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Ecosystem services guidance

Biodiversity and ecosystem services guide and checklists

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The global oil and gas industry association for environmental and social issues

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Table of contents

Executive summary

What are ecosystem services?
Ecosystem services are the benefits that people derive from the environment and from biodiversity (i.e. the flow of benefits provided by natural capital). Biodiversity comprises the habitats, species and genetic material that form the basis of ecosystems, thereby underpinning all ecosystem services.

Ecosystem services comprise **natural products** (provisioning services) such as water, fish and timber; **natural functions** (regulating services), such as flood control, waste assimilation and climate regulation; and **other social benefits** (cultural services) such as recreational, aesthetic and spiritual benefits. These services are also supported by underpinning **natural processes** (supporting services) such as nutrient cycling and photosynthesis.

How are they relevant to oil and gas operations?
The oil and gas industry both depend and impact upon biodiversity and ecosystem services (BES). For example, **dependencies** include utilizing water and natural materials such as timber and aggregates, and relying on natural waste assimilation and flood protection functions.

Potential **impacts** arise through depleting, displacing and polluting the organisms and habitats that give rise to the ecosystem services.

Ecosystem services are not all mutually compatible; what enhances one service may reduce another, resulting in trade-offs. For example, enhancing food production in an area may reduce existing natural flood control and carbon storage.

What is the business case for oil and gas companies to consider BES?
The global supply of biodiversity and ecosystem services that society and economies depend upon is in decline. This has led to the economic value of BES being increasingly recognized and new environmental markets (e.g. in carbon, water, biodiversity) being established.

These factors will significantly amplify risks and opportunities posed to oil and gas companies associated with environmental management. As a consequence, if ecosystem service dependencies and impacts can be identified and managed effectively, this could result in increasingly material cost savings and potential new revenue streams.

Typical environmental impact assessments can address many of these risks. However, an ecosystem services approach helps to better:

- understand human values and livelihoods associated with the environment (integrating ecological, social and economic considerations);
- evaluate trade-offs that affect different ecosystem services and stakeholders;
- assess oil and gas dependencies that may otherwise be overlooked (e.g. use of water, and reliance on flood control);
- identify impacts (particularly on natural regulating services) that may otherwise be missed; and
- highlight opportunities for ecosystem conservation or enhancement directed at sustaining healthy ecosystems that may lower associated risks and costs, and enhance economic opportunities (e.g. capturing revenues from new environmental markets).

What is the aim of this guide?

The aim of this guide is threefold. Firstly, it explains the relationship between biodiversity, ecosystem services and the oil and gas industry. Secondly, it provides a set of checklists to help identify the main ecosystem service dependencies and impacts of oil and gas developments. Thirdly, it highlights key associated risks and opportunities for oil and gas companies, and provides guidance on potential measures for managing them.

How do the checklists work?

Separate checklists are provided that cover different parts of the oil and gas exploration and production (E&P) lifecycle for six generic habitat types, onshore and offshore. The overall process for applying the checklists and considering how to manage ecosystem services associated risks and opportunities is shown below.

Process for applying the ecosystem services checklists

Step 1 – Select relevant ES checklist(s). This involves identifying the appropriate oil and gas E&P project phase and habitat type, and then selecting the relevant checklist.

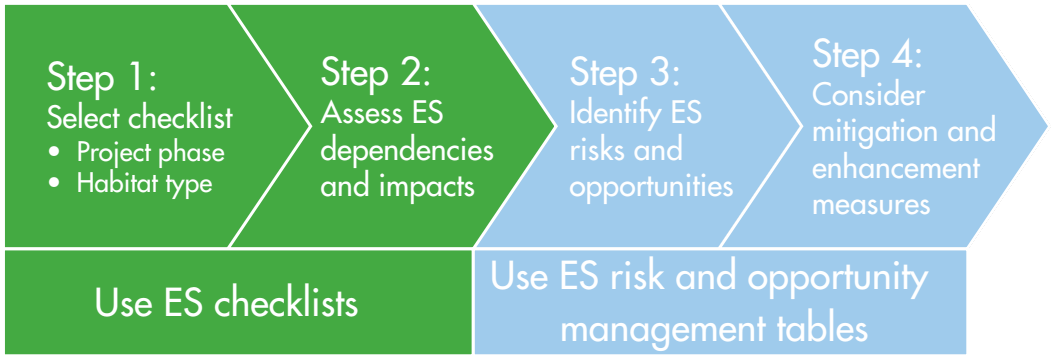
Step 2 – Assess ES dependencies and impacts. This involves working through the checklist to identify the potentially significant ecosystem service dependencies and impacts associated with relevant oil and gas sub-activities and issues.

Step 3 – Identify ES risks and opportunities. For each of the potentially significant ES dependencies and impacts, two *Risk and Opportunity* tables are used to identify relevant associated risks and opportunities.

Step 4 – Consider mitigation and enhancement measures. For each relevant risk and opportunity, the *Risk and Opportunity* tables are used to identify potential mitigation and enhancement measures to implement, drawing upon a set of examples.

It is important to note that the checklists as well as the *Risk and Opportunity* tables are not exhaustive; they simply represent a starting point that attempts to cover some of the more common examples.

Process for applying the ecosystem service checklist



1 Introduction

1.1 Aim of the guide

Ecosystem services are the benefits that people derive from the environment and biodiversity (i.e. the flow of benefits provided by natural capital). Biodiversity comprises the habitats, species and genetic material that form the basis of ecosystems, thereby underpinning all ecosystem services.

The oil and gas industry both depends upon BES (e.g. through consuming water and natural materials and, in places, being afforded natural storm and flood protection), and potentially impacts upon ecosystem services (e.g. through depletion, displacement and pollution). Growing awareness of these interactions with ecosystem services is resulting in increasingly material risks and opportunities for oil and gas companies.

There are three main aims of this guide.

- Firstly, it explains the relationship between biodiversity, ecosystem services and the oil and gas industry, and provides three relevant case studies.
- Secondly, it provides a set of checklists to help identify the main ecosystem service dependencies and impacts of oil and gas developments. Separate checklists are provided that cover different parts of the oil and gas E&P lifecycle for various different habitat types, onshore and offshore.
- Thirdly, it highlights key associated risks and opportunities for oil and gas companies, and provides guidance on potential measures for managing them.

The checklists are a focused set of prompts rather than an interactive tool, and are by no means a comprehensive list of all dependencies and impacts. Every project has its own particular context, and professional input will always be necessary to ensure all risks and opportunities are appropriately identified and managed. This checklist guide is intended as an initial introduction to the subject rather than a best practice or implementation manual.

The checklists have been designed in particular for technical HSE professionals at the site (field) and/or corporate level to help them understand the implications of ecosystem services for their operations in whichever habitats are relevant. The guide is also aimed at public affairs and other interested personnel to provide an overview of this increasingly important topic.

Box 1 – Key ecosystem service facts and figures

- Through deforestation alone, the world loses ecosystem services worth between US$1.9 trillion and US$4.5 trillion each year[1].
- The global carbon market grew from virtually nothing in 2004 to more than US$140 billion in 2009[2].
- The current global biodiversity offset market is worth a minimum US$3 billion and is expected to grow rapidly[3].
- 55% of corporate executives believe biodiversity should be among the top ten items on the corporate agenda, and 59% believe biodiversity is more of an opportunity than a risk for their company[4].

1 The Economics of Ecosystems and Biodiversity (2010).
2 World Bank (2010) *State and trends of the carbon market 2010*. World Bank Washington DC.
3 Madsen, Kelly and Moore Brands (2010). *State of Biodiversity Markets Report: Offset and Compensation Programs Worldwide*. Ecosystems Marketplace.
4 McKinsey (2010). *The next environmental issue for business: McKinsey Global Survey results*. McKinsey Quarterly. August 2010.

1.2 The business case

Why is it important for oil and gas companies to understand and manage their relationship with BES? (See *Box 1*.) The following factors combine to form a powerful argument:

1) The supply of nature's wealth (e.g. freshwater, fisheries, timber, genetic material) is decreasing, due to overexploitation and degradation, whilst demand from humans is steadily rising – resulting in increasing shortages.
2) The true value of BES is becoming recognized globally, and both efforts and requirements to assess its value are increasing.
3) Government regulations and new market-based mechanisms (e.g. carbon, biodiversity and water

markets, and other **payments for ecosystem services**) to protect BES are evolving rapidly.

4) New oil and gas resources are increasingly located in remote and sensitive environments where BES are essential in sustaining local populations, and culturally important wilderness values may be compromised.

The above factors will significantly amplify associated risks and opportunities posed to oil and gas companies. If managed well, this will result in increasingly material cost savings and potential new revenue streams.

Whilst typical environmental assessment processes are designed to focus on potential impacts on discrete components of the environment, including habitats and biodiversity, the incorporation of a more holistic ecosystem services approach can capture the dependencies, economic trade-offs, and supply/demand opportunity analysis required to meet these emerging challenges.

In addition, using an ecosystem services approach simply helps to better understand the interrelationships between oil and gas operations, the environment, biodiversity and people (their lives and livelihoods) – thereby informing improved environmental and social impact management.

Numerous drivers and initiatives are catalysing the growth in interest in BES by businesses. A few recent global initiatives are worth a brief mention.

1) **The Economics of Ecosystems and Biodiversity** (TEEB). This United Nations-backed report highlights the need for decision makers to identify, assess and capture the value of ecosystem services.
2) **TEEB for Business** stresses the need for businesses to identify business impacts and dependencies on BES and to assess associated business risks and opportunities.
3) The 2010 Conference of the Parties 10 to the **Convention for Biological Diversity** in Nagoya, Japan endorsed TEEB and ecosystem valuation in decision making, and encouraged businesses to consider BES-related risks and opportunities.
4) The International Finance Corporation (IFC) has updated its **Performance Standard 6** (PS6) on biodiversity, which requires a systematic assessment of ecosystem service dependencies and impacts for associated projects. The standards have been adopted by more than 60 'Equator Principle' banks, and apply to project finance investments over US$10 million.
5) An **International Panel on Biodiversity and Ecosystem Services** (IPBES) was established in 2010 to strengthen the science-policy interface on biodiversity and ecosystem services. Its creation acknowledges the need to embrace ecosystem services at a global level.

1.3 Links to other documents

In addition to the various IPIECA and OGP publications on managing environmental and biodiversity issues in relation to oil and gas activities, two other documents are worth noting that complement this guide.

The *Corporate Ecosystem Services Review* (WRI *et al.*, 2008) is a generic five-step methodology that helps managers develop strategies related to the risks and opportunities arising from their company's dependence and impacts on ecosystems[1]. The steps and methodology developed in this guide align with those of the *Ecosystem Services Review*. In addition, this guide complements the *Ecosystem Services Review* by providing a set of oil and gas sector-specific examples of ecosystem services and associated risks and opportunities.

The *Guide to Corporate Ecosystem Valuation* (WBCSD, ERM, IUCN and PwC, 2011) provides a methodological framework to allow both ecosystem degradation and the benefits provided by ecosystem services to be explicitly valued and accounted for to improve business decision making. As such, it can be used to help evaluate the overall financial (bottom line) and societal costs and benefits of alternative ecosystem service risk and opportunity management options to select the optimum one from a business and/or societal perspective.

1.4 Report structure

Following this introduction, *Section 2* outlines some of the key concepts surrounding BES and their relationship to oil and gas projects. *Section 3* explains how the ecosystem services checklists work. *Section 4* provides examples of how associated risks and opportunities can be managed. *Annex A* contains the detailed set of ecosystem services checklists.

1 Step 1 is Select the scope; step 2 is Identify priority ecosystem services; step 3 is Analyze trends in priority services; step 4 is Identify business risks and opportunities; and step 5 is Develop strategies.

2 Key concepts

2.1 What are ecosystem services?

Ecosystem services are simply the benefits that humans gain from the environment. As such, they represent nature's wealth. The concept of ecosystem services is also ideal for unifying economics (i.e. the benefits), social issues (i.e. humans) and the environment.

Ecosystem services are derived from underlying biodiversity, comprising habitats, species and genes. *Box 2* provides definitions and shows that ecosystem services are divided for convenience into four categories including provisioning, regulating and cultural services. In this guide, less focus is given to supporting services because they underpin all services, and the impacts and dependencies on these are typically accounted for when assessing the other services.

Biodiversity is not an ecosystem service itself, but forms the basis of all ecosystem services. Increased levels of biodiversity (i.e. greater variety of ecosystems, species and genes) tend to support a broader range of ecosystem services. Biodiversity also enhances the resilience of ecosystem services. However, the value associated with conservation of biodiversity is commonly covered under cultural service values through recreational use value, and non-use values whereby individuals may be willing to pay to maintain biodiversity whilst having no intention of using it.

It is also important to highlight the linkages between ecosystem services and socio-economic issues. Many provisioning services (e.g. fish, crops, livestock and timber) support local livelihoods. This is particularly important for indigenous populations who may rely on hunting and gathering of wildlife for their survival. Regulating services such as flood and storm control, and water flow regulation can be essential for maintaining the health and security of people in the even to extreme weather conditions, e.g. storms or droughts. Finally, cultural services such as recreation, tourism, aesthetic and spiritual values can be extremely important in terms of providing personal satisfaction and livelihoods.

Whilst the categorization of ecosystem services is not critical in itself, the categories serve as useful reference points for analysis. This categorization also serves to highlight that cultural services and often overlooked regulating services can have a significant value, potentially much greater than that of the more commonly recognized (and monetized) provisioning services.

2.2 Dependencies and impacts of oil and gas projects and operations

This guide and checklist help to identify ecosystem services that different parts of the oil and gas E&P lifecycle may depend and impact on. Oil and gas provisioning service **dependencies** include use of water, aggregates and timber for consumption by staff, and for the construction and operation of facilities. Oil and gas regulating service dependencies are typically more indirect, and include a range of physical functions provided by vegetation and habitats such as erosion control, water filtration and flood control. Although not exactly an operational dependency, cultural services can be important for remotely operating workforces that can benefit in terms of enjoyment, health and motivation, from activities such as ecotourism and bird watching, and simply from appreciating the surrounding undisturbed landscapes.

The potential impacts of oil and gas E&P on biodiversity and the environment are covered in detail elsewhere[2,3,4]. However, impacts to ecosystem services per se are less well documented. Potential impacts may be negative or positive. In terms of provisioning services, oil and gas impacts include potentially restricting access for gathering wild food. Oil and gas impacts on regulating services include reducing erosion and flood control through loss of vegetation cover. Potential oil and gas impacts on cultural services include disturbance to iconic species, such as whales from seismic activity. On the other hand, a range of positive provisioning, regulating and cultural services can be gained through oil and gas companies helping to restore and protect habitats from a multitude of threats.

Furthermore, as demand for oil and gas continues, supplies dwindle and technologies improve, the search for oil and gas is likely to focus on more remote, sensitive and

2 The Energy and Biodiversity Initiative. *Integrating Biodiversity into Environmental and Social Impact Assessment Processes.*

3 E&P Forum/UNEP (1997). *Environmental management in oil and gas exploration and production.* Technical Report 37.

4 The Energy and Biodiversity Initiative. *Good Practice in the Prevention and Mitigation of Primary and Secondary Biodiversity Impacts*

Box 2 – Key definitions

Biodiversity: The variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species and between ecosystems (*UN Convention on Biological Diversity, 1992*).

Habitat: A terrestrial, freshwater or marine geographical unit or an airway passage that supports assemblages of living organisms and their interactions with the non-living environment (IFC PS6). For the purposes of this guide, six generic habitat types have been identified. The term habitat is used loosely in this guide, and effectively refers to the variety of habitats found within different 'biomes' and climatic zones such as forests, deserts and polar.

Provisioning services

Ecosystem: A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit (Millennium Ecosystem Assessment, 2005). They make up the environment around us and include habitats and biomes (e.g. coral reefs, tundra, forests and grasslands).

Regulating services

Ecosystem services: The benefits that ecosystems contribute towards human well-being (Millennium Ecosystem Assessment, 2005). The concept **ecosystem goods and services** is synonymous with ecosystem services. They can be divided into four categories:

- provisioning services – products or goods such as water, fish, or timber;
- regulating services – ecosystem functions such as flood control and climate regulation;
- cultural services – non-material benefits such as recreational, aesthetic, and spiritual benefits; and
- supporting services – fundamental processes such as nutrient cycling and photosynthesis that support the above three categories.

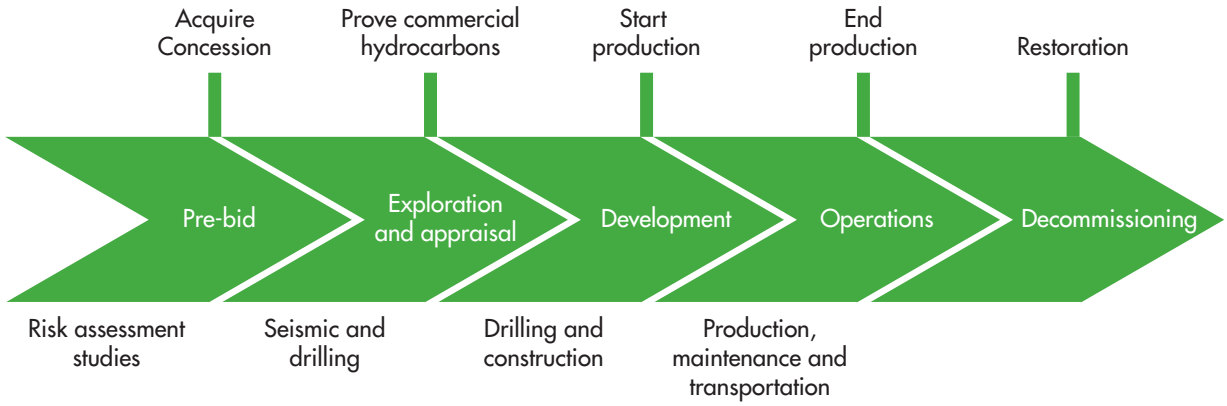
Cultural services

Source: Based on WRI materials.

biodiversity-rich locations. This includes deep sea, polar and wilderness environments. In addition, the extraction processes (including water demand) and surface footprint required for use in unconventional sources such as oil sands and gas shales have the potential to become increasingly damaging to biodiversity and associated ecosystem services.

This guide and checklist support oil and gas companies in their efforts to explore the interactions between development projects and the natural environment, and complement existing biodiversity evaluations with those relating to ecosystem services. An ecosystem service perspective gives additional emphasis to the potential importance and value of habitats and species to humans

Figure 2.1 – Oil and gas E&P project cycle



Source: EBI, Integrating Biodiversity into Environmental and Social Impact Assessment Processes.

affected (e.g. food and water resource use, recreational enjoyment and aesthetic values). This helps inform assessments as to what really matters to local, national and international stakeholders. In doing so, it more effectively integrates environmental, social and economic issues thereby facilitating sustainable development.

2.3 Stages of oil and gas exploration and production

Upstream oil and gas projects typically have a number of different stages associated with their life cycle. This guide adopts the Energy and Biodiversity Initiative (EBI) project development stages and activities (i.e. **project phases**) within each upstream E&P stage, as shown in *Figure 2.1*.

Although not covered in this guide and checklist, midstream and downstream oil and gas activities, such as LNG (liquefied natural gas) plants, pipelines, biofuels and refineries, also have potential associated ecosystem service impacts and dependencies.

Because drilling activities have common ecosystem service dependencies and impacts, but occur within succeeding E&P life-cycle stages, this guide (and the checklists) are organized around the three key activities of the exploration/appraisal and development stages, and the two subsequent stages (operations and decommissioning). As shown in *Table 2.1*, this results in five checklist categories that cover the main oil and gas stages and activities likely to have a dependence or impact on ecosystem services.

Table 2.1 – Oil and gas stages and activities covered by this guide

EBI oil and gas project stages	Main activities within each stage
Pre-bid	Risk assessment studies
Exploration and appraisal	Seismic surveys
	Drilling (exploration and development drilling)
Development	(Design and) Construction
Operations	Oil and gas production, maintenance and transportation
Decommissioning	Removal/disposal of facilities and rehabilitation

Note: Green shaded cells represent the project phases (stages and activities) covered by the checklists.

These five project phases are shaded in green in *Table 2.1*. Within the checklists themselves, the project phases are further broken down into sub-activities and issues.

Although not specifically covered by this guide and checklists, the pre-bid stage is actually a critical part of the assessment in terms of considering potential ecosystem service dependencies and impacts and influencing the outcome. It is at this stage that potentially critical impacts may be picked up, and other key risks identified that may influence the conceptual design, location and routing of key project components. At the pre-bid stage, developers should, ideally, familiarize themselves with potentially significant dependencies and impacts, risks and opportunities associated with the relevant habitat type for their proposed development.

There are considerable BES risk and opportunity implications associated with the decommissioning phase. This is particularly the case in relation to restoring and creating habitats and reusing parts of the facilities and infrastructure. Ecosystem service solutions may play an important role in the long-term sustainability credentials of an option, and early consideration in the process could result in the development of completely different (and potentially more cost-effective and successful) engineering options and technologies.

Ideally, assessments should precede each stage by as much time as possible in order to allow the adoption of design, development, and operational alternatives to limit risks and capture opportunities associated with potential

Box 3 – Definitions of secondary, cumulative and higher order impacts

Secondary impacts are those impacts caused by the presence of an oil and gas development triggering other third-party activities or developments (i.e. indirect or induced). Such other activities are not within the scope of, or essential to, the oil and gas project itself. The impacts are commonly caused by human population changes and economic activities resulting from project infrastructure such as roads, ports and towns.

Cumulative impacts are those that result when the effects of implementing the oil and gas development are added to analogous effects of other past, present and reasonably foreseeable future developments and other human activities within the vicinity (e.g. agriculture, fisheries, urbanization). Cumulative impacts are important because the impacts of individual projects may be minor when considered in isolation, but significant when the developments and activities are viewed collectively.

Higher order impacts are those that result when a primary impact triggers an additional impact or series of impacts that proceed without other human intervention or action. When these higher-order impacts result specifically from oil and gas project activities, they are considered equally the responsibility of the oil and gas project as are the direct or primary impacts.

dependencies and impacts. An ideal time to undertake an extensive ecosystem service assessment is whilst conducting an Environmental and Social Impact Assessment (ESIA).

2.4 Secondary, cumulative and higher order impacts

Consideration of dependencies and impacts is slightly complicated by (but fully integrated with) the concepts of secondary, cumulative and higher order impacts (see *Box 3* for definitions). The aggregation of secondary and cumulative impacts and demands can have significant implications for ecosystem services. Responsible companies should bear these in mind when assessing impacts and risks associated with their activities. In addition, by not considering these, a company's ecosystem services assessment will be flawed and the company may expose itself to considerable direct and indirect risks.

Secondary impacts associated with oil and gas developments are becoming increasingly significant and scrutinized. The existence of a development project may attract large numbers of jobseekers and their families to move to an area, whether or not they actually obtain jobs at the facility; this may lead to the building of new homes, and to commerce, infrastructure, agriculture and fishing pressures. A new road or right-of-way could encourage business to relocate to that area because of improved access to supplies and customers.

Whilst these associated developments are not part of the oil and gas development, such induced impacts can be indirectly attributed to it. It is recognized that the oil and gas business does not have direct control over these impacts; however, their implications for ecosystem service sustainability should be assessed, and company decisions made accordingly. Addressing and mitigating secondary impacts often entails collaborative efforts with communities and governments.

Cumulative impacts are also becoming increasingly important for oil and gas developments to consider, and are being scrutinized more closely by regulators. The effects on ecosystem services of one company's activities may be within bounds that do not threaten the integrity and functioning of the ecosystem. However when aggregated with those of other activities, the effects could become more significant.

For example, aggregated demand for an ecosystem service (or services) may exceed supply (e.g. running out of fresh water). In addition, synergistic impacts may occur or thresholds (tipping points) may be exceeded, which could result in non-sustainable conditions (e.g. elevated stream temperature from discharges combined with elevated sediment loads from separate construction-related erosion could depress dissolved oxygen below levels required to sustain fish life).

Oil and gas companies should also manage **higher order impacts**[5] or follow-on impacts associated with the construction and operation of their developments. For example, earth-moving activities of an oil and gas development may remove vegetation, resulting in erosion, that causes increased sediment load in a river, reducing water quality and affecting invertebrates and fish, and ultimately leading to the decline of local subsistence fisheries downstream. The latter is an impact on human values (i.e. a provisioning service is affected) through a series of cause-effect relationships resulting from the initial construction activities.

To help deal with these issues in the context of ecosystem services, it is useful to consider what trends are occurring

5 For more details on assessing higher order impacts, see Lohani *et al.* (1997). *Environmental Impact Assessment for Developing Countries in Asia.* Asian Development Bank. Volume 1 – Overview. 356 pp.

with the key ecosystem services of interest. As further explained in the *Corporate Ecosystem Services Review*, this could include understanding:

- the condition and trends in the supply and demand of the key ecosystem services being considered;
- other direct and indirect drivers affecting the ecosystem service; and
- the implications of other stakeholders and their activities on those drivers.

2.5 Risks and opportunities

The dependencies and impacts that oil and gas activities have on BES can give rise to a range of business-related risks and opportunities. *Table 2.2* provides a summary broken down into five main categories, each of which can ultimately lead to impacts on costs, revenues and the overall value of a company. The linkages between ecosystem dependencies and impacts, and risks and opportunities are revisited in *Section 4*.

Table 2.2 includes many standard business case arguments for improved environmental and social management. However, several key trends are acting to further enhance the magnitude of these risks and opportunities in relation to ecosystem services. These include:

- the move towards valuation of ecosystem services, together with the recognition that the full price is often not yet paid for the use of, or damage to, ecosystem services (e.g. water and aggregates);
- increased use of environmental market-based mechanisms to capture the value of ecosystem services (e.g. carbon, water and biodiversity markets); and
- growing consumer, business and financial sector awareness of environmental issues and increasing demand for greener products.

2.6 Advantages of adopting an ecosystem services approach

Linked to the above, there are four key advantages of adopting an ecosystem services approach for evaluating oil and gas developments, as follows:

- **Understanding human values and livelihoods.** Assessing ecosystem services provides a better understanding of how people interact with, benefit from, and value the environment. This may be in terms of nature providing products, services, incomes and livelihoods.
- **Evaluating trade-offs.** By having a better understanding of the importance to various stakeholders of different environmental features and activities, more informed decisions can be made about development options with alternative outcomes and implications.
- **Assessing dependencies.** The approach brings an added dimension through highlighting the ecosystem dependencies that oil and gas operations have on the environment that are often overlooked. As ecosystems decline, so too will the services nature provides that oil and gas companies depend upon (e.g. water), thus presenting additional risks.
- **Identifying impacts that may otherwise be missed.** The ecosystem services approach can help identify a more complete spectrum of impacts (including higher order impacts) that may otherwise not be considered, and thus help to avoid or mitigate them at the outset. This is particularly the case for provisioning services occurring offsite (e.g. fisheries) and some regulating services (e.g. impacts to habitats that provide erosion control, water filtration and flood control). In addition, the supply/demand component of the ecosystem services approach necessitates the consideration of cumulative dependencies and impacts that may be overlooked using more traditional methods.

2.7 Habitat types

This guide and the checklists have focused on six generic habitat types. Six was deemed a reasonable and representative number of subdivisions. They were selected based on key oil and gas operating environments and commonly grouped habitats (or biomes). An additional category of 'other habitats' is excluded from the checklists, but some of the key features of these habitats are briefly described in the text. The habitats covered are summarized in *Table 2.3*, which also indicates whether they are onshore or offshore habitats. In addition, the opening page of each habitat checklist (*Annex A*) provides a definition, and examples of ecosystem services and potential environmental concerns for oil and gas activities in each habitat. Note that some crossover may occur, for example with wetlands and habitats in the

Table 2.2 – Business risks and opportunities associated with managing BES

Categories	Examples of risk	Examples of opportunities
Operational The day-to-day activities, expenditures and processes of the company	• Increased compliance costs (e.g. increased delays) • Increased natural hazard-related risks and costs (e.g. damage from floods, storms and fires) • Increased security costs (e.g. due to stakeholder conflicts) • Increased resource costs (e.g. paying for ecosystem services such as water)	• Reduced compliance costs • Cost savings from maintaining or investing in natural flood/storm protection and natural water treatment function of habitats • Improved efficiencies through minimizing resource use • Reduced resource costs (volume and/or price)
Legal and regulatory The laws, government policies, and other regulations that can affect corporate performance	• Production delays and losses (e.g. through permits delayed and denied) • Increased fines, compensation and legal costs (e.g. due to environmental damages) • New regulations and license fees (e.g. new or elevated charges for water from aquifers)	• Permitting expedited • Reduced fines, compensation and legal costs (e.g. through better baseline information, avoidance of real and perceived impacts)
Marketing and product Portfolio of products and services offered customer preference, and other market factors that can affect companies	• Changing customer values or preferences; reduced market share	• New products (e.g. carbon, water and habitat credits); markets for ecosystem services provided or enhanced • Increased market share for products • Increased product premium (e.g. a green premium)
Reputational The companies image and/or relationship with customers, the general public, government agencies and other local and international stakeholders	• Increased employee salaries, recruitment and retention costs • Declining interest in shareholder investment; decline in share price	• Increased access to resources (e.g. through being partner of choice for governments and other oil and gas companies). • Increased market share for products • Improved ability to attract and retain employees • Increased share price (e.g. from investors seeing a well-managed company reducing risks)
Financial Costs and availability of capital from borrowing on open markets and other investors	• Increased financing costs (higher interest rates and harsher conditions) • Reduced financing options	• Access to IFC or Equator Bank financing • Reduced financing costs • New green funds available

Source: Based on work by ERM and FFI, originally adapted from WRI et al. *(2008)*

Table 2.3 – Habitat types covered in guide

Habitat type	Habitats included	Onshore terrestrial	Offshore marine/freshwater
Forests	Temperate and tropical forests, woodlands, etc.	✓	
Wetlands, rivers and lakes	Wetlands, bogs, lakes, and rivers		✓
Polar	Ice caps, tundra	✓	✓
Desert	Desert and semi-arid	✓	
Deep water			✓
Near shore/ transition zone	Coral reefs, seagrass, mangroves, beaches and rocky shores	✓	✓
Other (not in checklist)	Grassland, mountains and cultivated land	✓	

near shore/transition zone. Select the most appropriate for the situation.

Table 2.4 provides a summary of the main ecosystem services typically associated with each habitat type, together with their likely relevance. Note that exceptions will exist.

Forests

Forest habitats are defined here as areas dominated by trees and woody vegetation. Almost all forests provide abundant provisioning services in the form of timber, wild game, fruits, nuts, berries, mushrooms and medicines, etc. Examples of regulating services from forests include carbon sequestration, climate and nutrient regulation, local temperature and humidity control, and, in many places, regulation of water quality and stream flow. Forests also offer numerous cultural services such as recreation, bird and wildlife watching, and spiritual areas. They are associated with high heritage and non-use cultural values due to high levels of biodiversity, iconic species and as-yet undiscovered species.

Wetlands, rivers and lakes

Wetlands encompass a range of habitats such as tidal marshes, mud flats and bogs. They may be seasonal, inland, or coastal and may be tidal or non-tidal. Note that crossover with the near shore/transition zone habitat type may occur. Rivers (and streams) are bodies of water that flow into lakes or the sea. Lakes are categorized

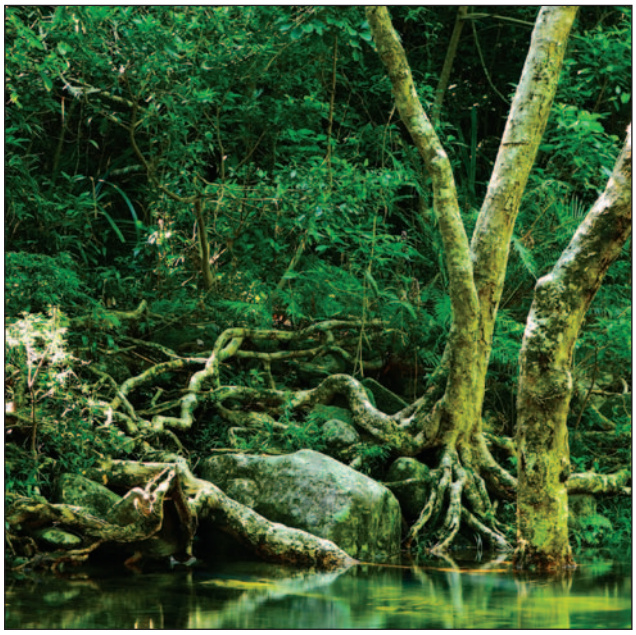


Table 2.4 – Typical ecosystem services by habitat type

Ecosystem services	Forests	Wetlands, rivers and lakes	Polar	Deserts	Deep water	Near shore/ transition zone
Provisioning						
Crops						
Livestock	○	○	○	○		
Capture fisheries		●	●		●	●
Aquaculture		●	○		○	●
Wild foods	●	●	●	●	○	●
Timber and other wood fibres	●	●	●	○		○
Fibres and resins	●	●	○	○		○
Animal skins	●	○	●	○		
Sand, gravel, etc.		○	●	●		●
Ornamental resources	●	○	○	○	○	●
Biomass fuel	●	○	○			○
Freshwater	●	●	●	○		○
Genetic resources	●	●	●	●	●	●
Biochemicals, natural medicines, and pharmaceuticals	●	○	○	○	●	●
Regulating						
Air quality regulation	●	○	○	○	○	○
Global climate regulation	●	○	●	○	●	●
Regional/local climate regulation	●	○	○	●		○
Water regulation	○	●	○	○		●
Erosion regulation	●	○	○	○		●
Water purification	●	●	●	○	●	●
Waste assimilation	●	●	○	○	●	●
Disease regulation	○	○	○	○		○
Soil quality regulation	●	○	○			○
Pest/invasive species regulation	●	○	○	○	○	○
Pollination	●	○	○	○		○
Natural hazard regulation	●	●	○	○		●
Cultural						
Recreation and ecotourism	●	●	●	●	○	●
Spiritual and religious values	●	●	●	●	●	●
Ethical/non-use values	●	●	●	●	●	●

Key: Importance of ecosystem service	
High	•
Medium/low	○
Not relevant/negligible	

Adapted from Millennium Assessment (2005) Note: This is a crude relative assessment, and there will always be exceptions.

as inland bodies of (usually) freshwater. Lakes, rivers and wetlands provide provisioning services in the form of water, food, fuel and materials for construction. They provide protein to many local communities through fish and shellfish as well as plant food. Peat is also harvested from bogs as a source of fuel, and reeds are utilized to make things and build houses. Regulating services in these habitats include groundwater recharge, water storage, flood control and water purification (waste assimilation). Bogs also offer significant carbon sequestration services. Ecotourism and bird watching are examples of cultural services. These habitats are particularly recognized for their populations of endemic and migratory birds and protected species such as crocodiles, manatees and turtles.

Polar

Polar habitats are the areas surrounding the north and south poles. Provisioning services in polar habitats might include, for example, fish, reindeer, seals, seabirds, reindeer moss, peat (fuel), berries and mushrooms that may be harvested by local communities. Aggregates, building materials and freshwater are also important provisioning services in this region. Regulating services in polar habitats are perhaps less obvious and significant than in other habitats, but can include, for example, carbon sequestration, ground surface stability, water filtration and waste assimilation. Cultural services include traditional lifestyles and iconic species such as polar bears, penguins and various endangered marine mammal species found seasonally in polar waters.

Deserts

Desert and semi-arid habitats are typified by low average rainfall, high evaporation rates, and high mean temperatures. Provisioning services in desert and dryland habitats include food (e.g. wild game, plants and fruit), freshwater (typically limited and valuable) and grazing habitat for livestock. Desert plants supply a regulating service in the form of erosion control. Waste assimilation is also an important regulating service in desert areas. Deserts and drylands are home to a number of iconic and culturally important species such as lions, antelope and large birds of prey, as well as trees such as the Baobab. Some desert areas are important for nature-based tourism, while others have important spiritual and cultural value to local populations.

Deep water

The deep water environment refers here to areas of ocean with a depth of around 300 metres and deeper. Commercial fishing is the most significant provisioning service provided by deep water habitats, with fishing for long-ranging species such as tuna, sardines and marlin prevalent. There is also considerable scope for genetic and pharmaceutical products from the diverse range of benthic species, many of which have yet to be discovered. Deep water ecosystems provide important regulating services, particularly waste assimilation, temperature and current regulation, and carbon sequestration (plankton/marine snow). In terms of cultural services, marine tourism is less prevalent in deep water environments, but deep waters are used as migration routes for culturally iconic species such as whales and turtles.

Near shore/transition zone

The near shore/transition zone as treated here includes a variety of habitats, ranging from coral reefs to marine estuaries, mangroves, seagrass beds, beaches and rocky tidal zones. In near shore waters, artisanal and subsistence fishing are critical provisioning services. Timber and non-timber forest products from mangroves, construction materials (e.g. sand, shingle, rocks and coral rubble) and ornamental and pharmaceutical products are other common provisioning services found in the near shore environment. Key regulating services from habitats such as mangroves and coral reefs include protection from storms, flooding and erosion. Estuaries and mangroves also offer water filtration, waste assimilation and carbon sequestration services. The near shore environment offers cultural services in the form of tourism and recreation (e.g. swimming, diving, sunbathing), and supports a variety

of iconic species including reef-associated fish, turtles, sharks, dugong and coastal seabirds.

Other habitats

A number of other habitat categories are not specifically covered in the checklist. Instead, some of them are briefly described here.

Grassland habitats, including prairies, steppes, savannahs and others, are defined as areas where natural grasses are the dominant form of plant life. Provisioning services in grassland areas include plants and wild game for consumption, and forage for livestock grazing. Grassland habitats can offer waste assimilation, carbon sequestration and water regulation services, depending upon the context. Grasslands are important habitats for culturally important bird and grazing species; tropical savannahs in particular are known for supporting iconic species and endangered wildlife. They can also be important destinations for ecotourism.

Mountain habitats are defined here as high altitude (montane, subalpine, and alpine) grasslands and shrublands (mountain forests are covered in the *Forest habitat* category). Provisioning services from mountain habitats include significant freshwater resources, as well as timber, wild game and nuts, berries and other wild foods. Mountain habitats offer regulating services such as regulation of water flows (e.g. glaciers and snow melt), air quality (and air movement) regulation and carbon sequestration. Mountains are important recreational sites, with hiking, snow sports, and wildlife watching valued as important cultural activities. Many mountains have spiritual significance for local people, and some have global significance as culturally important places. Mountain habitats support a wide range of iconic species, such as elk, bear, mountain lions, eagles, and other rare and endangered species.

Cultivated habitats include any areas that have been converted to support human agricultural uses. Cultivated land provides food in the form of grains, fruits and vegetables, plant fibres for clothing and other uses, and woody products for a variety of uses. In addition, biofuel crops are grown to provide energy. Some types of agriculture provide local climate and air quality regulation services (most likely from tree species). Certain crops may have a net carbon sequestration role when compared to fossil fuel use. When poorly managed, cultivated crops can lead to severe erosion problems. Agriculture is culturally valued as a source of livelihood and independence. Some areas may have served as cultivated land for generations, and hence have cultural significance to the communities and individuals who rely upon them.

2.8 Three case studies

The following three case studies reveal how provisioning, regulatory and cultural services have been relevant to oil and gas developments in South and North America.

In terms of lessons learned, and potential application of an ecosystem services approach:

- The first case could apply an ecosystem services approach to convert what could become an associated reputational risk into a reputational opportunity.
- There could potentially be many more applications of the second case.
- The substantial delays and costs incurred in the third case could perhaps have been avoided or reduced.

Case study 1

Changes in provisioning services usage: increased access to wild meat markets in the Ecuadorian Amazon

This case study provides an example of oil and gas companies' influence on the ways in which a rainforest's provisioning services are used by local people (a secondary impact). In the early 1990s an oil and gas company created a 150 km long access road into a section of Ecuador's Yasuni National Park. This area was inhabited by the Waorani and Kichwa peoples who traditionally practise a semi-nomadic subsistence hunting lifestyle. The creation of the access road provided the forest communities easier access to the local wild meat market.

This led to a shift in how the communities used the forest's provisioning services. They moved from using the forest's provisioning services (in the form of wild meat) for subsistence purposes, to using the meat for commercial purposes at a market for wild meat that was established shortly after the road was constructed. Whether these changes are positive or negative is a much more complex issue that may be perceived differently by the various stakeholders. There is a trade-off between generating increased revenues and potentially depleting a resource. The ideal situation may be to help to ensure that a sustainable commercial operation develops, that involves the local people.

Sources:
http://news.mongabay.com/2009/0913-hance_ecuador_oil.html
E. Suarez, M. Morales, R. Cueva, V. Utreras Bucheli, G. Zapata-Rios, E. Toral, J. Torres, W. Prado and J. Vargas Olalla. Oil industry, wild meat trade and roads: indirect effects of oil extraction activities in a protected area in north-eastern Ecuador. Animal Conservation, *Vol. 12 , Issue 4 (2009), 364–373.*

Case study 2
Use of a natural regulating service: use of reed bed technology for wastewater management in Oman

This case study provides an example of how an oil and gas major harnessed the natural regulating services (waste assimilation and water filtration) of reedbeds as a solution for waste management which is both simple and cost-effective.

In running its drilling operations in Oman, the company needed to deal with the 60 m^3 of sewage effluent produced per day. The remote location of the site, 600 km from an approved disposal centre, posed challenges including the environmental effects linked to transport of equipment into and out of the site, and the requirement that any waste management solution be robust and require minimal technological support.

The solution selected was a reedbed system. In this system, sewage flows through a series of ponds containing reedbed plantations which contain micro-organisms that break down the nutrient load. Clear water suitable for irrigation (regularly monitored to check that it falls within the required limits) and bio-solids suitable for compost or burial on site are the only by-products; the water can be used for irrigation, the humus for arable use and the fodder for animal consumption. The plant is run entirely by three pumps, which do not need to be operational at all times.

Photo: Offshore-technology.com: "A Simple Waste-Management Plan" 12 April 2010 http://www.offshore-technology.com/features/feature81859/

The use of this type of low-tech solution also has the advantage of significantly lower operational costs and reduced maintenance requirements. The plant became cost-effective after 18 months of operation, allowing the company to make monthly savings of US$9,200, based on reduced transportation costs. Furthermore, this process results in production of naturally stabilized humus of additional value, rather than a dehydrated intermediate product, which needs to be disposed of in a landfill site.

The company also reports that the morale of the crew has been improved by the scheme, due to large-scale greenery on site. Furthermore, the scheme obviates the need for trucks to drive 500,000 km per year, which has reduced health and safety risks, and provided air quality benefits.

Sources:
Offshore-technology.com: 'A Simple Waste-Management Plan' 12 April 2010, http://www.offshore-technology.com/features/feature81859/

Case study 3
Impacts to cultural services: conflict over plans to drill in the sacred Badger-Two Medicine area of the Rocky Mountains

This case study provides an example of the resistance met by oil and gas companies against plans to drill in an area with significant cultural value.

The Badger-Two Medicine area is located within the Rocky Mountain Front close to the Blackfeet Reservation in Montana. The mountains in this area are sacred to local Native American people, the Blackfeet, who value the area due to its isolation and ties to creation stories. They use the area for activities such as traditional vision quests undertaken by adolescent boys. The area is also home to the revered bison.

There has been a long history of conflict between the oil and gas operators and local people in the area, starting in the 1980s when several oil and gas operators received leases to conduct exploratory drilling in the area. Drilling was held up due to vigorous lobbying by the local people that caused delays and inconvenience for the oil companies such that they eventually abandoned their plans. Over more recent years, further attempts were made to initiate drilling here, but once again local tribes lobbied successfully against the drilling operations.

It was acknowledged that drilling could have impacted the spiritual practices of the Blackfeet because of the noise, construction, increased human traffic and destruction of the land itself. This example highlights the **risks** that actual or perceived impacts to cultural ecosystem services can pose to oil and gas operators in terms of causing delays and barriers to their operations in certain areas.

Source:
http.://www.sacredland.org/badger-two-medicine/

3 The checklists

3.1 Introduction

This Section gives an overview of the overall assessment process to apply the ecosystem services checklists. It also provides detailed guidance on using the checklists, covering its scope, application and limitations.

As mentioned previously, the main targeted end-user is an operator faced with assessing ecosystem service risks and opportunities for a particular project phase (as shown in *Table 2.2*) in a specific habitat type among those covered (see *Table 2.3*). It should be used as early on in the development evaluation process as possible prior to the development stage it applies to. The assessment can also be integrated within an associated ESIA.

3.2 Overall checklist assessment process

The overall process for applying the checklist and considering how to manage ecosystem services associated risks and opportunities is shown in *Figure 3.1*. The process comprises four key steps which are summarized briefly on this page. Steps 1 and 2 are further discussed in this Section, whilst Steps 3 and 4 are covered in *Section 4* on managing dependencies and impacts.

How the checklists will be used is down to the user and their objective. The process outlined here simply helps to explain the logic of the assessment. Companies may wish to adapt the approach to suit their own purposes and align with their internal processes.

Step 1 – Select relevant ES checklist(s). This involves identifying the appropriate oil and gas E&P project phase (i.e. life-cycle stage/activity) and habitat type, and then selecting the relevant ES checklist in *Annex A*. There is one checklist for each combination of potential project phase and habitat type. Multiple checklists may need to be considered if more than one project phase and/or several habitat types are relevant.

Step 2 – Assess ES dependencies and impacts. This involves working through the checklist to identify the potentially significant ecosystem service dependencies and impacts associated with each relevant oil and gas sub-activity and issue.

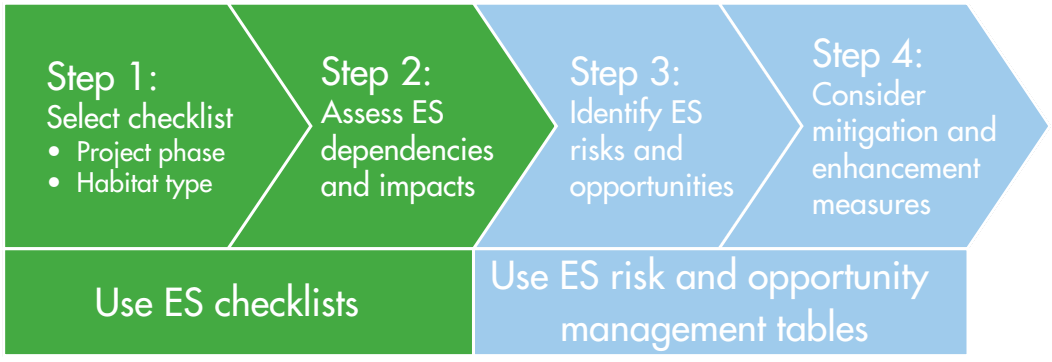
Step 3 – Identify ES risks and opportunities. For each of the potentially significant ES dependencies and impacts, use the ES risk and opportunity management tables (*Tables 4.1* and *4.2*) to identify relevant associated risks and opportunities, respectively.

Step 4 – Consider mitigation and enhancement measures. For each relevant risk and opportunity, use *Tables 4.1* and *4.2* to identify potential mitigation and enhancement measures to implement.

3.3 Background to the checklists

The checklists are organized according to different activities in five stages of the oil and gas project life cycle. The life cycle of dependency and impact begins with the exploration stage and ends with the decommissioning stage (see *Table 2.1*).

Figure 3.1 – Process for applying the ecosystem services checklists



For each project phase (i.e. life cycle stage/activity), the checklist provides an overview of the types of ecosystem service dependencies and impacts that may occur. The checklist has been applied separately to six generic habitat types, onshore and offshore, representing key oil and gas operating environments. A full set of the 30 (i.e. 5 x 6) checklists is included in *Annex A*.

The design of the checklist involved lengthy discussions and a workshop that considered various alternative formats. The final design was selected based on creating an easy-to-use single table for the end user, typically considering one project phase in a specific habitat type.

The checklists are not meant to be exhaustive; rather, they provide an initial capture of some of the more typical dependencies and impacts. Blank cells are generally either not relevant or are unlikely to have significant dependencies or impacts. In many cases, context-specific dependencies and impacts may arise that are not possible to capture at a summary level. However, even at the current, fairly generic level of detail, the checklist will be useful for feeding into relevant environmental and social risk and opportunity assessments.

3.4 Step 1 – select relevant ES checklist(s)

The first step is to determine the applicable project phase and habitat type that will be covered in the analysis[6]. This will dictate which checklist in *Annex A* to use. For example, this may be drilling (whether exploratory or development drilling) in a forest, for which the checklist is reproduced in *Table 3.1*.

The main differences among habitat types within the checklists include:

i) Differences in the types of services affected (e.g. ecotourism and recreation may be an important cultural service in some habitats but not present in others); and

ii) Differences in the detail relating to aspects such as relevant iconic species and types of wild foods (e.g. see services in **bold** in *Table 3.1*).

When undertaking an ecosystem assessment, a useful starting point is to consider any particularly sensitive or designated areas. These are likely to have more significant impacts associated with them.

6 This relates to Step 1 of the *Ecosystem Services Review*.

Table 3.1 – Example checklist excerpt: drilling in forest habitats, exploratory and development stages

Sub-activity/ issue	Potential environmental and biodiversity impact/change	Dependencies on ecosystem services			Impacts on ecosystem services		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Access: Construction and operation of access roads and airstrips.	Modification, fragmentation and removal of habitats and agricultural land. Terrain modification. Noise, dust and vibrations. Visual disturbance.	Use of local natural materials (e.g. aggregates) for roads, etc.	Natural flood and erosion control of surrounding vegetation.		Change (reduction or increase) in local people's ability to hunt and gather wild foods **(e.g. meat, fruit, nuts)**, and to harvest timber and agricultural outputs.	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation	Change (reduction or increase) in access to cultural (e.g. spiritual trees) or recreation features (e.g. bird watching areas) and settlements. Disturbance (visual, auditory and physical) of wild habitats, iconic species **(e.g. orchids, monkeys, tigers)** and landscapes.
Exclusion zones: Temporary exclusion of people from a defined area.	Reduced human access to an area. Protection and maintenance of habitats and species (e.g. reduced logging, land conversion and hunting).				Temporary reduction in local people's ability to hunt and gather wild foods **(e.g. meat, fruit, nuts)**, and to harvest timber, medicines and agricultural outputs. Potential increase in key species due to protection from overuse.		Temporary loss of access to cultural, livelihood and recreation features. Protection of habitats and species from misuse and overuse by people.
Workforce and ancillary camps: Construction, operation and closure.	Disposal and pollution from wastes and wastewater, having visual, physical, biological and chemical impacts. Cutting down of trees. Potential introduction of alien-invasive species.	Use of local natural materials for building camps.	Assimilation service of rivers, soils, etc. disposing of liquid and solid wastes. Water filtration service to provide clean water		Possible pollution of water supply. Potential changes to supply of wild foods through introduction of alien species (typically negative impacts).	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation.	Visual and aesthetic impact of camp and waste on locals and visitors. Threats to iconic species **(e.g. orchids, monkeys, tigers)**. Possible impacts on spiritual or religious value of an area and other non-use values.

Important note: Blank cells are generally either not relevant or unlikely to have significant dependencies or impacts. However, the checklist is not exhaustive, and there will always be exceptions.

3.5 Step 2 – Assess ES dependencies and impacts

Oil and gas sub-activities/issues

The first column in each checklist sets out the oil and gas sub-activities and issues commonly associated with each project phase. These have been generalized across all habitat types and are listed in roughly chronological order. The user should select the relevant sub-activities and issues and then begin the process using the first one listed.

Potential environmental and biodiversity impacts

The second column provides an overview of potential environmental and biodiversity impacts and changes that may be associated with a given project sub-activity/issue. These have been summarized at a high level and are not meant to provide the type of detailed information that would be contained in an impact assessment. These environmental and biodiversity changes are linked to the ecosystem service dependencies and impacts that emerge in the following columns, so it is important to check that the description of impacts included here is applicable to the actual sub-activities under assessment. The user should consider all environmental and biodiversity changes potentially relevant to the sub-activity/issue under assessment. Note that the tool can be used to capture both actual and perceived impacts.

Dependencies on ecosystem services

Moving from left to right, the next three columns in the checklist describe some of the key ecosystem services that each sub-activity/issue may depend upon. Most of the more common and material dependencies are identified.

The dependencies are divided into the three main categories of provisioning, regulating and cultural services. In *Table 3.1*, an excerpt from one of the checklists, the first activity listed is construction of access routes to the drilling site. In some cases, forested habitats may be able to provide natural materials (e.g. aggregates) for building roads (a provisioning service); they can also offer natural flood and erosion control, protecting roads or airstrips from washing away (a regulating service). These examples will not be applicable in every situation, so the user needs to work through the checklist to identify where the ecosystem service dependencies are relevant for the sub-activity/issue in question.

Impacts on ecosystem services

The final three columns describe some of the potential impacts on ecosystem services that may result from each sub-activity/issue. Most of the more common and material impacts have been identified.

These impacts stem directly from the types of associated environmental and biodiversity changes. Using *Table 3.1* as an example, the construction of access routes for drilling in forests could have impacts on all three categories of ecosystem services. The construction of roads, for example, could either increase (by improving access) or decrease (by blocking access or disturbing habitat) the availability of key provisioning services such as wild foods, timber and crops for local people.

The checklist does not address all **higher order** (follow on) **impacts** on ecosystem services, but takes them into account where possible. For example, contamination of a water source could lead to downstream impacts on livestock, agriculture or iconic species in addition to the direct impacts on the drinking water source.

Similarly, **secondary and cumulative impacts** are not all accounted for here, but it would be expected that a user of the checklist would be aware of their possibility and apply the checklist accordingly. The user is thus encouraged to go beyond the checklist examples as additional secondary, cumulative and higher order impacts come to mind.

Identifying priority ecosystem services

Depending on the context, there may be many possible ecosystem service impacts and dependencies, but not all of potential significance. Some form of rationalization or prioritization may thus be needed to focus the analysis on a selection of more relevant and significant (i.e. priority) ecosystem services[7]. Factors to consider include, amongst others, the level of impact and dependence, the degree of substitutability of the ecosystem service, and the strength of stakeholder opinions.

7 See Step 2 of the *Ecosystem Services Review* for guidance on one approach to doing this.

4 Managing dependencies and impacts

4.1 Introduction

This Section provides guidance on identifying and managing potential business risks and opportunities associated with oil and gas ecosystem service dependencies and impacts.

4.2 Step 3 – identify ES risks and opportunities

After working through the checklist, the next step is to determine the potential business risks and opportunities stemming from the ES dependencies and potential impacts associated with a given sub-activity. Two ES Risk and Opportunity Management Tables have been developed to assist with this. Risks and opportunities associated with dependencies are covered in *Table 4.1*, whilst those for impacts are addressed in *Table 4.2*.

For each relevant (or priority) ES dependency and impact identified in the checklist, find the equivalent item in the second column of each table. The third column then suggests some possible associated risks (shaded in orange) and opportunities (shaded in green). To be most effective in fully evaluating potential risks and opportunities (and management options), one should consider the context surrounding the ecosystem service in question. For example, this could include assessing the current status and both past and future associated trends and drivers.

The *Ecosystem Services Review* provides additional useful advice on how to analyse the status and trends of ecosystem services[8]. Issues to consider include, amongst others: aspects around supply and demand (e.g. relating to quantity and quality of the ecosystem service); direct drivers (e.g. land-use changes, overconsumption, climate change, pollution and invasive species); indirect drivers (e.g. government regulations, new environmental markets and demographics); and activities of the company and other actors (e.g. other stakeholders and businesses using or impacting the same ecosystem services – i.e. including cumulative impacts).

While a number of risks and opportunities may be identified directly from the summary tables, the recognition of additional risks and opportunities arising is encouraged to achieve maximum business benefit from the assessment. Note that both actual and perceived risks should be considered, the latter on some occasions being equally or more important. *Table 2.2* and the *Ecosystem Services Review* provide further information on ecosystem service-related business risks and opportunities[9].

4.3 Step 4 – consider mitigation and enhancement measures

Having identified the main potential risks and opportunities, the final column in *Tables 4.1* and *4.2* can be used to identify potential mitigation measures to reduce risks, and potential enhancement measures to increase opportunities.

The measures in the table do not align precisely with the risks and opportunities listed in the previous column, but rather represent a set of example measures that could be selected, or that may prompt other ideas.

In addition, in terms of mitigating general environmental impacts and risks, it is assumed that standard best practice prevention and mitigation measures should be adopted (and are hence not specifically included within the tables). This would include, for example, standard measures to avoid or limit accidental releases, and impacts such as pollution, erosion and introduction of invasive alien species.

The *Ecosystem Services Review* provides further generic advice for companies to develop and prioritize strategies to address ecosystem service-related risks and opportunities[10]. This includes considering internal company actions; sector or stakeholder engagement (e.g. partnering and collaboration); and policy-maker engagement (e.g. helping governments improve sustainability of policies).

8 See Step 3 of the *Ecosystem Services Review*.

9 See Step 4 of the *Ecosystem Services Review*.

10 See Step 5 of the *Ecosystem Services Review*.

Table 4.1 – Risks and opportunities, managing dependencies

Category of service	Key ES dependency	Example associated risks and opportunities	Example mitigation and enhancement measures
Provisioning services	Use of water for drinking and oil and gas activities and processes.	**Risk of increased price of water.** The company may not be currently charged, but in the future it may be; or the charges may escalate. **Risk of future supply shortages.** There may be a decline in water availability due to other stakeholder uses and climate change impacts, threatening production or causing social conflict.	Reduce water volumes needed by company activities (e.g. through technology and techniques to reduce water requirements) or use alternative water sources (such as wastewater). Contribute to, and encourage, water catchment management to overcome administrative shortages, and promote equitable sharing of available resources. Identify and contribute to conservation measures with improved water quality and quantity implications (e.g. reforestation of watershed recharge or headwaters areas that can sustain clean water supplies). Identify potential markets /uses for water improved or provided through rehabilitation measures or company activities.
		Opportunity to improve efficiency through optimizing source selection, minimizing resource use and maximizing recycle and reuse. This could reduce costs, reduce waste outputs and reduce the likelihood of conflicts. **Opportunity to supply water to others.** If a company has ownership rights it may be able to supply and charge others for its use, if appropriate, thereby gaining additional revenues.	
	Use of agricultural output for food. Use of wild flora and fauna for food and medicines (possible indirect dependence of local workforce). Use of wood for building and energy. Use of aggregates for building.	**Risk of depleting local resources.** This could lead to supply shortages and/or conflicts with other resource users. **Risk of increased prices.** Local shortages could lead to higher costs for local materials or for importation from other locations (imports carry additional alien invasive species risks)	Develop a procurement strategy that encourages use of local goods, but that involves some mechanisms for assessing or maintaining the sustainability of the supply. As part of a social investment strategy study, consider what investments could be made to support the productivity and sustainability of local supplies for the workforce and operations. Support scientific studies and monitoring programmes aimed at assessing the sustainability of using local resources.
		Opportunity to reduce resource costs by using locally available materials. **Opportunity to support the local economy by sourcing food and materials locally, where feasible.** **Opportunity to contribute to, or promote, sustainable agriculture.** **Opportunity to reduce carbon emissions.** In some cases, sustainable utilization of local sources of food and building materials may help reduce global impacts.	

Note that the contents of this table are by no means exhaustive.

Table 4.1 – Risks and opportunities, managing dependencies

Category of service	Key ES dependency	Example associated risks and opportunities	Example mitigation and enhancement measures
Regulating services	**Natural flood, erosion and storm control.** **Water filtration service of vegetation and soil.** **Carbon storage (offsets to carbon emissions)** **Assimilation services of water, air, soil and vegetation to reduce pollution impacts.**	**Risk of damaging natural regulating services.** Loss of natural protective features could lead to higher damage costs from flooding, winds and erosion and/or the need to invest in costly engineered solutions. **Risk of overloading natural filtration and waste assimilation services of water, vegetation and soils.** This may have implications for water quality and impacts to organisms such as fish. This could also lead to increased costs for engineered treatment and controls. **Opportunity to benefit from natural services afforded.** It may be possible to locate infrastructure to gain the most benefit from natural flood and storm protection services (e.g. behind mangroves).	Assess the relative importance of natural regulatory services at the site, and design infrastructure to accommodate and enhance such services where feasible. Where natural protection services are negatively impacted, provide replacement services to the extent practicable and worthwhile. Where possible, replace or enhance natural barriers/mitigating factors before investing in man-made replacements. Consider the natural capacity of water filtration and waste assimilation services, and make sure through monitoring and analysis that these are not exceeded.
Cultural services	**Use of local recreation features for/by workers.**	**Risk of impacting cultural resources.** Staff may impact the recreational and cultural features if they do not behave appropriately (e.g. causing damage, noise, waste and offence to locals). **Opportunity to benefit from local cultural resources.** These may be used to entertain staff and benefit the local economy through associated staff expenditures.	Provide information to staff about different local activities and attractions, and ways that they can support local economy. Provide strict guidance to staff as to what they can and cannot do, and how they should behave. Work with local organizations and resource managers to assess the capacity for sites to absorb a large increase in users. Where practicable, provide support to enhance institutional capacity.

Note that the contents of this table are by no means exhaustive.

Table 4.2 – Risks and opportunities, managing impacts

Category of service	Key ES impacts	Example associated risks and opportunities	Example mitigation and enhancement measures
Provisioning services	**Reduced availability of fresh water** **Pollution of water supply**	**Risk of social unrest and confrontation from local communities and stakeholders.** **Risk of reputational impacts.** Stakeholders may generate negative publicity, impacting on the company's wider reputation. Reputational impacts could influence share price, market share, access to finance, and resource rights going forward. **Risk of delays and other operational impacts.** In the event that real or perceived impacts on the water supply cause local or wider unrest, or legal disputes, changes or stoppages in operation may occur. **Risk of resource conflicts with other major water users** (e.g. other companies, utilities and municipalities).	Gather information/map water constraints and uses in the area. Where necessary, make provisions to enhance long-term water availability; either through technological means (water reclamation, desalination) or by investing in protecting natural water sources in the area. Identify water saving measures early in the project cycle. Work with other water users early in the process to avoid conflict and look for opportunities to improve efficiency of water use across the area. Where water is being used for many other purposes, engage in and support appropriate water resource management strategies to maximize the long-term values of water in a fair and equitable way. Seek alternative technology, processes and practices to reduce volume and concentration of wastes generated. Implement appropriate water pollution control measures such as oil interceptors, treatment of wastewaters etc.
		Opportunity to improve efficiency of water use and resource management. This could yield cost and reputational benefits.	
	Reduction (or perceived reduction) in agricultural outputs through indirect effects (e.g. pest introduction, dust, air emissions).	**Risk of social unrest and confrontation, from local communities and stakeholders, and claims for compensation.**	Manage dust-generating activities to avoid crop impacts. Institute tight controls on introduction and transfer of alien invasive species. Consult with farmers and scientists to ascertain the true likely impact on their yields, and consider providing mitigation and/or an appropriate level of compensation. Undertake monitoring of air quality at sites where issues are suggested to have arisen.

Note that the contents of this table are by no means exhaustive.

Table 4.2 – Risks and opportunities, managing impacts

Category of service	Key ES impacts	Example associated risks and opportunities	Example mitigation and enhancement measures
Provisioning services	**Change (reduction or increase) in availability of, or access to, wild meat, fish, medicines, etc.**	**Risk of reputational impacts (see above).** **Risk of delays and other operational impacts (see above).**	Support local communities in developing sustainable farming, aquaculture, bee keeping, fruit growing, ecotourism or other activities that provide alternative food and income over the long-term. When a large outside workforce is anticipated, assess and plan for potential resource constraints. Work with local authorities to manage access issues appropriately. Where appropriate, build long-term land-use planning into site and access route management. Apply strict bans or guidelines for workforce regarding hunting, gathering and purchasing of certain wild products where protected areas or species are at risk or nearby.
		Opportunity to help conserve native plants and animals if threatened by overuse. Temporary or permanent access restrictions can have beneficial long-term effects on fish or game populations, for example. **Opportunity to increase access to new areas for hunting and gathering.** This may help increase food resources for local communities, where appropriate, and sustainable use of resources can be achieved. **Opportunity to build capacity for more sustainable lifestyles as populations grow.** This can improve future community and individual well-being.	
Regulating services	**Loss of carbon sequestration services**	**Risk of reputational impacts.** Risks to the international reputation of the company for overall carbon footprint, possibly leading to loss of competitiveness, access to resources, ability to attract and retain employees.	Dedicate a portion of the land used for the project for native forest, and/or invest in replacing or protecting CO_2 sequestration/storage services in the immediate area. Where practical, reduce the number and size of roads, cleared areas and rights-of-way constructed, and coordinate with local authorities to minimize the extent of roadside colonization stemming from the project. Initiate long-term rehabilitation plans for the project site that include re-planting and maintaining the natural habitat.
		Opportunity to enhance reputation, save costs and mitigate impacts through offsetting schemes. This may be most appropriate in countries where carbon offsetting is eligible for credits.	
	Reduction in flood and erosion control **Loss of natural water purification services**	**Risk of loss of, or damage to, facilities and infrastructure** due to flooding or erosion, or added cost of preventing such damage through engineered measures. **Risk of legal disputes.** A reduction in potable water supplies available for stakeholder groups and protection from flooding could increase stakeholder conflicts and result in legal disputes and claims for compensation.	Provide replacement services to the extent possible and worthwhile. Where practicable, invest in replenishment of natural vegetation (e.g. mangroves, riparian buffers). Work with local authorities and businesses to incorporate natural protective features into development planning more widely.
		Opportunity to enhance natural flood and erosion control in the area by taking a proactive approach to retaining and enhancing natural protective features near oil and gas activities.	

Note that the contents of this table are by no means exhaustive.

Table 4.2 – Risks and opportunities, managing impacts

Category of service	Key ES impacts	Example associated risks and opportunities	Example mitigation and enhancement measures
Cultural services	**Disturbance to iconic species.**	**Risk of loss of, or damage to, community livelihoods,** through decrease in subsistence or economic opportunities associated with iconic species. Unintended alteration of ecological/food web balance, with implications for other services. **Risk of social unrest and confrontation from local communities and stakeholders.** **Risk of reputational impacts through criticism and confrontation from international bodies or NGOs.**	Limit impacts to iconic species through careful engineering/operational design and timing of work activities, etc. Contribute to associated conservation efforts and/or research – e.g. through NGOs and/or universities, or through commissioning and making available detailed research through the project. Habitat restoration/creation and offsetting may be an option if the habitat provided will support the species affected. Proactive conservation activities could include capacity building for conservation, creation or conservation of habitat beyond offset requirements, etc. If excess biodiversity habitat is created, there may be scope to sell habitat credits (in the future, subject to facilitating policy).
		Opportunity to take proactive steps towards preservation of iconic species, and reap market benefits from conservation actions.	
	Loss of access to cultural and recreation features. **Degradation of the quality of cultural or recreation services.** **Loss of tranquillity for communities, visitors.** **Loss of visual amenity for communities, visitors.**	**Risk of social unrest and confrontation from local communities and stakeholders.** **Risk of legal disputes (see above).** **Risk of loss of ability to attract and retain local employees.** **Risk of rise in unemployment, crime and unrest due to impacts on the local economy.** The decline of ecosystem-based livelihoods such as the tourism and recreation industries could have wider impacts on social and economic stability.	Minimize impacts on cultural and recreation features through careful scheme design and timing of work activities. Reinstate or provide alternative access to important natural spaces where possible. Work with local authorities and NGOs, as appropriate and practicable, to improve infrastructure, access and management of recreational, cultural and conservation (protected) areas.
		Opportunity to support management of recreational and protected areas. There may be scope to provide support (e.g. technical, management, equipment or financial) to help manage important recreational or conservation areas. This could generate important reputational benefits for the company and economic benefits for the community.	

Note that the contents of this table are by no means exhaustive.

Table 4.2 – Risks and opportunities, managing impacts

Category of service	Key ES impacts	Example associated risks and opportunities	Example mitigation and enhancement measures
All services	**Potential loss (or gain) of all ecosystem services associated with destroying (or creating) habitats.**	**Risk of project delays, loss of external financing and international reputational impacts, and loss of social license to operate.**	Avoid and minimize loss of, or damage to, habitats through careful engineering/operational design and timing of work activities, etc. Undertake habitat restoration, creation and offsetting. Use of techniques such as 'habitat equivalency analysis' and ecosystem services valuation can help quantify the biodiversity offset required, or the additional value generated by the offset.
		Opportunity to take proactive steps towards preservation of ecosystem services and reap market benefits from conservation actions.	
	Potential impacts on all provisioning, regulating and cultural services from accidental events.	**Risk of legal disputes and fines, project delays, loss of external financing, international reputational impacts, and loss of social license to operate.**	Implement standard best practices in accident avoidance and management, including a full risk assessment and scenario analysis. Develop risk maps showing areas that are sensitive and valuable in terms of biodiversity and ecosystem services, and develop suitable plans for protection and clean-up, etc.

Note that the contents of this table are by no means exhaustive.

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Annex A – Ecosystem services checklists

The *ecosystem services checklists* are available on the CD below.

The checklists cover five stages of the oil and gas life cycle for six generic habitat types, onshore and offshore. Operators can choose the relevant checklist for a particular project phase in a specific habitat type. The checklists are not meant to be exhaustive; rather, they provide an initial capture of some of the more typical biodiversity and ecosystem services dependencies and impacts along the project life cycle.

Please note the checklists can also be downloaded at:

http://www.ipieca.org/publication/ecosystem-services-guidance

IPIECA is the global oil and gas industry association for environmental and social issues. It develops, shares and promotes good practices and knowledge to help the industry improve its environmental and social performance, and is the industry's principal channel of communication with the United Nations. Through its member led working groups and executive leadership, IPIECA brings together the collective expertise of oil and gas companies and associations. Its unique position within the industry enables its members to respond effectively to key environmental and social issues.

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OGP represents the upstream oil and gas industry before international organizations including the International Maritime Organization, the United Nations Environment Programme (UNEP) Regional Seas Conventions and other groups under the UN umbrella. At the regional level, OGP is the industry representative to the European Commission and Parliament and the OSPAR Commission for the North East Atlantic. Equally important is OGP's role in promulgating best practices, particularly in the areas of health, safety, the environment and social responsibility.

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