water. I conducted dozens of onshore and offshore exploration studies for clients that included British Petroleum, Shell Oil Co., Exxon, and the U.S. Department of Energy, among many others. I was team member on a ground-breaking, NASA-funded study to develop remote sensing techniques for detecting and mapping both natural and human-caused oil slicks at sea. I have analyzed hundreds of satellite and aerial images of the world's oceans, collected by a variety of radar, visible and infrared sensors.

In 2001 I founded SkyTruth, a non-profit organization dedicated to investigating and illustrating environmental issues using satellite imagery, digital mapping, and other remote sensing technologies. This testimony addresses several instances of oil spills observed by SkyTruth that are directly related to current offshore oil and gas drilling and production. These incidents are notable for their magnitude and/or the potential risk they expose, and include a broad range of causes including:

- Drilling accidents (Western Australia, August-November 2009)
- Severe storm damage (Katrina and Rita, 2005; Ike, 2008)
- Aging pipeline infrastructure (Eugene Island Pipeline, July 2009)

I. Drilling Accidents: The Montara / West Atlas Blowout and Spill

On August 21, 2009, Seadrill, a Norwegian offshore drilling services company[1], was working from their West Atlas portable jackup drilling rig at the new Montara oil production platform in the Timor Sea, about 150 miles off the coast of Western Australia, at a water depth of 260 feet[2]. The West Atlas rig was drilling a new production well[3] when one of the previously completed and temporarily plugged wells on the platform experienced a "blowout," ejecting its cement plug and spewing oil, natural gas, and vaporized natural gas condensate[4] into the air and water. The rig and platform were immediately evacuated, with no injury to the 69 workers involved. Due to the extreme fire and explosion hazard posed by the situation, all personnel were excluded from the immediate vicinity of the platform and rig[5].

For the next ten weeks, oil and gas flowed from the damaged well unabated[6], despite repeated attempts to plug the well (Figure 1). Australian authorities and the platform operator, PTTEP-Australasia[7], responded primarily by aerial spraying of chemical dispersants on the oil slick, with limited boom-and-skimmer operations to mechanically recover the spilled oil. PTTEP determined that the best way to stop the flow from the damaged well was to drill a relief well that would intercept the damaged well at a point approximately 8,600 feet below the seafloor[8]. Because the West Atlas drill rig was deemed too hazardous for personnel, a second jackup drill rig, the West Triton, was transported from Singapore[9]. The West Triton rig did not arrive on-scene until September 10, nearly three weeks after the spill began[10]. It was stationed about 6,500 feet from the West Atlas drill rig[11], and began to drill the relief well.

---

[1] http://www.seadrill.com/
[2] http://www.worleyparsons.com/Projects/Pages/MontaraPlatform.aspx
[3] http://www.offshore-mag.com/index/article-display/6066428130/articles/offshore/company-news/australia-new-zealand/2009/08/seadrill-issues_update.html
[4] http://www.ens-newswire.com/ens/aug2009/2009-08-24-02.asp
[5] http://www.abc.net.au/news/stories/2009/08/25/2666754.htm
[6] http://www.watoday.com.au/photogallery/wa-news/the-west-atlas-oil-spill/20090829-f34l.html
[7] http://www.au.pttep.com/
[8] http://www.news.com.au/perthnow/story/0,21598,26172761-5017962,00.html
[9] http://www.theaustralian.com.au/news/breaking-news/oil-gas-leak-to-continue-for-seven-weeks/story-fn3dxity-1225765343929
[10] http://www.watoday.com.au/wa-news/mobile-rig-to-clean-up-oil-arrives-today-20090910-fj8p.html
[11] http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aUYFMY8a.T6U

Nearly one month later, on October 6 the relief well had finally reached the target depth and the first attempt was made to intercept the damaged well, a target about ten inches in diameter. This attempt missed the well[12], requiring the crew on the West Triton to pull the drillstring back and drill forward again on a slightly different trajectory, a process that takes several days to accomplish. This process was repeated three more times without success. Finally, on November 1, the fifth attempt to intercept the damaged well succeeded[13]. The West Triton crew began pumping heavy drilling mud into the damaged well to squelch the flow of oil and gas. Concurrently, the damaged well ignited (Figure 2), engulfing the Montara platform and attached West Atlas drill rig in flames[14]. The fire continued for two days[15] before finally burning out all the residual oil and gas in the well and other combustible materials on the structures (Figure 3).

At this time, leakage from the damaged well has been stopped. Engineers are assessing the structural integrity of the Montara platform, heavily damaged by the fire. The $250M West Atlas drill rig is reported to be a total loss[16]. Difficult and complex work remains to re-enter the damaged well so a permanent cement plug can be installed[17]. The ultimate disposition of the other previously drilled production wells has not been announced.

Oil and gas flowed uncontrollably from the damaged Montara well for 73 days. No estimate has been made of the amount of methane – a potent greenhouse gas – released during this event. Estimates of the amount of oil spilled vary widely. Based on visual approximation only, PTTEP estimated 400 barrels (16,800 gallons) per day[18]. The Australian government's Department of Resources, Energy and Tourism estimated the spill rate at "up to 2,000" barrels per day[19]. The Australian Greens party collected data on the measured flow rates from other oil wells in the vicinity and came up with an estimate of 3,000 barrels per day[20]. These spill rates translate into total spill volumes of 1.2 million gallons, 6.1 million gallons, and 9.2 million gallons respectively. For comparison, the *Exxon Valdez* tanker spill in Alaska in 1989 released an estimated 10.8 million gallons[21].

Even at the lowest estimate of 400 barrels per day, the Montara event ranks as the worst production-related spill in Australia's 40-year history of offshore energy development[22]. SkyTruth obtained daily

---

[12] http://www.news.com.au/perthnow/story/0,21598,26172761-5017962,00.html
[13] http://www.google.com/hostednews/afp/article/ALeqM5gwLtvodwRVStfa7BCRLFsX6WbqPg
[14] http://www.google.com/hostednews/afp/article/ALeqM5jBnSKYWjVXfddqxWb00p8eb6SqXQ
[15] http://www.google.com/hostednews/afp/article/ALeqM5gwLtvodwRVStfa7BCRLFsX6WbqPg
[16] http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aFa6kCclA1Yg
[17] http://www.google.com/hostednews/afp/article/ALeqM5gwLtvodwRVStfa7BCRLFsX6WbqPg
[18] http://www.watoday.com.au/wa-news/oil-spill-is-now-one-of-australias-worst-20091022-hagd.html
[19] http://www.theaustralian.com.au/news/nation/timor-oil-leak-larger-than-claimed/story-e6frg6pf-1225790241987
[20] http://www.news.com.au/perthnow/story/0,21498,25996354-2761,00.html?from=public_rss
[21] http://www.sciencentral.com/video/2009/03/24/exxon-valdez-anniversary/
[22] http://www.bloomberg.com/apps/news?pid=20601130&sid=asC4plvYuEuE

NASA satellite imagery throughout the course of the spill to track and measure the locations of oil slicks and sheen in the Timor Sea[23]. MODIS[24] satellites capture light reflected from the Earth's surface in visible and infrared wavelengths. MODIS imagery on August 30[25] showed slicks and sheen spread across an area of 2,500 square miles[26] (Figure 4). On September 3 patches of slicks and sheen ranged across 5,800 square miles[27] (Figure 5). On September 24, MODIS images showed slicks and sheen spanning nearly 10,000 square miles of the Timor Sea[28], an area larger than the state of Maryland[29].

Before the spill was stopped on November 1, satellite images obtained and analyzed by SkyTruth showed that oil slicks and sheen had cumulatively ranged across more than 24,000 square miles of ocean[30], an area the size of West Virginia. Slicks had moved far into Indonesian territorial waters[31], coming within 40 miles of the Timor coast and within 20 miles of islands along Western Australia's biologically rich Kimberley coast. Slicks and sheen were observed at times as far as 225 miles away from the leaking Montara well.

Preliminary investigations of the spill's environmental impacts by World Wildlife Fund[32] and by Australian government-funded researchers[33] have documented impacts on seabirds and marine mammals. Timorese and Australian fishermen have cited fish kills and significant declines in catch in the region affected by the spill and the application of dispersants[34]. News accounts report that fishermen are going bankrupt as a result of the steep decline in catch[35]. A multi-year study of the spill's impacts and lingering toxicity is being launched[36]; recent studies of the Exxon Valdez spill aftermath suggest that measurable impacts on ecosystem health and fisheries can be anticipated for decades[37].

The Australian government has launched an investigation into the causes of the Montara blowout, effectiveness of the response, and environmental impacts[38]. This investigation is expected to take at

---

[23] http://blog.skytruth.org/search?q=timor
[24] http://modis.gsfc.nasa.gov/
[25] http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=40029
[26] http://blog.skytruth.org/2009/09/timor-sea-drilling-spill-covers-2500.html
[27] http://blog.skytruth.org/2009/09/timor-sea-drilling-spill-covers-5800.html
[28] http://blog.skytruth.org/2009/09/timor-sea-drilling-spill-september-24.html
[29] http://www.ipl.org/div/stateknow/popchart.html#statesbysize
[30] http://www.flickr.com/photos/skytruth/sets/72157622226354812/
[31] http://www.flickr.com/photos/skytruth/3951854968/sizes/l/in/set-72157622226354812/
[32] http://www.wwf.org.au/publications/montaraoilspillreport/
[33] http://www.environment.gov.au/coasts/publications/pubs/montara-rapid-survey.pdf
[34] http://www.news.com.au/perthnow/story/0,21598,26286663-5017007,00.html
[35] http://www.abc.net.au/news/stories/2009/11/07/2736012.htm
[36] http://thegovmonitor.com/energy_and_environment/australia-looks-at-long-term-environmental-plan-for-montara-oil-spill-13389.html
[37] http://www.time.com/time/health/article/0,8599,1902333,00.html
[38] http://www.watoday.com.au/environment/inquiry-announced-into-timor-sea-oil-spill-20091105-hz7x.html

least six months to come to completion[39]. Ideally, it will include an analysis of regulatory gaps or weaknesses that may have contributed to or allowed the occurrence of this accident. As with most major spills, it is unlikely that the exact causal chain of events will be repeated anywhere, including in U.S. waters. Yet the Montara blowout and spill offers cautionary lessons about modern offshore drilling, regardless of its cause:

1. The West Atlas drill rig is new, technologically advanced equipment, built in 2007[40]. It is a jackup rig[41], a style commonly used for drilling in relatively shallow water (<400 feet), including much of the Gulf of Mexico continental shelf. The Montara production platform is also new equipment. Construction was completed in 2008[42], and the platform was installed in 2009 by an Australian engineering firm[43].
2. The West Atlas rig is owned and operated by Seadrill, a major international offshore drilling contractor that operates a global fleet of 41 drilling units, including nine that are under construction[44]. They have an office in Houston, identify the Gulf of Mexico as an important business target[45], and are currently under contract with Devon Energy to drill deepwater wells in the U.S. Gulf of Mexico using their new West Sirius semisubmersible rig[46]. All of the personnel present when the Montara blowout occurred were working on the West Atlas rig[47].
3. The U.S. Minerals Management Service has investigated 18 blowouts and 13 losses of well control in the U.S. Gulf of Mexico since 1983, with three such incidents occurring since 2007[48].
4. The Montara platform is located in relatively shallow water (260 feet), and the Montara well suffered a failure 8,600 feet below the seafloor. Despite generally calm tropical seas and favorable weather for offshore operations, more than ten weeks elapsed before the Montara blowout could effectively be killed by one of the world's leading well-control contractors (Alert Well Control)[49]. In contrast, drilling in the U.S. Gulf of Mexico has moved into ultradeep waters, approaching 10,000 feet for some recently targeted plays on the continental slope[50], and wells in the Gulf are now being drilled to depths exceeding 30,000 feet below the seafloor[51]. The Gulf of Mexico and Atlantic coasts are regularly hit by tropical storms[52]. Portions of the Arctic, where offshore energy development is being considered, feature adverse winter conditions

---

[39] http://www.cbsnews.com/stories/2009/11/05/ap/business/main5530677.shtml
[40] http://www.seadrill.com/stream_file.asp?iEntityId=935
[41] http://oilgasglossary.com/jackup-drilling-rig.html
[42] http://www.rigzone.com/news/article.asp?a_id=64979
[43] http://www.upstreamonline.com/live/article172586.ece
[44] http://www.seadrill.com/modules/module_123/proxy.asp?D=2&C=19&I=1772&mid=18
[45] http://www.drillingcontractor.org/dcpi/dc-julyaug08/DC_July08_Seadrill.pdf
[46] http://www.rigzone.com/news/article.asp?a_id=69946
[47] http://drillingclub.proboards.com/index.cgi?board=wellcontrol&action=display&thread=4315&page=1
[48] http://www.gomr.mms.gov/homepg/offshore/safety/acc_repo/accindex.html
[49] http://www.upstreamonline.com/live/article197622.ece
[50] http://www.gomr.mms.gov/PDFs/2009/2009-016.pdf
[51] http://blog.nola.com/tpmoney/2008/05/mcmoran_says_highprofile_black.html
[52] http://commons.wikimedia.org/wiki/File:Atlantic_hurricane_tracks_1980-2005.jpg

characterized by sea ice, subzero temperatures, tropical storm-force winds, and low visibility. Effective response to a comparable accident in the deepwater Gulf, or mid-winter Arctic, could be significantly more difficult, prolonged, and costly.

II. Storm Damage: Hurricanes Katrina, Rita and Ike

In late August of 2005, Hurricane Katrina moved through oil fields in the central Gulf of Mexico as a Category 5 storm[53]. Just three weeks later another Category 5 storm, Hurricane Rita[54], drove through the offshore infrastructure in the western Gulf. SkyTruth acquired radar satellite images taken a few days after Katrina made landfall[55]. Our analysis of these images revealed extensive oil slicks covering more than 700 square miles in the Gulf of Mexico (Figure 6). Close examination revealed multiple sources for the slicks, including known platform locations[56] (Figure 7). Months later, the Minerals Management Service reported that Katrina and Rita had destroyed more than 100 platforms (Figure 8) and severely damaged more than 50 others; damaged more than 450 pipelines; and caused at least 124 separate spills in the Gulf totaling 750,000 gallons of oil and other liquid hydrocarbons (primarily based on self-reporting by industry)[57]. Five drilling rigs were destroyed, and 19 others were severely damaged[58]. Nineteen mobile drilling units were broken loose from their moorings and set adrift by the storms, dragging their heavy anchor chains on the seafloor and causing much of the pipeline damage[59]. We conclude that many of the oil slicks SkyTruth identified on satellite images of the Gulf resulted from pipelines damaged in this manner.

Aside from the direct damage to, and spills from, offshore facilities, these storms exposed a significant and previously unrecognized risk posed by offshore production: catastrophic spills resulted from the onshore oil and gas infrastructure that supports offshore production in the Gulf – the refineries, pipelines, and tanks required to receive, process, store and distribute oil and gas from offshore fields. In a May, 2006 report to the U.S. Department of Homeland Security, the U.S. Coast Guard reported that Katrina and Rita released over 9 million gallons of oil, not including more than 5,000 minor spills[60]. Storm-damaged onshore infrastructure spilled 7 to 8 million gallons of oil into coastal wetlands, streams, and communities. A single spill from a ruptured storage tank at the Murphy Oil Refinery inundated

---

53 http://www.katrina.noaa.gov/
54 http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=15546
55 http://blog.skytruth.org/2007/12/hurricane-katrina-gulf-of-mexico-oil.html
56 http://skytruth.mediatools.org/node/12846
57 http://www.mms.gov/ooc/press/2006/press0501.htm
58 http://meetingorganizer.copernicus.org/EGU2009/EGU2009-13707.pdf
59 http://www.mms.gov/tarprojects/581/44814183_MMS_Katrina_Rita_PL_Final%20Report%20Rev1.pdf
60 http://www.uscg.mil/ccs/npfc/docs/PDFs/Reports/osltf_report_hurricanes.pdf

more than 1,700 homes in the towns of Chalmette and Meraux, Louisiana, with more than one million gallons of crude oil[61] (Figures 9 and 10).

On September 13, 2008, this coastal vulnerability was exposed again when Hurricane Ike made landfall near Galveston, Texas, with Category 2 winds but a storm surge more typical of a Category 5 event. Coastal oil facilities were flooded. SkyTruth obtained NOAA aerial survey photographs[62] that showed extensive oil slicks emanating from coastal wells[63] and damaged storage facilities[64] (Figure 11). Onshore facilities related to offshore production continue to pose risks that should be acknowledged and effectively managed.

III. Pipeline Spills: Aging Infrastructure

Oil and gas infrastructure can become damaged and cause oil spills even in the absence of major storms. On July 25, 2009, Shell Oil Co. reported to the U.S. Coast Guard's National Response Center that they had detected a loss of pressure in the Eugene Island Pipeline off Louisiana. Divers found a crack in the 20" diameter pipe at a point about 30 miles offshore, in water about 60 feet deep[65]. 63,000 gallons of oil leaked into the Gulf[66], a "medium" spill by Coast Guard definition. Radar satellite imagery from NOAA showed the resulting oil slick[67], which eventually stretched over 15 miles and reached a size of 80 square miles[68] before it was effectively dispersed (Figure 12). Had this break occurred from a point closer to shore, beaches and coastal resources could have been directly impacted (Figure 13), as they were with the 1997 Torch spill from a pipeline just off the California coast[69].

The Eugene Island Pipeline was installed in 1976[70]. In 2009[71] it began carrying oil produced from Chevron's new deepwater "Tahiti" platform[72], situated approximately 190 miles south of New Orleans[73]. In a common industry practice, Tahiti was "tied back" to the existing infrastructure: new pipeline was only extended 55 miles from Tahiti to Shell's Boxer platform, where it was connected to the existing

---

[61] http://www.epa.gov/katrina/testresults/murphy/
[62] http://ngs.woc.noaa.gov/ike/IKE0000.HTM
[63] http://www.flickr.com/photos/47684393@N00/2861763336/sizes/l/
[64] http://www.flickr.com/photos/skytruth/2924786274/sizes/l/
[65] http://www.incidentnews.gov/attachments/8061/524175/EugeneIslandNewsRelease090729.pdf
[66] http://www.incidentnews.gov/incident/8061
[67] http://www.incidentnews.gov/attachments/8061/524191/NESDIS_Analysis.jpg
[68] http://www.incidentnews.gov/entry/524230
[69] http://www.dfg.ca.gov/ospr/spill/nrda/nrda_irene.html
[70] http://www.reuters.com/article/environmentNews/idUSTRE56R46E20090729
[71] http://www.chevron.com/news/Press/release/?id=2009-05-06
[72] http://www.gasandoil.com/goc/company/cnn71530.htm
[73] http://www.offshore-technology.com/projects/tahiti/

pipeline network[74]. From Boxer, Tahiti oil flowed to shore through older pipelines including the Eugene Island Pipeline.

The cause of the Eugene Island Pipeline failure has not yet been publicly reported, but as the existing nearshore pipeline network ages, structural failures become increasingly likely due to accumulated strain and corrosion. Offshore production of oil in the U.S. Gulf of Mexico began in the late 1940s[75]. In 2006, federal waters in the Gulf of Mexico produced 5.5 trillion cubic feet of natural gas and 400 million barrels of crude oil[76]. Today, the seafloor in the western and central Gulf is crisscrossed by a complex network of over 25,000 miles of active pipeline, connecting 3,600 platforms and thousands of oil and gas wells to coastal processing, storage and distribution facilities[77] (Figure 14). A recent SkyTruth analysis of pipeline data from the Minerals Management Service showed that 60 miles of still-active pipeline exceed 30 years in age. But most of the active pipeline segments in the MMS online dataset – totaling over 18,000 miles, or 72% of the active pipeline network – lack information pertaining to their installation date[78], so the real extent of the age problem is elusive.

Rigorous inspection and maintenance, routine monitoring, and aggressive programs to decommission aging pipeline can help manage the risk. But effective design and implementation of such programs may be complicated by the existing regulatory regime for offshore pipelines, with jurisdiction split between two separate agencies, the Department of Transportation and the Department of the Interior. This is a classic example of gaps and overlaps in ocean governance of the kind discussed in a widely quoted 2006 paper[79] in the journal *Science*.

IV. <u>Key Observations</u>

Based on SkyTruth's experience over the past five years investigating significant oil spill incidents caused by drilling mishaps, severe storm damage, and leaking pipelines, we offer the following thoughts:

1. Offshore oil and gas production is a complex, technically challenging industrial activity. Relatively small spills occur regularly and, although accidents that lead to major spills are not common, they do still occur and pose a continuing threat to other marine and coastal resources, and to the communities and economic systems that depend on the integrity and sustainability of those other resources.

---

[74] http://www.subseaiq.com/data/Project.aspx?project_id=127&AspxAutoDetectCookieSupport=1
[75] http://www.gomr.mms.gov/homepg/regulate/environ/history_louisiana.html
[76] http://tonto.eia.doe.gov/dnav/pet/pet_crd_gom_s1_a.htm
[77] http://www.gomr.mms.gov/homepg/pubinfo/repcat/arcinfo/index.html
[78] http://www.gomr.mms.gov/homepg/pubinfo/repcat/arcinfo/zipped/8321.zip
[79] Crowder, L.B., G. Osherenko, O.R. Young, S. Airamé, E.A. Norse, N. Baron, J.C. Day, F. Douvere, C.N. Ehler, B.S. Halpern, S.J. Langdon, K.L. McLeod, J.C. Ogden, R.E. Peach, A.A. Rosenberg, and J.A. Wilson (2006). Resolving mismatches in U.S. ocean governance. Science, v. 313, pp. 617-618

2. While continual improvements to comprehensive regulation and enforcement, coupled with advances in technology and technique, can significantly reduce the likelihood of accidents that lead to major spills, offshore production still poses risks.
3. When things go wrong offshore, the results can be disastrous, difficult to remediate, and extremely costly[80] to both industry and society[81]. The risk becomes much higher in deeper water, in stormy locations, or where other difficult conditions (such as ice cover) slow and complicate oil spill response.
4. Prepare for the worst. Determine the worst-case scenario wherever drilling is allowed, and integrate that scenario into the processes that will guide the decisionmaking and management of our nation's marine and coastal resources.

Other impacts, not addressed in this testimony, can also occur. This testimony does not provide a comprehensive analysis of the pollution that inevitably accompanies an intensive industrial resource extraction operation such as oil and gas production. Other important topics that should be thoroughly investigated and carefully considered when weighing the merits of offshore drilling include:

- The routine, expected pollution from drilling and production activities (air, water).
- The occurrence of minor accidental spills and discharges. See Table 1, for example, showing the frequency of spills >2100 gallons. Data addressing the frequency and cumulative impact of smaller spills are difficult to come by[82].
- Fugitive emissions of methane, a potent greenhouse gas, from oil and gas development activities and facilities.
- The short- and long-term environmental, economic, and sociological impacts of spills and pollution.

[80] http://www.watoday.com.au/environment/cause-of-wa-oil-spill-revealed-20091109-i59k.html
[81] http://www.watoday.com.au/wa-news/oil-spill-cleanup-cost-tops-5-million-20091020-h6qx.html
[82] Fraser, G.S., J. Ellis, and L. Hussain, 2007. An international comparison of governmental disclosure of hydrocarbon spills from offshore oil and gas installations. *Marine Pollution Bulletin*, v. 56, pp. 9-13.

TABLE 1. Annual number of offshore spills greater than 50 barrels in U.S. waters, Gulf of Mexico (GOM) and Pacific (PAC), 1996-2009. Source: U.S. Minerals Management Service, "Spills - Statistics and Summaries 1996-2009"
http://www.mms.gov/incidents/spills1996-2008.htm

	1996		1997		1998		1999	
	GOM	PAC	GOM	PAC	GOM	PAC	GOM	PAC
Crude Oil & Natural Gas Condensate	0	1	1	0	3	0	2	0
Refined Petroleum, e.g. Diesel, Lube Oil	2	0	0	0	1	0	1	0
Synthetic - Based Fluids	0	0	0	0	0	0	1	0
Chemical, e.g., Zinc Bromide, Glycol	1	0	2	0	5	0	1	0
(Total)	3	1	3	0	9	0	5	0
Combined total for the Year	**4**		**6**		**18**		**10**	

	2000		2001		2002		2003	
	GOM	PAC	GOM	PAC	GOM	PAC	GOM	PAC
Crude Oil & Natural Gas Condensate	3	0	1	0	1	0	0	0
Refined Petroleum, e.g. Diesel, Lube Oil	0	0	0	0	2	0	3	0
Synthetic - Based Fluids	5	0	5	0	7	0	7	0
Chemical, e.g., Zinc Bromide, Glycol	0	0	3	0	2	0	2	0
(Total)	7	0	9	0	12	0	12	0
Combined total for the Year	**7**		**9**		**12**		**12**	

	2004		2005		2006		2007	
	GOM	PAC	GOM	PAC	GOM	PAC	GOM	PAC
Crude Oil & Natural Gas Condensate	11	0	32	0	7	0	1	0
Refined Petroleum, e.g. Diesel, Lube Oil	4	0	7	0	0	0	0	0
Synthetic - Based Fluids	5	0	5	0	5	0	2	0
Chemical, e.g., Zinc Bromide, Glycol	4	0	6	0	2	0	1	0
(Total)	22	0	49	0	14	0	4	0
Combined total for the Year	**22**		**49**		**14**		**4**	

	2008		2009	
	GOM	PAC	GOM	PAC
Crude Oil & Natural Gas Condensate	19	0	2	0
Refined Petroleum, e.g. Diesel, Lube Oil	5	0	0	0
Synthetic - Based Fluids	2	0	1	0
Chemical, e.g., Zinc Bromide, Glycol	12	0	2	0
(Total)	33	0	5	0
Combined total for the Year	**33**		**5**	

Figure 1. Oil, natural gas, and vaporized natural gas condensate leaking from the Montara oil platform and West Atlas drill rig in the Timor Sea off Western Australia, August 2009. Photograph by Chris Twomey, courtesy WA Today.

Figure 2. West Atlas drill rig (left) and Montara oil platform engulfed by flames following fifth and ultimately successful attempt to intercept the leaking well on November 1, 2009. Photograph provided by PTTEP-Australasia.

Figure 3. Aftermath of the fire: detail of the $250M West Atlas drill rig, likely a total loss. Taken on or about November 3, 2009 by an anonymous photographer.

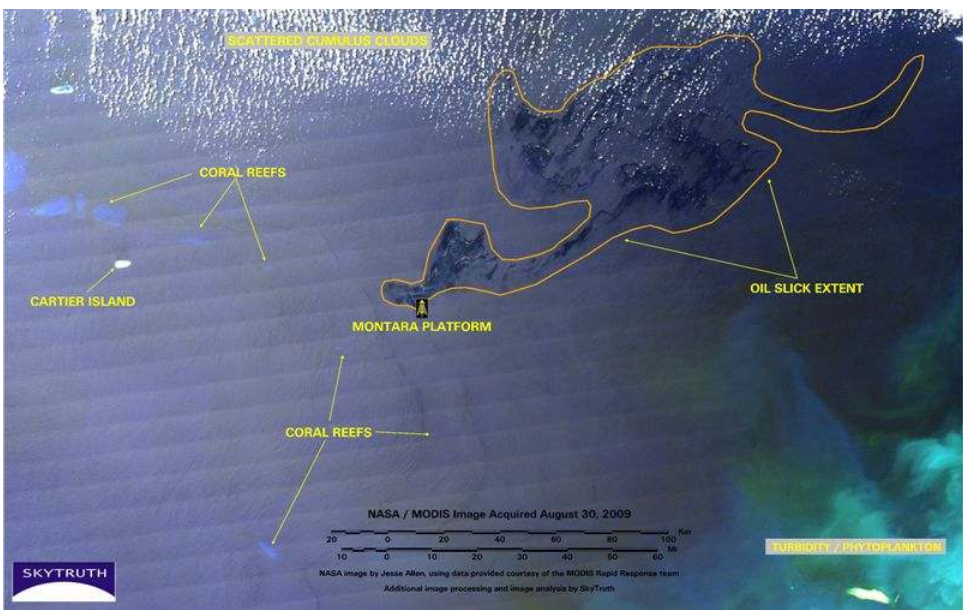

Figure 4. NASA satellite image showing oil slicks and sheen emanating from Montara oil platform, August 30, 2009. Area affected covers 2,500 square miles. Analysis by SkyTruth.

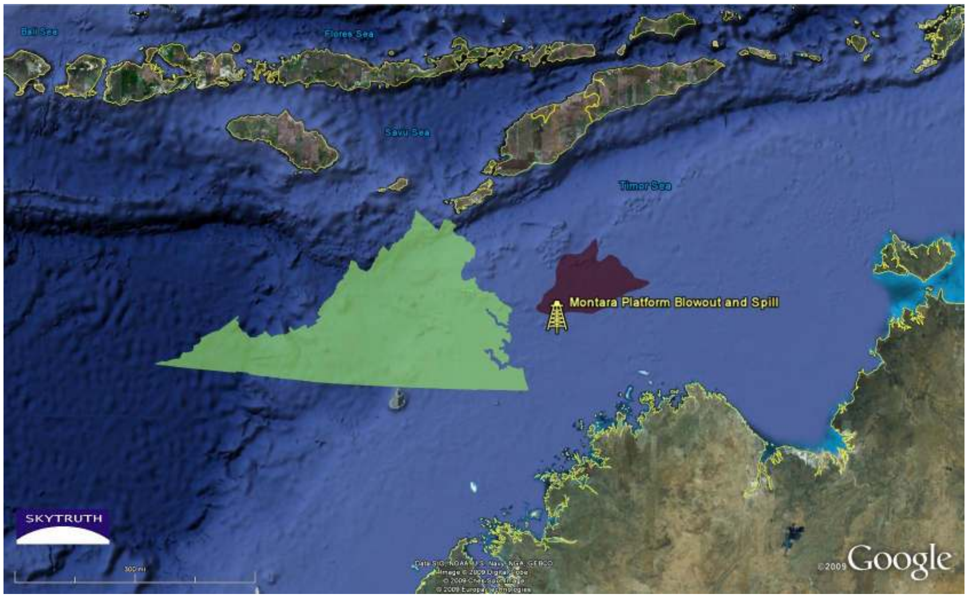

Figure 5. Map showing Montara platform location and 5,800 square mile area covered by slicks and sheen on September 3, 2009 (red). State of Virginia (green) is shown at same scale. Analysis by SkyTruth.

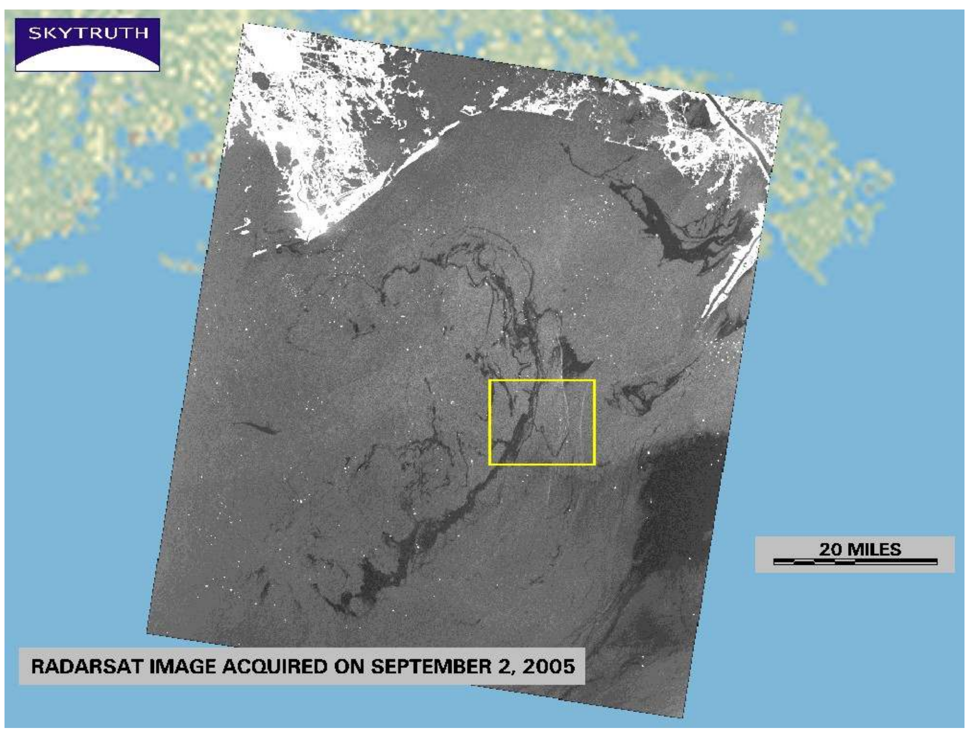

Figure 6. Radar satellite image showing extensive oil slicks and sheen (black) in the Gulf of Mexico following Hurricane Katrina. Yellow box indicates area shown in Figure 7. Analysis by SkyTruth.

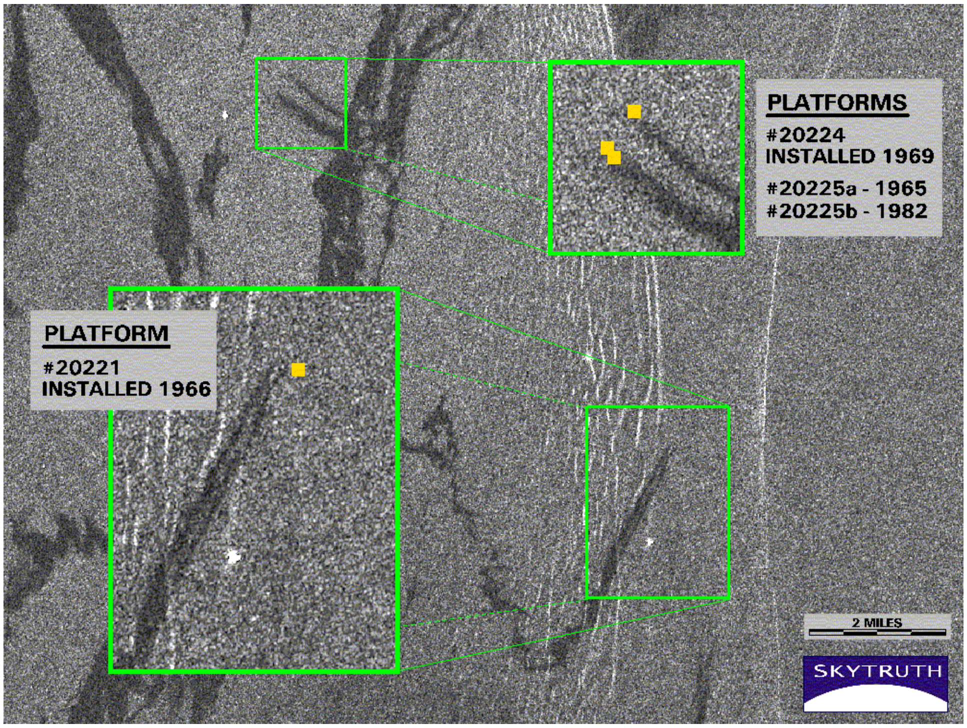

Figure 7. Detail from Figure 6 showing multiple sources for post-Katrina oil slicks. Known platform locations shown as yellow squares. Analysis by SkyTruth.

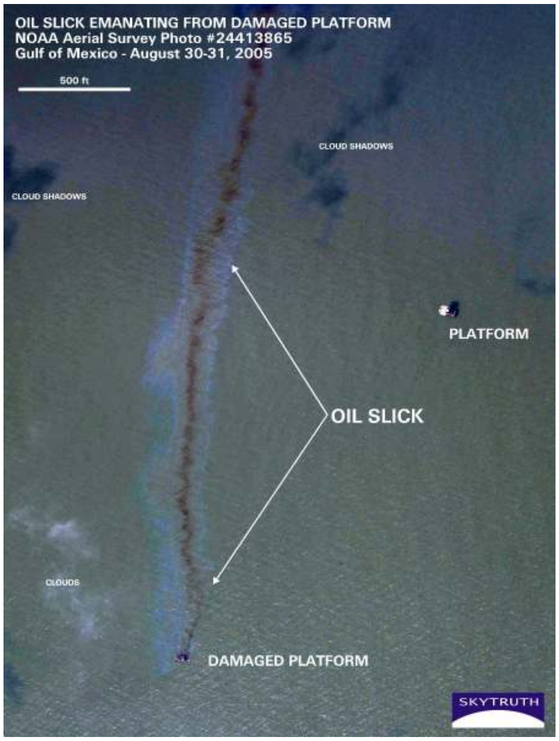

Figure 8. NOAA aerial survey photo showing oil leak from Katrina-damaged platform. Analysis by SkyTruth.

Figure 9. Over one million gallons of oil spilled from a storage tank damaged by Hurricane Katrina. The U.S. Coast Guard estimated at least 9 million gallons of oil were spilled from combined Katrina-Rita damage to offshore and coastal facilities. Photograph by U.S. Environmental Protection Agency.

Figure 10. Crude oil from a failed storage tank impacted 1,700 homes in Chalmette and Meraux, Lousiana. Source: http://commons.wikimedia.org/wiki/File:Murphy_Oil_Spill_Chalmette_Oil_inside_of_house.jpg.

Figure 11. NOAA aerial photographs showing oil spilled from coastal facilities near Galveston, Texas, following landfall by Hurricane Ike in 2008. Analysis by SkyTruth.

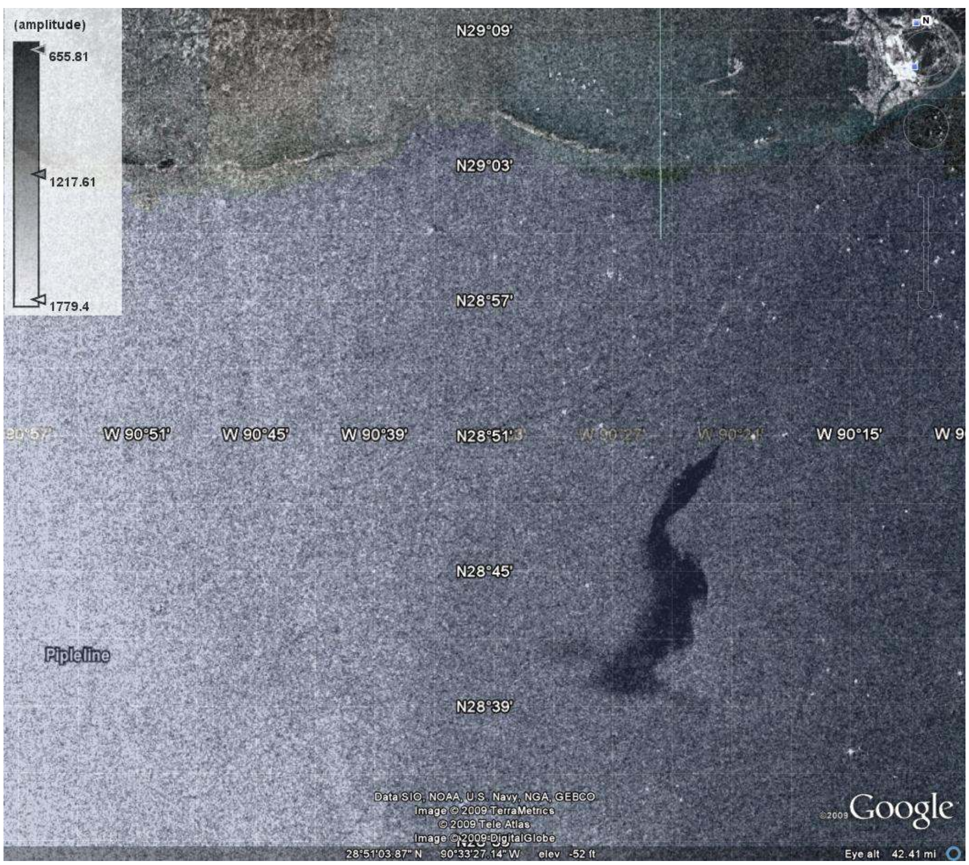

Figure 12. Satellite radar image showing 15-mile-long oil slick caused by Eugene Island Pipeline break in July 2009. Image courtesy of NOAA/NESDIS.

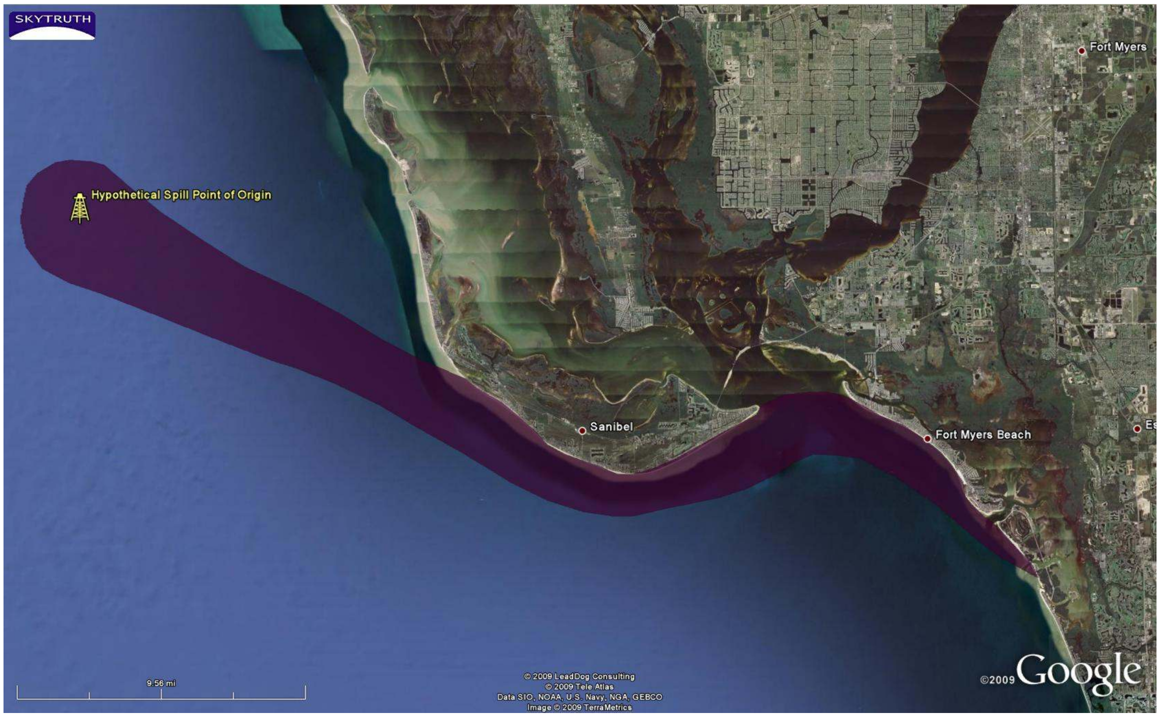

Figure 13. Illustration showing a hypothetical 80-square-mile oil slick originating from a source ten miles off shore. Sanibel Island at center. Illustration by SkyTruth.

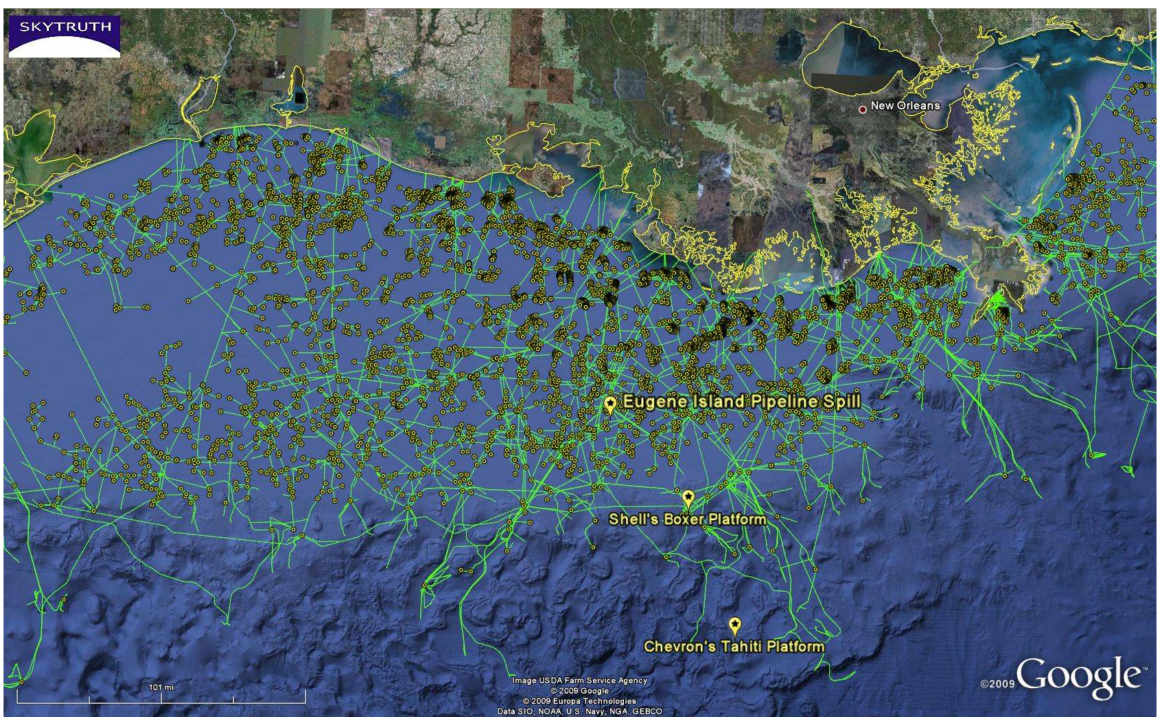

Figure 14. Map showing a portion of the active pipeline (green) and platform (yellow dots) infrastructure in the U.S. Gulf of Mexico. There are currently 25,000 miles of active pipeline and 3,600 active platforms. Map by SkyTruth.