Paper #2-16

BIODIVERSITY MANAGEMENT AND TECHNOLOGY

Prepared by the Technology Subgroup
of the
Operations & Environment Task Group

On September 15, 2011, The National Petroleum Council (NPC) in approving its report, *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Task Groups and/or Subgroups. These Topic and White Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic and White Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 57 such working documents used in the study analyses. Also included is a roster of the Subgroup that developed or submitted this paper. Appendix C of the final NPC report provides a complete list of the 57 Topic and White Papers and an abstract for each. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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ABSTRACT

Exploration and production (E&P) technologies and business practices have the ability, motivation and demonstrated case histories to drive forward biodiversity protection along with hydrocarbon resource development. Some common polarized viewpoints – such as all development is bad for biodiversity or that biodiversity protection is prohibitively expensive to commerce – are rendered obsolete by many global case studies where development and biodiversity have enjoyed balanced, positive outcomes thanks to thoughtful collaborations among stakeholders.

Technology plays a significant role in the E&P efforts to protect biodiversity in three ways. First, in the area of direct impacts, technology can play a key role in reducing the footprint of E&P operations. Secondly, the science of measuring biodiversity indicators to evaluate the effectiveness of biodiversity protection can be enhanced. Finally, communication technology and practices are key elements to manage secondary E&P impacts to biodiversity. Global citizenship programs and social responsibility programs are a growing element of the cultural evolution that includes health, safety and environmental protection.

One of the key aspects of biodiversity protection in the E&P industry has been a focus on reducing the operational footprint of E&P activities. Major progress has been made to reduce the number of well pads that must be built to recover available oil and gas resources. Refinements in seismic prospecting techniques have led to many fewer "dry holes", thereby allowing emphasis to shift toward developing hydrocarbon fields with a minimum number of well locations. Smaller-footprint development typically is accomplished with directional and horizontal drilling that allows many wells to be drilled from a single well pad and thus removing the need for multiple locations and associated roads.

Biodiversity challenges will be met with a combination of proactive programs and technology. Social responsibility programs and related biodiversity protection programs will move toward reduced impacts from E& P operations. Biodiversity technology will involve the following.

- Advanced systems of monitoring biodiversity resources and documenting existing resources.
- Advanced systems for planning to protect biodiversity resources.
- Advanced products, drilling techniques, seismic techniques, production techniques all moving toward lowering footprint and negative impacts on biodiversity.
- Developing systems for monitoring the effectiveness of biodiversity protection technology.
- Advanced systems for recovery, remediation and offsetting negative impacts to biodiversity resources form E&P activities.

BIODIVERSITY OVERVIEW

Life on Earth developed within a highly complex, interactive web involving animal and plant species that established delicate interdependencies with each other. Because the numbers, types and sensitivities of such interdependencies are only partly understood, caution is necessary in all human actions that might disturb the web of life. Biodiversity denotes the reality of that complex existence as well as the scientific discipline for its study (National Research Council, 1992).

From a narrow and polarizing perspective, biodiversity protection is sometimes seen as an all-or-nothing issue. From that potentially confrontational position, the divisive idea arises that biodiversity protection and oil and gas exploration and production (E&P) development cannot co-exist. However, an emerging view of the oilfield and biodiversity protection is finding a different view that demonstrates that E&P operations and biodiversity protection can and do co-exist.

Over the history of E&P operations, there has been a can-do spirit that promotes innovation to overcome challenges. Such is the case with biodiversity protection. From a global perspective, biodiversity is fundamental to our existence. We depend on it for almost every aspect of our lives. Scientists have catalogued 1.75 million species but estimate that there are still millions more yet to be identified (Species 2000, 2011). The future options for biodiversity, and humankind's possible use of it, drive many to argue that we should be cautious about how we manage and use it. From an E&P business perspective, protecting biodiversity is crucial to the future of E&P operations. There are legal and regulatory requirements, strategic, operational, reputation and financial reasons why biodiversity is important.

In order to see the big picture on protecting biodiversity, it is important to understand that the issue involves a range of threats:

- Habitat loss
- Changing land use
- Over harvesting/exploitation
- Alien species
- Pollution
- Climate change
- Human population growth

Although E&P is by no mean the only potential threat to biodiversity, managing the impacts of E&P will be a continuing activity in light of the world's dependence on hydrocarbon-based fuels for at least the next several decades.

BIODIVERSITY TECHNOLOGY

A. Technology Context

Historical environmental protection efforts have focused on discharges of water and waste as well as air pollution. Those concerns were addressed mostly in parallel with similar issues in other industries and commercial operations. While significant strides have been made in the area of waste minimization, ongoing efforts to protect the environment resulted in the awareness that the impact to the environment from E&P operations extended beyond direct discharges. Biodiversity is short for biological diversity. The Convention on Biological Diversity (CBD) defines biodiversity as: "The variability among living organisms and the ecological complexes of which they are part; including diversity within species, between species and of ecosystems." (CBD, 2006).

Technology plays a significant role in the E&P efforts to protect biodiversity in three ways. First, in the area of direct impacts, technology can play a key role in reducing the footprint of E&P operations. Second, the science of measuring biodiversity indicators to evaluate the effectiveness of biodiversity protection can be enhanced. Finally, communication technology and practices are key elements to manage secondary E&P impacts to biodiversity. Global citizenship programs and social responsibility programs are a growing element of the cultural evolution that includes health, safety and environmental protection.

B. Impacts of the Oil and Gas Industry

Unlike many industries that operate from a fixed location located in urban areas, E&P operations must go to where the oil and natural gas resources are located. In many cases those resources are located in remote areas and in some cases the resources are in locations with high biodiversity value. The overlap of hydrocarbon and biodiversity resources sets up a potential conflict between those who want to develop oil and gas resources and those who want to protect biodiversity resources. Oilfield operations have a range of potential negative direct impacts on species and ecosystems. Those potential impacts include soil, air and water contamination, habitat fragmentation, deforestation and erosion. Direct impacts are characterized by the specific operations associated with E&P activities such as the drilling rig and the roads specifically constructed within an oilfield to service the wells, comprising land modifications and traffic that can degrade biodiversity resources.

Oil and gas development in undeveloped areas can also indirectly lead to further secondary impacts, resulting in immigration and spontaneous settlement, land conversion for agriculture, building of infrastructure. Secondary impacts are characterized by the local population impacting biodiversity resources using the infrastructure established by E&P operations.

Many of the direct primary impacts of an oil or gas project can be reduced (if not fully overcome) through careful management and technology. Some of the secondary impacts present a larger challenge to industry and to society as a whole.

C. E&P Industry Management Techniques to Enhance Biodiversity

As with other operational, economic and discharge issues, once a concern is recognized the opportunity to manage the concern evolves appropriate and effective tools to achieve success. In the case of protecting biodiversity resources, the following list provides the basic tools used to recognize and protect biodiversity resources with the same level of importance as other critical business issues:

- Address biodiversity issues early on
- Consult with biodiversity experts
- Integrating biodiversity into the impact assessment process
- Carry out Biodiversity Baseline Assessment and Monitoring Studies
- Following up impact assessment with management systems
- Build biodiversity into performance monitoring
- Establishing a Biodiversity Working Group
- Providing communication tools to help raise internal awareness

While management techniques listed above are critical to success, more specific tools that involve the application of technology result in biodiversity on a project level. Those specific tools and the associated technologies are the focus of future developments in the area of biodiversity protection for E&P operations:

- Minimize discharges
- Minimize Foot print
- Minimization of habitat disturbance,
- Creating new habitat to offset habitat taken during operations,
- Prevention of introduction of invasive species,
- Restricting development of new areas through controlled access.

When the management tools and project tools are applied they must be adjusted to fit the specific ecosystem where the E&P operations occur.

In offshore regions, the two main concerns are ocean-bottom and coastal effects. First, there are some marine protected areas with hard-bottom communities that can be negatively impacted by discharges of solids from drilling operations. Second, the bases that support the offshore operations can impact coastal biodiversity resources. For the aspect of transporting tools and equipment, offshore operations have an easier job of protecting biodiversity resources because there is no need to build roads to the field operations and a single offshore base of operations can service a wide area of offshore operations.

Another regional concern is drilling in the wetlands. With the increased knowledge of the importance of wetlands to the ecosystem, a high level of importance has been placed on protecting wetlands areas. In south Louisiana, before drilling operations moved offshore there was extensive drilling in the wetlands. In those earlier times, the techniques used to drill the wells resulted in both direct and indirect impacts on the wetlands. Of specific concerns were the dredging operations that cut paths though the wetlands so that drilling barges could move from location to location. More recent drilling practices have evolved to minimize both direct and indirect impacts on the wetlands.

A third regional concern is the general category of upland areas. In upland areas, the key biodiversity challenges are roads and footprint of drilling operations. Concerns about roads and protection of biodiversity resources are not exclusively an oilfield issue. Roads have a range of biodiversity impacts that need to be addressed. In addition to roads, the practice of multiple drilling locations in a field lead can lead to concerns about habitat fragmentation.

Another region with special biodiversity concerns is the Arctic. In the earlier days of development on the North Slope of Alaska, the gravel roads and reserve pits both were common E&P practices. As efforts began to focus on minimizing biodiversity impacts, the routine use of ice roads and pad drilling have evolved the ability to protect biodiversity resources in the Arctic.

ENVIRONMENTAL BENEFITS AND ECONOMIC IMPACTS

A. Environmental Benefits

The environmental benefits of biodiversity protection technology are in line with the management tools and project-specific tools that were previously described. The importance of biodiversity resources have been recognized and the challenge of extracting oil and gas resources while protecting biodiversity resources is growing in importance. While the importance of direct biodiversity protection efforts are clear, the importance of a healthy and robust economy afforded by cost-effective oil and gas production is also well understood.

B. Economic Impacts

The major economic impact from biodiversity protection technology is the ability to keep drilling areas open. The polarized positions that have evolved from a public policy standpoint have often resulted in all-out prohibition of drilling operations. The ability to develop and apply technology to address biodiversity protection is the key to maintaining access to oil and gas resources. The other significant economic impact from biodiversity protection is cost of the controls placed on drilling operations in order to achieve increased biodiversity protection. In

some cases the cost of biodiversity protection measures exceeded the value of the oil and gas reserves that were being pursued. In most cases, when specific projects are under development it is easy to get lost in polarizing positions about the specific value of biodiversity protection. For example, how much is that bird worth, why must I spend *x* thousands of dollars protecting it? In the western areas of the US, there are vast areas of public land and biodiversity protection is frequently a regulatory issue. The use of land, construction of roads and protection of biodiversity resources is a public issue. The same can be said for Arctic drilling and offshore drilling. However, in the central and eastern areas, most land is privately held and the issue of land use and biodiversity protection is more difficult to track. Regardless of the region and regulatory implications, the economic impacts of biodiversity protection are increasing economic importance.

CASE HISTORIES OF BIODIVERSITY MANAGEMENT IN E&P PROJECTS

Sometimes the polarizing positions of to-drill or not-to-drill have overshadowed the significant progress that technology and innovative management techniques have been made toward biodiversity protection within E&P operations. In the following international examples, a range of both management techniques and technologies are discussed as examples of positive implementation of the techniques described above.

- Management of E&P operations in mangrove ecosystem (Indonesia)
- Management of pipeline installation. (NW shelf of Western Australia)
- Management of two oilfields in a protected area of a tropical rainforest (Gabon)

A. Indonesia Case History

In this first example, a company had been conducting production operations in a dense mangrove area for 30 years. The operations covered 2% of the delta plain areas. As with many drilling operations, local population shared the same ecosystem. The local community consisted of five districts with many villages and about 50,000 total inhabitants in the region. Previously the local inhabitants used trawl nets from fishing that were eventually prohibited from use in the 1980s. Once the trawl nets were prohibited, the population switched from fishing to shrimp culture. At the time of the paper in 2004, 73% of the mangrove system had been converted to in shrimp culture.

The biodiversity challenge evolved in the ecosystem within the 1990s when rapid increase of local population and deforestation due to shrimp culture development caused impacts to the mangrove ecosystem. Knowledge of mangrove ecosystems though study and monitoring uses a range of modeling and monitoring techniques. Once the mangrove system was damaged there was degradation of water quality, decreased shrimp and fish productivity, increased occurrence of disease on shrimps, increases in erosion and coastal abrasion.

Once the symptoms of ecosystem disruption began to appear, the operator experienced land disputes with shrimp farmers. As the occurrence of increased shrimp disease and decreasing harvest occurred, the local population had a tendency to place blame on the exploration and development operation. The ongoing disputes with the local population continued to impact the operations and resulted in an effort to address the issues in a proactive manner.

In this case history, the operator took several management steps to address the degradation of the ecosystem. First, for those areas within its own operational control, the E&P operations, minimized land clearing for operations, re-vegetated cleared land. Beyond its own operations, the operator conducted shrimp pond training for the local population and constructed a shrimp pond pilot project that preserved mangroves. In this case the biodiversity protection technology had to do with non-E&P operations and the new technology that was demonstrated allowed continued shrimp production with lower impacts on the mangrove forest.

Beyond addressing the ecological issues, the operator also engaged in addressing community issues. First, the operator participated in community development. In order to proactively address local concerns, they developed a system for management of environmental claims.

In addition to addressing community concerns, the operator, promoted community environmental awareness and impacts of their own activities on the environment. In order to promote trust and transparency, the operators involved the local community in exploration and development operations.

There were positive results from the management efforts. The programs were successful and the relationship between the company and the community improved. Through participation in environmental awareness the local community gained knowledge in the methods of sustainable management of shrimp culture activities and mangrove preservation. Besides being involved in monitoring process the local community were also employed in the E&P industry according to their skill level. Consequently, in this case the E&P operations in sensitive social and mangrove ecosystem required an integrated approach to minimize social and environmental impacts. The actions taken by the operator improved communication with the community and solved disputes and claims in a manner that met both business and environmental objectives. In this case, the biodiversity technology was integrated into community interaction which in many cases is beyond the traditional role of operators.

B. Offshore Australia Case History

The second case history takes place in a different receiving environment and the use of technology to protect biodiversity resources plays a leading role. In this operational situation an offshore drilling operation required two pipelines to be constructed in the North West Shelf of Western Australia. The construction of the pipelines required the use of a barge with eight anchors to lay pipe. In this case, the biodiversity challenges focused on the protection of sensitive coral resources. Though the use of advanced sensing technology, 237 sensitive seafloor areas were identified along first pipeline route and 1,150 sensitive seafloor areas were identified along the second pipeline route. As with many biodiversity protection projects, several management steps and technologies were used in concert. First, there was a novel application of

remote sensing data to identify sensitive receptors. Next, the operation development an effective method of mapping seafloor resources using GIS system. Extensive route planning was used that considered avoidance of sensitive areas. Since the greatest potential impact from the operation was the anchor system an innovative anchor management system was developed that included computer-based navigation of barge and real-time diver monitoring of anchor locations. In addition to the technology employed, there were management techniques used to further focus efforts toward protection of the natural resources. The operator developed a monetary incentive program for the contractor and the contractor was measured against a numerical target for damage to coral areas. The operator also provided awareness training for operational personnel.

In this case the results of management steps and technology employed to protect biodiversity resources was impressive. After 786 anchor moves, only 2 of 237 areas were slightly damaged on first pipeline route and only 2 of 1,150 areas were slightly damaged on the second pipeline route. This case history indicates that by demonstrating through performance that the industry can preserve the natural environment the regulators and wider community are provided confidence that the petroleum industry can continue to develop oil and gas resources in sensitive marine environments. The use of planning and onsite monitoring to insure that the technology employed was effective, combined with awareness programs, resulted in the goals of the project being successfully achieved.

C. Gabon Case History

The third case history pertains to yet another different receiving environment and incorporates a longer range of time and broader scope of operations, In this case, the operation encompasses two production operations for over 40 years. Biodiversity challenges in this area include a tropical rain forest area which experienced some deforestation due to E&P operations, followed by erosion due to deforestation. Most of the impacts were associated with roads and operational areas.

In order to address biodiversity protection over the scope of the operations a combination of technology and management steps were performed. First, there was an emphasis on control of emissions which included reducing the organic loading into receiving streams. Second, there was a program to re-vegetate rainforest areas. The main technology employed to recover operational areas was hydro-seeding which was used to restore abandoned road berms and drill sites. In addition to remediation efforts, the operator conducted a biodiversity monitoring program.

As a result of these efforts, oil in water discharges was reduced. Hydro-seeding accelerated re-growth by 15-30 years with added benefits of increased mammal populations. A total of 75 hectares (185 acres) have been reseeded.

The conclusions this operator reached were that biodiversity protection can be accomplished by E&P operations without unrealistic measures. If we as a petroleum industry can commit to the minimum environmental efforts and take the responsibility and foster success, we can make the

difference and ensure that areas with high biodiversity value can be preserved for generations to come. In this case, the focus of protection was twofold. First, a biodiversity monitoring program included the use of biodiversity experts. The second tool was the use of hydro-seeding as a recovery tool. While the technology used in this case is important, the larger message was that not all biodiversity protection measures are expensive and that biodiversity protection and E&P operations can co-exist in sensitive environments.

OUTLOOK FOR BIODIVERSITY APPLICATIONS

A. Innovation and Future Development for Biodiversity Protection Technology

Investigation of the available information on biodiversity protection frequently focuses on the protection of biological resources by simply staying away from them and minimizing any and all human intrusion into protected areas. That avoidance approach is frequently advocated across all types of industries and human activities including recreational activities. But that narrow view of biodiversity protection does not recognize that biodiversity protection can take place in a wide range of receiving environments beyond the borders of protected areas. There are many examples on a global basis across the full range of ecosystems where oilfield technology has been successfully employed to develop natural resources while also protecting biodiversity resources. There are examples around the world where past practices have impacted biodiversity resources both with primary and secondary effects. By learning from the past and applying the lessons in the future, the historical ability for the E&P industry to innovate to overcome challenges will continue to push biodiversity protection technology forward.

There has been a gentle shift in the focus of environmental impact issues from E&P operations so that in addition to onsite discharge concerns, biodiversity protection is being recognized as an important aspect of environmental protection. In the US, discussions frequently involve polarized positions on regulatory requirements that are seen as overly intrusive by some and under-protective by others. Outside of the domestic operations many large multinational E&P operators have robust biodiversity protection programs and have recognized the value of those programs toward their business and operational goals.

Certainly the technology associated with the ability of scientists to evaluate biodiversity resources has improved. Technology is evolving with ongoing gains in the ability to monitor, quantify and track biodiversity resources in specific areas. Those tools along with advanced understanding of local ecosystems allow the identification of sensitive receptors so that plans can be made to avoid disturbance or destruction of biodiversity resources.

One of the key aspects of biodiversity protection in the E&P industry has been a focus on reducing the operational footprint of E&P activities. Major progress has been made to reduce the number of well pads that must be built to recover available oil and gas resources. First, in the area of seismic studies, refinements in techniques to identify specific producing formations have led to many fewer “dry holes.” With a focus on only drilling in areas that have resources the shift moves from finding the oil and natural gas to developing the field with a minimum number of locations. Smaller-footprint development typically is accomplished with directional and horizontal drilling that allows many wells to be drilled from a single well pad and thus removing

the need for multiple locations and associated roads. Additional opportunities in the oilfield to reduce footprint include waste minimization and beneficial reuse of drilling fluids and cuttings. Roads are frequently the focus of biodiversity protection and continuing innovation to address this issue has moved in several directions. First, in some remote locations in Peru, the use of helicopter rigs and onsite waste management has resulted in the elimination of roads. As an alternative to elimination of roads, temporary ice roads have been used in Arctic conditions. A variation to that theme is the removal of roads combined with hydro-seeding areas to remove traces of roads once production has been completed. In all of those cases, recognizing and managing issues in a cost-effective manner is the key to long-term, successful co-existence with E&P operations and biodiversity protection concerns.

B. Barriers and Opportunities for Biodiversity Protection in E&P Operations

One significant barrier to biodiversity protection within E&P operations has been polarized positions that focus on drill-or-don't-drill scenarios. Within the structure of current biodiversity protection laws and regulations, some operations are focused on meeting the existing requirements with the assumption that they are sufficiently protective of the environment. With this structure and legally enforced approach the rules are often seen as a barrier to drilling operations. Likewise, the adherence to minimum standards for biodiversity protection often leads to significant concerns that not enough is being done.

Another barrier is the frequent focus on project by project issues from individual operations and not a regional approach to biodiversity protection issues. Many smaller operators do not have sufficient resources to develop biodiversity protection programs.

The opportunities that continue to evolve focus on the benefits of biodiversity protection as part of a successful drilling operation. Clearly there are many examples of successful projects that incorporate biodiversity protection on a global basis. The long term challenge is to make the necessary investments on a project basis and regional basis so that the vision that E&P operations and biodiversity protection can successfully co-exist can be recognized by all stakeholders.

C. Long-Term Biodiversity Vision

The issue of biodiversity is going to become increasingly important to E&P operations. Operators are currently developing technology and management systems around the world that allow for E&P operations in sensitive areas to mitigate impacts on biodiversity resources. Biodiversity protection can have many pathways and continued evolution and innovation of technology need to include biodiversity protection as an important measure of success. Taking a seat a the table with stakeholders that focus on biodiversity to become more a part of the solution and less a part of the problem will result in a greater long term business success.

FINDINGS

- Biodiversity challenges will be met with a combination of proactive programs and technology.

- Social responsibility programs and related biodiversity protection programs will move toward reduced impacts from E& P operations.

- Biodiversity technology will involve the following.

    - Advanced systems of monitoring biodiversity resources and documenting existing resources.

    - Advanced systems for planning to protect biodiversity resources.

    - Advanced products, drilling techniques, seismic techniques, production techniques all moving toward lowering footprint and negative impacts on biodiversity.

    - Developing systems for monitoring the effectiveness of biodiversity protection technology.

    - Advanced systems for recovery, remediation and offsetting negative impacts to biodiversity resources form E&P activities.

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