APPROACHES TO VISUAL IMPACT ASSESSMENT OF OFFSHORE WIND: THE NEW YORK BIGHT CASE STUDY

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ABSTRACT

The federal Bureau of Ocean Energy Management is currently planning the nation's first large-scale offshore wind farms which are slated to be installed throughout the mid-Atlantic. A key consideration in the planning process is the potential visual impact of wind farms on coastal landscapes and communities. The New York Bight is one of the areas currently undergoing such Visual Impact Assessment (VIA).

This report seeks to evaluate the efficacy of the New York Bight VIA through a literature review of considerations in OWF VIA and a comparison with other offshore wind VIA methodologies currently employed in the U.S. and United Kingdom, both of which are leaders in advancing the application of VIA methodology to offshore wind energy. The report analyzes the theoretical frameworks and techniques used in the New York Bight VIA and, by extension, the strengths and limitations of offshore wind VIA in the mid-Atlantic.

The analysis identifies shortcomings in methodologies relating to public involvement, visualization techniques, and cumulative impact ranking scales, as well as significant gaps in criteria used to establish the visibility of OWFs and the sensitivity of viewers to visual change. Improved methodological and visual perception considerations will help accurately assess the consequences of OWFs for people who live, work, and play along the coast, and ultimately impact the long-term success of offshore wind energy on the east coast of the U.S. and the continued growth of this important development in sustainable energy.

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LIST OF ABBREVIATIONS

APVI	area of potential visual impact
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
CCC	Cape Cod Commission
DOI	Department of the Interior
DTI	Department of Trade and Industry
EIS	environmental impact statement
GAA	geographic analysis area
GIS	geographic information system
GLVIA	guidelines for landscape and visual impact assessment
KOP	key observation point
NEPA	National Environmental Policy Act
NYB	New York Bight (offshore wind lease area)
OCS	outer continental shelf
OWF	offshore wind farm
PEIS	programmatic environmental impact statement
PFOWF	Pentland Floating Offshore Wind Farm
SLIA	seascape and landscape impact assessment
SLVIA	seascape, landscape and visual impact assessment
SNH	Scottish Natural Heritage
SVIA	seascape and visual impact assessment
VIA	visual impact assessment
ZTV	zone of theoretical visibility

CHAPTER 1: INTRODUCTION

The United States is seeing growing investment in renewables. Under the Biden administration, substantial resources have been allocated to the development of renewable energy, and renewable energy goals have been adopted at both the state and local level. The Federal Energy Act of 2020 set aside nearly USD 7 billion for carbon management and renewable energy development, including permitting of "at least 25 gigawatts of electricity from wind, solar, and geothermal projects by 2025". The development of offshore wind energy is of particular importance to meeting these goals, and the Department of the Interior's (DOI) Bureau of Ocean Energy Management (BOEM) is currently planning nearly 200 offshore wind farms around the nation. Much of this development has been focused on the east coast, where two small-scale pilot projects have been completed, and the mid-Atlantic seaboard has been parceled into 36 OWF utility-scale lease areas for future development.

Visual impacts are an important consideration in the planning of OWF. The use of Visual Impact Assessments (VIA) is widespread in the siting and development of infrastructure and utilities, including wind energy, and involves the analysis of changes to the landscape scenery created by contrast between the visual elements of a new development (e.g. wing farms) and its surroundings, as well as how these changes affect the experience of people in the landscape (BLM, 1986). The magnitude of visual change and contrast is an important metric in determining the extent to which viewers are affected by new developments. However, the type (including features, land uses, etc.) of visual change and, in turn, how much viewers notice and care about the type of change is also a large component of VIA. Various terms relating to peoples' visual experiences, values, and opinions are used in different ways to describe this aspect of VIA. For the purposes of this paper, the following definitions of terms are used:

Aesthetic experience – an individual or community's perceptual experience of a view or landscape as beautiful, attractive, or otherwise visually pleasurable.

Aesthetic preference / Visual preference – what an individual or community finds visually desirable based on their aesthetic values as well as other cultural and contextual factors.

Aesthetic value – the value that an individual or community places on an aesthetic experience.

Landscape – a portion of the visible environment. In this paper, "landscape" is used as a general term that pertains to any type of environment, including those that are primarily water, such as oceans.

Scenery – the general appearance of the landscape based on its visible characteristics (such as open, forested, natural, urban, etc.). This is not subjective.

Scenic value – the perceived value that an individual or community places on certain scenery based on its aesthetic value.

Seascape – a type of landscape that is primarily comprised of the ocean and its immediate surroundings.

Sensitivity – The degree to which viewers notice and care about visual changes to the scenery.

View – what one sees when looking from a particular point on earth. In this paper, it is any area within a 360 degree cone of vision (both vertically and horizontally) that includes any portion of the project without foreground obstructions.

Visibility – The degree to which something can be seen by the human eye and interpreted by the brain.

Visual elements – visible components and spatial relationships within a view, including form, line, color, texture, scale, complexity, and arrangement/order. These elements are commonly identified and standardized by professionals for each project's VIA.

Visual experience – a viewer's perceptual experience of a view or landscape.

Visual perception – the combined subjective and objective factors that determine what people notice in a view. This is impacted by what is recognizable to the human eye in addition to what the individual notices, influenced by what they care about or value.

VIA has a long history and a significant body of research surrounding it, but little research has been done on the validity of VIA methodologies in the context of offshore wind, especially in the United States (e.g. Churchward et al., 2013; Smardon, 2016; Swanwick, 2007; Gobster et al., 2019; Sullivan et al., 2013; Sullivan et al., 2014). While the first OWFs were built in Europe in the 1990s, their development did not expand to other parts of the world, including the U.S., until the last decade. Existing literature on the visual impact of offshore wind focuses on visibility tradeoffs, the implications of OWF VIA on offshore energy planning, and the efficacy of technologies employed in the assessment of visual effects (Ladenburg & Lutzeyer, 2012; Sullivan et al., 2012; Lamy et al., 2017; BOEM, n.d.; Loannidis & Koutsoyiannis, 2020; Evans, 2022; Griffin et al., 2015; Cranmer et al., 2023). However, the considerations and methodologies employed in determining the cumulative visual impact of offshore wind have not been evaluated. As offshore wind energy expands in the U.S. and across the world, it is important to fill this knowledge gap.

Due to the ocean setting and important role that coastal landscapes play in the identity and daily lives of coastal communities , offshore energy development presents unique considerations in the VIA process compared to other energy and infrastructure developments (Ladenburg & Lutzeyer, 2012; Sullivan et al., 2012; Lamy et al., 2017; Loannidis & Koutsoyiannis, 2020; Evans, 2022; Griffin et al., 2015). Research shows that in coastal landscapes, the identity of individuals and communities is closely tied to their relationship with and perceptions of the ocean and seascape (Micallef, 2018; Gee et al, 2017). On the east coast of the U.S., this is particularly true. The Intergovernmental Oceanographic Commission's Marine Spatial Planning Northeast Ocean Plan (2016) explains that "New England was born of the ocean—[t]he region's identity and its vitality are inextricably intertwined with the sea". Insufficient consideration of the visual impacts of mid-Atlantic OWF developments could have serious consequences for people who live, work, and play along the coast, and ultimately for the long-term success of offshore wind energy on the east coast of the U.S.

The New York Bight (NYB) contains six of the 36 recently established OWF least areas in the mid-Atlantic. In 2022, the NYB began undergoing programmatic environmental impact assessment, and Argonne National Lab was tasked with carrying out a VIA as part of this effort. This paper investigates the theoretical frameworks and techniques utilized in these efforts in order to better understand the benefits and limitations of offshore wind VIAs specific to the mid-Atlantic.

The first chapter surveys literature on the contributing factors to human visual perception of OWF and current methods for identifying and evaluating these factors in OWF VIA. Notably, this paper does not include a complete inventory of broader VIA approaches and frameworks for other infrastructure and developments, but rather is limited to the VIA considerations specific to large-scale offshore wind developments. This includes the unique visual characteristics of wind turbines in ocean settings, the experiences of people unique to coastal landscapes, and the methodologies and approaches of evaluating the visual impacts of offshore wind given these factors.

The second chapter explores the NYB VIA as a case study of the approaches and methodologies currently being employed in the development of mid-Atlantic OWFs. The paper concludes with a discussion of the strengths and limitations of current approaches to OWF VIA, and provides suggestions for future OWF VIA efforts specific to the mid-Atlantic, drawing on findings from the NYB case study.

CHAPTER 2: LITERATURE REVIEW

2.1 Visual Perceptibility of Offshore Wind Farms

Standard VIA methodology entails establishing a baseline of existing landscape conditions, inventorying changes that occur to them, and assessing how people perceive and experience the visual changes. This is usually done by assessing the type and magnitude of visual change through an analysis of the visibility of the project and its contrast with the visual elements of the existing landscape along with sensitivity to visual and scenic changes. In VIA approaches developed for assessing offshore wind in the United States and Great Britain, viewer and landscape sensitivity are regularly described as distinct *sensitivity receptor*s that contribute to viewers' overall perception of changes to the scenery (see Figure 1).

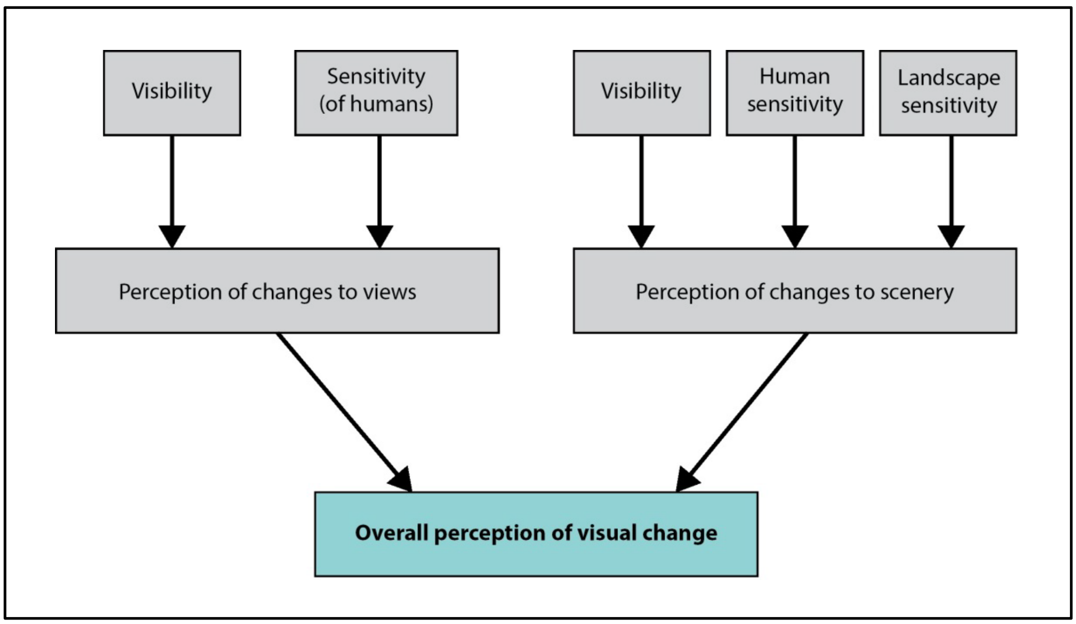


Figure 1. Considerations in determining perception of visual change that might typically be employed in international VIA methodology

Landscape scenery sensitivity receptors are frequently discussed in terms of the landscapes' ability to "absorb" visual contrast based on existing scenic quality, while the impact to human sensitivity receptors is based on the value people place on the scenery. Human and landscape sensitivity are clearly interrelated, and evaluating them separately obscures the relationship between viewers and the landscape. Visual change occurs to the landscape, but determining peoples' perception of the visual change (the purpose of VIA) is inherently dependent on the degree to which viewers notice and care about the visual changes. It may also be confusing to lay audiences to describe inanimate landscapes as "sensitive".

To provide a clearer understanding of the relationship between impacts to landscape scenery and the people viewing it, this paper refers to overall perception of visual change in terms of visible impacts to landscape views and scenery in conjunction with human sensitivity to visible impacts. It uses the term *impact receptors* as an alternative to *sensitivity receptors* to broadly refer to things that are impacted by visual change. Figure 2 shows the relationships between these terms, and the following discussion of literature on the visual perceptibility of OWFs is structured accordingly.

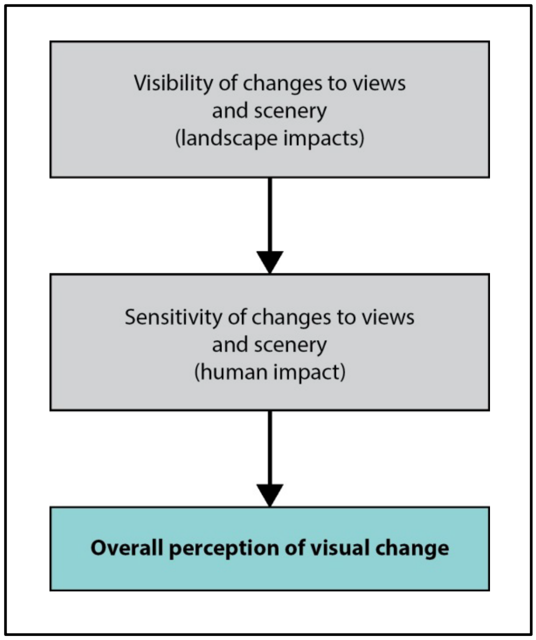


Figure 2. Proposed considerations in determining perception of visual change

2.1.1 Visibility of Offshore Wind Farms

Contrast and viewshed extent are central to characterizing the visibility of a project. While GIS-based viewshed methodologies are a popular area of study in all types of infrastructure VIA, the unique visibility considerations of OWF primarily pertain to visual contrast. The degree and magnitude of contrast is described based on visual elements of the scenery and views given how visual information is typically processed by the human eye and brain (Churchward et al., 2013; BC Visual Impact Assessment Handbook, 2022; BLM, 1986; BLM, 1986; USFS Handbook for Scenery Management, 1996). This includes the following visual elements of turbines and their siting/arrangement, the surrounding ocean characteristics, and the onshore environmental context of the viewer.

Materiality: Color & Reflectiveness

Turbine materiality has long been recognized as one of the most noticeable visual elements of OWF, particularly regarding the color and reflectiveness of the turbines. The difference between the color of turbines and the sky behind them is found to be important in assessing wind farm visibility. Especially in the early days of OWF development, emphasis was placed on researching the optimal color of turbines (Gee, 2010; Runge and Nommel, 2006; Bishop and Miller, 2007; Sullivan et al., 2012). Smooth, reflective materiality of turbines is also shown to produce noticeable glint and glare, and plays a role in the lighting effects described below (Sullivan et al., 2013; Sullivan et al., 2014).

Atmosphere & Lighting Effects

Research has found that the degree of contrast—particularly the contrast caused by turbine materiality—between offshore wind turbines and their surroundings is significantly impacted by both weather and lighting (Bishop & Miller, 2007). Specifically, Bishop & Miller (2007) found that a combination of clearness of the air, cloud cover, and sun exposure are major factors in the visibility of offshore wind farms. Since all offshore wind turbines are viewed against open skies, clouds can significantly alter all or part of the background against which turbines are viewed, and the speed at which clouds travel can rapidly alter the degree of contrast of turbines (Sullivan et al., 2014). Haze and fog can significantly change the visibility range of turbines from the shore, and the position and direction of the sun plays a significant role in illuminating and exacerbating the contrast between the turbines and the sky behind then as well as reflectivity of the water surrounding them (Sullivan et al., 2012). For example, "[i]n the northern hemisphere a wind farm off a south-facing coast"—such as those in the mid-Atlantic—"will typically have full sun on the exposed side of the turbines much less than a farm off a north-facing coast" (Bishop & Miller, 2007). While these atmospheric and lighting conditions are often unpredictable, literature suggests that that a general range of fluctuation based on local weather patterns and path of the sun can and should be considered in offshore wind VIA efforts (Bishop & Miller, 2007; Sullivan, 2021).

Light & Night Skies

Though lights on wind turbines are not as bright as some other energy utilities and may not be noticeable to viewers in the daylight, their impact on dark night skies is an important consideration of offshore wind farms (Sullivan et al., 2012). Since offshore wind turbines are not surrounded by other light sources, their lights may be particularly noticeable against dark night skies (Sullivan, 2013). Furthermore, the flashing of standard navigation lights required for wind turbines has been found to be particularly noticeable (Sullivan et al., 2014).

Movement

Movement of turbine blades is considered a major factor in many studies of OWF visibility impacts (Bishop & Miller, 2007; Sullivan et al., 2012). Bishop & Miller (2007) find that it is of greater influence on visibility of turbines than other contrasts from color, texture, light, and atmospheric conditions. A secondary movement consideration is wave action, which can reduce the overall contrast of turbines, and should be considered in relation to the movement of turbine blades (Bishop & Miller, 2007).

Distance

While onshore visual impact assessments are usually concerned with views of the development from various distance zones (foreground, mid ground, and background), onshore viewers of OWF only view it from far distances. Currently, visibility analysis of OWF mainly focuses on this onshore visibility, with numerous studies conducted on visibility thresholds based on turbine height (Cranmer et al., 2023; Bishop & Miller, 2007; Ladenburg & Lutzeyer, 2012; Sullivan et al., 2012). Prevalent research on "willingness to pay" for visual impacts frequently uses distance as a proxy for visual magnitude (Bishop

& Miller, 2007; Sullivan et al., 2012; Ladenburg & Dubgaard, 2007). In this context, determining the visibility threshold for the point of diminishing return is often of interest (Bishop & Miller, 2007). Little attention is given to visibility impacts of viewing OWF from different distances within the ocean (i.e. from boats).

Turbine Layout

While the layout of turbines is a common consideration in OWF visibility research and assessment, recent studies have found that the number and arrangement of turbines may not be a primary visibility factor for OWF (Cranmer et al., 2023; Bishop & Miller, 2007). However, other research has found statistically significant impact based on the unevenness of turbine arrangements (Gonzalez-Rodriguez, 2016; Gonzalez-Rodriguez et al., 2022). Little research has been done on the impact of turbines density.

Size of turbines

Literature consistently shows that turbine size is one of the least important visibility factors of OWF (Cranmer et al., 2023). However, questions of turbine size in relation to energy production capacity are a frequent topic of investigation in offshore wind, and VIA studies consequently consider size variations in their investigation of different design scenarios. Furthermore, these studies assume that the viewer is located on land, and they do not address how the relative scale of turbines is perceived differently for people on boats. Gobster et al. (2007) explain how the human perception of the landscape operates within the “perceptible realm”, beyond which people may not experience the same visual impacts. The visibility of turbines is not well understood for people close to the turbines on boats, but understanding the size of turbines in relation to the perceptible realm could help bridge this gap.

Onshore Environment

While all the other visibility factors discussed above pertain to the turbines in their immediate surroundings of sky and ocean, the on-shore environment is also an important consideration of OWF visibility. The contrast between turbines and the visual characteristics of the broader coastal landscape character is a primary area of study (Sullivan et al., 2012). Overall visibility is also impacted by obstruction of views of the OWF from on-shore elements such as trees or buildings that block viewer’s sightlines to the ocean horizon and OWF, or even temporary obstructions such as birds (Cranmer et al., 2023). As the viewer moves through the landscape, the sudden or gradual change in sightlines based on these obstructions and how the viewer is moving through the landscape is also an area of consideration (CCC, 2012; Sullivan et al., 2012).

2.1.2 Sensitivity in Coastal Landscapes

Widespread research has shown that viewer’s opinions of offshore wind installations are influenced by more than just the visibility of the turbines (Westerberg et al., 2015). The degree to which viewers notice, care about and are affected by changes to the coastal scenery is just as important if not more so to the overall visual impact of OWF (Gee, 2010; Churchward et al., 2013; BLM, 1986; BLM, 1986; BLM, 1996). Viewers’ sensitivity to scenic changes and their visual perception of OWFs is influenced by who they are and what they are doing. The viewer's culture, relationship to the ocean (and specifically the coastal scenery), ways in which they use the landscape, demographic identity, life experiences, and personal values, beliefs, and aesthetic preferences all factor into their perception of the visual presence of OWF.

Cultural Significance of Coasts & Seascapes

Many studies have explored the nuanced connection between individuals' relationship with the sea and costal communities' sense of identity of coastal communities (Gee, 2010; Gee et al., 2017; Turner & Essex, 2016; Rodriguez, 2017). These studies have found that the symbolic significance of the sea plays an important role in "local residents' sense and quality of place" (Gee, 2010). In turn, this provides an understanding of why coastal places or features are culturally important. While this is a new topic of discussion in coastal VIA literature and methodology, broader coastal planning and management frameworks have a longer history of incorporating "culturally significant areas" into their coastal development and planning guidelines in order to spatially prioritize areas for development and conservation (Gee, 2010; Gee & Burkhard, 2010; Gee et al., 2017). If the nature of a community's identity is specifically tied to the scenic qualities of the ocean, it is imperative that this relationship is reflected in visual effect analysis of offshore wind (Gee, 2010). Depending on the nature of the local community's connection to the ocean, visual changes to the ocean may lead to adverse impacts on the community's cultural identity. Some communities might have a strong cultural connection to the visual appearance of the ocean and seascape while other cultural identities may be more closely tied to non-visual aspects of the ocean, making them less sensitive to visual changes to the seascape. This burgeoning field of study suggests that a viewer's culture may be particularly important in understanding the visual impact of OWFs compared to other infrastructure development.

Experience with Offshore Wind Farms

Viewers' past experience with wind farms has been shown to strongly correlate with their sensitivity to the visual effects of offshore wind (Parsons & Yan, 2021; Ladenburg & Lutzeyer, 2012; Ladenburg, 2009). For example, Ladenburg & Lutzeyer (2012) show that there is diminishing demand for visual impact reductions as people become more familiar with the visual attributes of wind turbines in the landscape. Both tourists and locals who experienced the construction of the turbines also had an improved perception of the project once it was complete (Bidwell, 2023).

Another significant body of research has shown the importance of viewers' perceived involvement in the siting of offshore, including through clear communication with stakeholders and community engagement (Rensburg & Brennan 2024; Westerberg et al 2015; Sorensen et al. 2002, Gee 2010). Greater perceived involvement in OWF development is an important indicator for both local acceptance of, and visual sensitivity to OWF upon completion of construction. While neither of these experience factors may be reflected in a visual effects analysis conducted in during the OWF planning process (prior to the completion of the project), it points to the importance of considering the cumulative impact of visual sensitivity over time.

Viewer Values, Beliefs & Knowledge

Arguably one of the most influential factors in a viewers' sensitivity is their existing values, beliefs, and knowledge, specifically their environmental beliefs, local knowledge, and aesthetic values and experiences. Bidwell (2017, 2023) explains that environmental beliefs influence local perceptions of offshore wind farms. In particular, viewers' opinions about the existing landscape and beliefs about renewables and the impact of wind energy on the environment factor into their general opinions about OWF (Westerberg et al., 2015; Gee, 2010; Klain, 2020; Maeher, 2015; Bidwell, 2023). These opinions and beliefs in turn influence what viewers perceive when viewing OWFs and how they feel about the visual changes to the scenery. Described by Gobster et al. (2007) as an individual or community's "ecological aesthetics", different viewers may care more about, and gain more pleasure from different landscapes or scenic qualities based on differing knowledge of and opinions about the environment. Viewers' knowledge and values about other contextual factors such as local history or economics may similarly influence their aesthetic experience of the landscape and visual perception of OWFs (Westerberg et al., 2015; Gee, 2010).

Viewers' aesthetic values also play an important role in their visual perception of OWFs. Different people may care more about certain visual elements and scenic qualities and therefore have different aesthetic experiences of the landscape and be more sensitive to certain changes to it. Understanding viewers' individual aesthetic values relating to seascapes, as well as local knowledge and contextual values, and beliefs about the ocean environment and renewable energy is key to assessing visual sensitivity to OWFs.

Demographic Identity

Literature shows significant correlation between certain socio-demographic characteristics including age, nationality, and education, and the perceived visual intrusiveness of OWFs (Bishop & Miller, 2007; Gee, 2010; Westerberg et al., 2015; Ladenburg & Lutzeyer, 2012). However, Westerberg et al. (2015) point out that these factors likely stand out from other demographic characteristics because they strongly influence viewers' values, beliefs, and knowledge. Understanding individuals' values, beliefs, and knowledge may provide a more complete picture of how viewers perceive changes to the scenery, but age, nationality, and education may be useful for predicting broad trends in viewers' aesthetic experiences and the cumulative visual impacts of OWFs.

Landscape User Types

Coastal visitors and local residents are often discussed in OWF VIA literature as important and distinct viewer groups that reliably demonstrate differing opinions about OWF (Westerberg et al., 2015). The differences in aesthetic values and preferences between the two groups may be attributed to differences in the activities that they partake in, the related type of view of the project (i.e. the duration and frequency of the view), the nature of their connection to the ocean, and the variances in their socio-demographic characteristics (Ladenburg & Dubgaard, 2009; Westerberg et al., 2015; Ladenburg &

Lutzeyer, 2012). In particular, studies have shown that visitors and local residents have different opinions about the number and arrangement of turbines (Moon et al., 2023).

However, it is important to note that some studies do not find a statistically significant difference in visual preferences about OWFs solely based on viewers' identity as a visitor or a local (Ladenburg & Dubgaard, 2009; Moon et al., 2023). Instead, Ladenburg & Dubgaard (2009) find that the type of activity that the viewer in engaged in is more useful in assessing preferences of OWFs. While a viewer's identity as a local or a tourist may be useful in predicting visual perception of OWF in some places, it may be more reliable to specifically consider the viewer's activity and type of view in conjunction with their aesthetic and contextual knowledge, values, and beliefs.

2.2 Offshore Wind Farm VIA Methodologies

2.2.1 Case Study Selection

In order to understand the current methods of determining the visual perceptibility of OWF and how existing OWF development are evaluated based on the factors addressed above, four case study OWF VIA methodologies were selected for investigation. As of 2023, 9 countries across the world have operational OWFs, and new OWFs are in the planning stages in at least 5 additional countries ("Offshore Wind Projects", n.d.; "What Does Offshore Wind Energy", n.d.; Williams & Zhao, 2023). With the exception of the United States, all of these countries are located in Europe or East Asia, though early proposals are being developed in other countries such as Australia and Canada (Williams & Zhao, 2023). A broad survey of available procedures of existing OWFs showed that nearly all acknowledge the importance of assessing potential visual impact in the planning of the project, but few employ comprehensive VIA assessment methodologies that combine visibility and sensitivity valuations. Most simply rely on viewshed analyses while some incorporate preference studies. However, the United Kingdom stands out as a leader in advancing the application of VIA methodology to offshore wind energy, and in recent years, the U.S. has also played an important role in advancing this field of research.

Based on this understanding of current OWF VIA, the following four case studies were selected and are summarized in Table 1 below:

1. **Hexicon (methodology developed for the Pentland Floating Offshore Wind Farm (PFOWF))** ("Appendix 15.1 Dounreay Tri", 2016)
2. **Forewind (methodology developed for the Dogger Bank Offshore Wind Farm)** (Land Use Consultants, 2014)
3. **Cape Cod Commission** (CCC) (CCC, 2012)
4. **Bureau of Ocean Energy Management** (BOEM) (BOEM, 2023)

The first two case studies were created by private wind developers in conjunction with proposed OWF lease areas under national UK guidance. One of these—Hexicon's PFOWF—is located in Scotland and was guided by a consortium of national Scottish planning bodies. The other—Forewind's Dogger Bank OWF—is from the UK under a combination of regional and national planning bodies across the UK, and presents a unique focus on VIA of OWF construction and on-shore facilities. The second two case studies were developed by local and federal agencies in the United States. One was developed by the Cape Cod Commission (CCC), a local planning commission, and the other was developed by the BOEM.

All four case studies are based at least in part on the UK's Guidelines for Landscape and Visual Impact Assessment (GLVIA), but use three different methodological frameworks: **Seascape, Landscape, and Visual Impacts Assessment (SLVIA)**, **Seascape and Visual Impact Assessment (SVIA)**, and modified **Visual Impact Assessment (VIA)**. Two of the case studies—Hexicon and BOEM—use a SLVIA framework, but implement them differently. While Hexicon assesses seascape, landscape, and visual impacts separately and then combines this analysis into one cumulative visual impact, BOEM assesses the cumulative impact of seascape and landscape separately from visual impacts without combining them.

While the geographic diversity of these case studies is limited, an emphasis on the US is appropriate for the purposes of this report since it has been on the forefront of VIA specific to OWF. Because the UK is a leader in development of both offshore wind and broader VIA methodology, it is a suitable secondary area of focus. The range of legislative context and procedural scope and frameworks across the case studies provides a valuable comparison between different types of governing and regulatory bodies and methodological approaches.

OVERVIEW OF OWF VIA CASE STUDIES				
CASE STUDY	**METHOD-OLOGICAL FRAMEWORK**	**LEGISLATIVE CONTEXT**	**GUIDANCE USED**	**UNIQUE CONSIDERATIONS**
Hexicon (PFOWF) (2016)	SLVIA	Consortia of national Scottish planning organizations including Marine Scotland The Highland Council and Scottish Natural Heritage (SNH)	• UK's Guidelines for Landscape and Visual Impact Assessment (GLVIA) • SNH Offshore Renewables Guidance in Assessing the Impact on Coastal Landscape and Seascape & Guidance for Landscape/Seascape Capacity for Aquaculture	• Landscape, seascape, and visual impacts assessed separately then combined
Forewind (Dogger Bank) (2014)	SVIA	Alignment with UK planning policies from the UK National Policy Statements	• GLVIA • Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report by the Department of Trade	• Presents a zero turbine visibility from land scenario; SVIA pertains to the installation of subsea export cables and landfall works

			and Industry (DTI) • Offshore Wind Farm Landscape/Seascape, Visual and Cumulative Assessment: Recommended Outputs from SNH and Marine Scotland • Seascape Assessment guidelines from the Countryside Council for Wales, Natural England & SNH	• Historic landscape characteristics are assessed separately from seascape
CCC (2012)	VIA	Local (within the state of Massachusetts) Cape Cod Ocean Management Plan	• GLVIA • Seascape Assessment Best Management Practices from Countryside Commission of Wales • U.S. Army Corps Visual Resource Assessment Procedures	• Prepared for future OWF development, has not yet been used in practice • All factors are assessed together; there are no separate metrics for sensitivity, magnitude, visual receptors, or seascape/land-scape
BOEM (2021)	SLVIA	United States federal National Environmental Policy Act (NEPA) regulations	• GLVIA	• Seascape and landscape are assessed together, but separately from visual impacts; these assessments are not combined into one cumulative metric but are kept separate • Considers cumulative impact with possible future nearby OWFs

Table 1. Overview of frameworks, legislative context, guidance, and key considerations for each OWF VIA case study

2.2.2 Public Involvement

Neither UK-based case study includes discussion of public consultation, or involvement of any other stakeholders. CCC methodology calls for the inclusion of wind farm owner/contractors, Commission staff, Commission members, and other public stakeholders, and BOEM ambiguously states the need for engaging public stakeholders throughout the SLVIA process. However, neither of these specify how to engage stakeholders or where in the VIA process it is most important. All case study methodologies rely exclusively on landscape professionals to conduct the analysis itself, and public involvement in the final evaluation is not a consideration.

2.2.3 Project Scope

2.2.3.1 Geographical Extent

The two UK-based case studies define the geographical extent of the VIA through strictly objective geographic information system (GIS)-based methods. Hexicon relies only on a viewshed analysis (discussed in greater detail below) while Forewind uses both viewshed analysis (for on-shore elements) and pre-determined potential visibility distances (around cable lines). BOEM and CCC both use a combination of viewshed analysis and identified character area extents, so that the total area of potential effect may extend beyond the viewshed to include the entirety of overlapping character areas. BOEM's methodology is also unique in that it establishes separate geographical extents for the SLIA and VIA portions of its analysis. While both start with the same viewshed analysis, SLIA geographic extents may be modified based on identified character areas to extend beyond the boundaries of the viewshed whereas VIA geographical extents are not.

BOEM's methodology also introduces consideration of all non-negligible impact areas compared to areas where impact is *most likely to occur*. BOEM conservatively includes all areas where non-negligible visibility of the project could reasonably be expected to occur under favorable viewing conditions for SLIAs, but identifies only the areas where potential effects are most likely to occur for the VIA. BOEM identifies areas of likely visual effect through consideration of the following parameters:

- The likely maximum distance of visibility of offshore wind facilities during the day;
- The likely maximum distance of visibility of offshore wind facilities at night;
- The magnitude of impact considered to be important enough to discuss in the impact assessment;
- The distance at which the threshold of impact considered important is crossed.

Hexicon's methodology similarly established a "core study area" closest to the project and an "extended study area" where the consideration of impact receptors is weighted differently.

2.2.3.2 Viewshed Analysis

All case studies employ a line-of-sight viewshed analysis somewhere in their methodology (either to determine project scope, observation point selection, or both) based on well-established Zone of

Theoretical Visibility (ZTV) methodologies (Bishop, 2002). Following these methodologies, all of the case studies use the following data to conduct the viewshed analysis:

- Elevation data (of topography, viewer location and height, and project height);
- Visual obstructions (such as vegetation and structures);
- Curvature of the earth;
- Standard atmospheric refraction coefficients.

All four of the methodologies call for verification of these viewshed desk studies with field analysis—specifically to check for visual obstructions not included in the dataset and accuracy of refraction coefficients used—but do not describe how these field analyses should be conducted or what they should involve.

2.2.3.3 Observation Point / Viewpoint Selection

The case studies represent a wide range in terms of how key observation points are selected. The most comprehensive of the four are Hexicon and BOEM, which select observation points based on their representation of all four of the following categories:

- Different viewers;
- Different types of views;
- Different scenery;
- Locations with greatest potential impact.

Table 2 below shows the specific types of observation points that are considered in each of these categories. Neither CCC nor Forewind consider all of these categories or explain the particular observation points selected. CCC only considers observation points based on representation of different viewers and location with the greatest potential impact, while Forewind only considers points of greatest potential impact.

CASE STUDY	VIEWPOINT SELECTION PARAMETERS

Hexicon (PFOWF)	• Views that are representative of different viewers, including:
	  • People living in the area (residents);
	  • People working in the area (on sea and land);
	  • People travelling through the area on roads, ferries, or by air;
	  • People visiting the area (including tourists); and
	  • People engaged in recreation.
	• Range of distances and elevations
	• Range of conditions to represent full range of development design
	• Sequential view along specific routes
	• Visual composition
	• Different landscape/coastal areas
	• High scenic value & important vantage points

Forewind (Dogger Bank)	• Convergence points of main shipping and cruising routes

CCC	• Different viewers • High quality and value scenery and visual resources • Key scenic features and characteristics

BOEM	• Known locations where the view is valued, including:
	    • Scenic overlooks and other viewpoints within specially designated areas
	    • Places where people work
	    • Where people engage in recreational activities
	    • Where people live (residential areas)
	• Views that are representative of the general nature of users of a larger area that lacks specific viewpoints, including:
	    • Wilderness areas, linear features, roads, trails, and other transport routes on land and sea
	    • Points within these that people are known to visit, at different distances, terrains, vegetation types
	• Views that demonstrate a particular effect or specific issues, such as the restricted visibility at certain locations of great concern to stakeholders

Table 2. Comparison of observation point selection parameters used in each case study

2.2.3.4 Scenarios / Project Envelope

Overall, the scenario selection methods of all four case studies are very limited. While all four consider size (including turbine height, turbine number, length/width of project area) and surface color and texture in their scenario selection, only two (Forewind and BOEM) consider multiple project phases and only one (BOEM) considers nighttime conditions. Forewind considers three different phases (construction, operation, and decommissioning) while BOEM considers four (construction, maintenance, decommissioning, and post-decommissioning). All of them rely solely on maximum potential impact scenarios, and none consider other important visibility factors found in relevant literature such as different atmospheric and lighting conditions, turbine blade movement speed, safety light characteristics, or presence of other artificial lighting.

2.2.4 Baseline Assessments

All VIA involves establishing baselines against which visual change is assessed. In broader VIA, this usually includes landscape and visual (i.e. specific view) baselines, but OWF includes an additional seascape baseline. All of the selected OWF VIA case studies consider some combination of seascape, landscape, and visual baseline assessments (see Table 3 below), with the exception of CCC which does not establish a visual baseline. Some of the case studies acknowledge the interrelated impacts to different baselines, while others assess each baseline separately and combine them later (weighted equally) to find the cumulative visual impact. All methodologies use character areas established through mapping desk studies to describe the seascape and landscape baselines. They all also acknowledge the importance of conducting field analysis to verify the validity of the character areas, but none describe how these field analyses should be conducted or what they should include.

2.2.4.1 Seascape/Landscape Baselines & Character Areas

Definition

While all of the case studies use some version or seascape and landscape baseline assessments (with the exception of Dogger Bank that does not have any landscape impacts), there is a very broad range of how the case studies define and describe these baselines (see Table 3 below). For example, only one of the case studies considers historic character as a component of the seascape, while all others only consider historic character as part of the landscape. Hexicon and Forewind are the only ones that differentiate local as well as regional character description, and Hexicon is the only one that separates landscape character areas based on types of scenery. Three of the four consider existing human activity and influence, and only one (Forewind) differentiates based on navigational features and activity. BOEM stands out as the only one to describe open ocean character separately from seascape character.

This inconsistency in baseline descriptions may be largely due to the poor understanding of seascapes in broader VIA literature. When used in literature, "seascape" is often left undefined. When it is given a definition, they vary considerably. For example, two of the more common definitions include:

> *"the extent of the coastal landscape that is influenced by its proximity to the ocean"*
> or
> *"the physical environment for which the sea is a key defining element".*

These definitions do not clearly identify whether the seascape is primarily defined by is physical attributes, the associations that people have with the physical attributes based on their relationship to the sea, or in terms of human impact on the coastal landscape (or some combination of the three). Sometimes the area of ocean closest to the coastline in included in the seascape, and sometimes it is not. Sometimes seascapes are viewed as large-scale areas that are comprised of smaller discrete coast, land, and sea sub-areas, while at other times it is applied at small scales based on unique compositions of coast, land, and sea elements.

Only two of the case studies provide working definitions of seascape: Forewind and BOEM. Forewind employs Natural England's definition of seascape as "an area of sea, coastline and land, as perceived by people, whose character results from the actions and interactions of land with sea, by natural and/or human factors" (Natural England, 2012, page 8). Meanwile, BOEM uses the Department of Trade and Industry's (DTI) definition of seascape as "a discrete area within which there is shared inter-visibility between land and sea" which always includes "an area of sea (the seaward component), a length of coastline (the coastline component), and area of land (the landward component)" (DTI, 2005). While Forewind conceptualizes the seascape more broadly as the unique interactions of natural, physical, and human factors, BOEM describes it purely in terms of the physical and geographical attributes. The lack of understanding of seascapes means that there is also confusion about how the other character areas (such as the ocean and landscape) are defined in relation to each other. For example, one of the case studies describes oceanscapes separately from seascapes, but two of the other three include it as part of the seascape. The lack of clarity about the definition and importance of seascapes carries over into methodological inconsistencies in the selected case studies, making them hard to understand and compare.

Regardless of the particular character areas and terminology used in the case studies, the baselines are all generally based on the following considerations:

- Overall character (including level of human influence, activities, function, and historical character);
- Key physical elements (including navigation features);
- Key physical influences;
- Presence of important experiential views;
- Aesthetic and perceptual qualities.

CASE STUDY	SEASCAPE AND LANDSCAPE BASELINE CONSIDERATIONS		
	BASELINE ASSESSMENTS	**CHARACTER AREAS**	**BASELINE DEFINITION**
Hexicon (PFOWF)	Seascape	• Seascape Character • Coastal Character • Local Costal Character	• Overall character • Key physical elements and features • Aesthetic or perceptual qualities
	Landscape	• National Scenic Areas • Special Landscape Areas • Wild Land Areas • Historic Gardens and Designed Landscapes	
Forewind (Dogger Bank)	Seascape	• Broader Marine Plan & Landscape • Landfall and inshore area • Offshore Export Cable Corridor area • Development Area	• Key physical elements and features • Human influence
	Historic seascape	• Landfall and Inshore Area • Offshore Export Cable Corridor Area • Development Area	• Overall character • Navigation features & activity
CCC	Seascape	• Seascape Character • Coastal Character • Landscape Character	• Broader character • Key physical elements and features • Human activities & functioning
	Landscape	n/a	

BOEM	Seascape and landscape	• Seascape Character Area
		    • Seaward component
		    • Coastline component
		    • Landward component
		• Landscape Character Area
		• Ocean Character Area
			• Overall character
			• Key physical features
			• Physical influences
			• Human activity
			• Aesthetic and perceptual qualities
			• Experiential views

Table 3. Comparison of seascape and landscape baseline considerations used in each case study

Assessment

With the exception of CCC, all of the case studies evaluate the landscape and seascape visual impacts similarly (see Table 4 below). They assess sensitivity to visual impact in terms of the landscapeor seascape's susceptibility to change and the value of the view to the viewer. Susceptibility is generally made up of the landscape or seascape's existing physical characteristics and the quality of the existing view, which includes the visual and perceptual elements and scenic value. BOEM also considers aesthetic experience in determining the landscape or seascape's quality. Each of the case studies considers slightly different factors when determining value, but all of the factors collectively used in any of the case studies include:

- Existing scenic character such as wildness/naturalness, remoteness, and tranquility;
- Past character;
- Scenic quality or condition;
- Significance to natural heritage and contribution to local, regional, national and international landscapes;
- Conservation designation;
- Popularity, recreational activity, and number of users;
- Cultural associations or other special interests such as tourism and economy;
- User types (resident, visitor, traveler, etc.) and reason for being in environment;
- Sense of place and perceptual values;
- How the seascape is experienced.

All of the case studies define magnitude of visual impact on landscapes or seascapes as the size or scale of change from existing conditions (degree of contrast based on loss, additions, and alterations), geographic extent (based on area within view of the project and percentage of the total landscape/seascape area), and duration and reversibility of change (Table 4 below). Forewind additionally considers the scale and nature of the development and the impact on neighboring areas.

CASE STUDY	LANDSCAPE / SEASCAPE IMPACT ASSESSMENT PARAMETERS	
	SENSITIVITY ASSESSMENT PARAMETERS	MAGNITUDE ASSESSMENT PARAMETERS

Hexicon (PFOWF)	• Susceptibility
	  • Physical characteristics
	  • Quality of view
	• Value to viewers
		• Size or scale of change
		• Geographic extent
		• Duration and reversibility

Forewind (Dogger Bank)	• Susceptibility
	  • Physical characteristics
	  • Quality/condition of scenery
	• Value to viewers/users
		• Degree of contrast
		• Scale and nature of development
		• Impact on neighboring areas
		• Geographic extent
		• Duration

CCC	Combined sensitivity and magnitude parameters: • Physical characteristics / absorption capacity • Quality	

	• Value of scenery and use of landscape • Frequency and number of users	

BOEM	• Susceptibility
	    • overall area character or individual feature
	    • visual elements
	    • perceptual elements
	    • experiential aspects
	• Value
		• Size or scale of change
		• Geographic extent
		• Duration and reversibility

Table 4. Comparison of seascape and landscape impact assessment parameters used in each case study

2.2.4.2 Visual Baselines

Definition

Visual baseline assessments used in OWF VIA are very similar to those used in broader VIA methodology. Notably however, views of the open ocean (from land) and of land (from the ocean) are unique subcategories used by some OWF VIA (see Table 5 below). Two case studies (Forewind and CCC) divide their visual baseline inventories into separate land-based receptors and sea-based receptors and then combine these assessments to determine overall impact. The other two do not separation separate sea-based and land-based receptors and lack any consideration of OWF impacts on sea-based views looking from the ocean back towards the shore. In the case of Forewind, all sea-based receptors are transitory since they consist of higher-speed vessel transit routes, as opposed to potentially slower or stationary vessels considered in CCC. Forewind's visual assessment also accounted for the highly diurnal, seasonal nature of the sea-based receptors, as well as the consideration of the inconsistent movement path of vessels. To address this they propose a generalized analysis of common directions of travel based on popular destinations. These ocean-based visual considerations provide important insights for other OWF VIA. Cumulatively, all of the factors used in any of the case studies to establish the visual baselines include:

- Viewer types:
    - Activity groups such as residential, recreational, or traveling
    - Vessel types
    - Individual identities
        - Familiarity with the landscape
        - Activities engaged in while viewing
        - Concern for the landscape
- Number of viewers or distinct viewer groups
- Key features of particular views
    - Form, line, color, texture, scale, and view composition
    - Motion and lighting
- Expected range of viewing conditions

- Seasons, time of day, and lighting condition
- Weather and visibility

CASE STUDY	VISUAL BASELINE CONSIDERATIONS	
	SUBCATEGORIES	BASELINE DEFINITION
Hexicon (PFOWF)	n/a	• Viewer groups • Locations/range of viewer groups • Nature of views (duration and frequency)
Forewind (Dogger Bank)	Landfall	• Viewer types
	Cable route	• Vessel type • Number of vessels • Frequency of vessels
CCC	Views of the sea	• Value to the viewer • Presence of night lighting
	Views of the land	• Value to the viewer • Presence of night lighting • Backdrop/key physical characteristics of view
BOEM	n/a	• Viewer types • Number of viewers • Duration & frequency of views • Key physical characteristics of view • Expected range of viewing conditions

Table 5. Comparison of visual baseline considerations used in each case study

Assessment

The assessment metrics of visual baseline impacts (Table 6 below) generally fall into the same categories as the assessment metrics of landscape/seascape impacts (Table 4 above). In visual baseline assessment, value is usually evaluated based on contribution of the view to viewer enjoyment, importance or significant of the view, and viewer opportunities and activities found at the view location. Magnitude is assessed using similar terms, but here, size and scale refers to the number of viewers and frequency of views in addition of degree of contrast. Extent is measured in terms of proportion of view.

CASE STUDY	VISUAL IMPACT ASSESSMENT PARAMETERS	
	SENSITIVITY ASSESSMENT PARAMETERS	MAGNITUDE ASSESSMENT PARAMETERS

Hexicon (PFOWF)	• Susceptibility
	  • Physical characteristics
	  • Quality of view
	• Value to viewers
		• Size or scale
		• Geographical Extent
		• Duration and Reversibility

Forewind (Dogger Bank)	• Susceptibility
	  • Visual characteristics
	  • Type and nature of existing view
	• Value
		• Degree of contrast and change
		• Number of viewers
		• Frequency of view
		• Extent existing view is affected by development

CCC	n/a	• Positive or negative effect • Proportion of view affected
BOEM	• Susceptibility of viewers to visual change • Value attached to views	• Size or scale of change • Geographic extent • Duration and reversibility

Table 6. Comparison of visual impact assessment parameters used in each case study

2.2.5 Visualization Techniques

Overall, the visualizations used in all four case studies are inadequate to accurately represent OWF in the landscape. Visualizations are central to assessing the potential visual impact, and accurately representing the OWF in the landscape is essential to conducting a reliable and accurate visual impact assessment. There is a breadth of research on the accuracy of different techniques to visually represent and communicate change in the landscape, including how best to represent the existing landscape as well as how to simulate the project in the landscape in a way that people will perceive as realistic (Sullivan, 2021; Sullivan et al., 2021; Bishop, 2002).

Well-documented photography methodologies are standard for accurately representing the existing landscape in visual impact assessments, and all four of the case studies use these standard camera specifications and photo location, resolution, size, and content requirements. However, only two of the four case studies (CCC and BOEM) utilize the guidelines presented in this literature regarding how the final visualizations should be presented and viewed, including the viewing distance, image size, image metadata, and order and arrangement of the visualizations (Sullivan, 2021; Sullivan et al., 2021).

Importantly, none of the case studies use visualizations that depict all of the visual characteristics of the project that are identified as important perceptibility factors in literature, such as materiality, size, movement and flashing lights. All four case studies rely solely on static simulations that are unable to capture movement or changes in light such as glint off of the turbines or flashing safety lights. Three of these use high-quality 3D rendering software that is able to accurately depict the exact geographic location and color of the turbines as well as the atmospheric and lighting conditions to match the conditions at the time of the baseline photo, but one uses a wireframe model of the turbines that does not account for color, atmosphere, or lighting.

2.2.6 Cumulative Visual Impact

Criteria

The cumulative visual impacts are evaluated using similar criteria across all of the case studies (see Table 7 below). They all consider the cumulative impact to be a combination of factors affecting the magnitude of visibility and visual change and sensitivity to this change. With the exception of the CCC case study, all of them consider both human and landscape receptors as components of these criteria, and all provide separate metrics for magnitude and sensitivity as well as the combination of these two. However, none of the case studies consider cultural context to be a factor in sensitivity; they only consider viewers as individuals. BOEM is also the only one that considers the impact of potential future projects as part of the cumulative impact rating.

Metrics

All case studies characterize the cumulative visual impact using ordinal rating scales with 4 to 6 metrics each. All but CCC first determine magnitude and sensitivity using different ordinal scales, and two of the three also use a different number of metric categories for the magnitude and sensitivity ordinal scales. They then combine these two metrics into one cumulative impact metric based on predetermined rules of combination that treats the ordinal scales as interval scales to add them together (i.e. linear combination).

The same three case studies—the SLIA and both SLVIA case studies—include neutral rating metrics, and both of the SLVIA methodologies also include consideration of positive impact. However, Hexicon's approach presents this in one continuum of positive to major (negative) impact, while BOEM has two separate ratings systems for negligible to major positive impact and negligible to major negative impact. BOEM also provides two separate cumulative valuations for SLIA and VIA without combining them into a single cumulative impact rating (though both of the SLIA and VIA cumulative metrics are the result of combined ordinal scales).

While the overall consistency in the cumulative impact metrics used in the case studies is valuable for comparing findings across different projects, and the range of positive to negative impact metrics is fairly comprehensive, the use of linear combination techniques in determining cumulative metrics may be problematic. Literature describes the challenges of using mathematical addition and multiplication methods to combine nominal or ordinal scales. This means that combinations of different factors measured as nominal or ordinal cannot be performed as additive or multiplicative operations because the result will distort the relative importance of certain points on the original ordinal scales (Wilson, 1971; Nassauer, 1980). In assessing landscape quality, employing rules of combination that identify relevant combinations of landscape parts and their relationship to the whole is suggested as a more valid alternative to standard linear combination techniques (Hopkins, 1977; Nassauer, 1980). Linear combination may be more appropriate for combining ordinal sensitivity and magnitude metrics, but a rationale must be provided for treating them as interval scales, or the ordinal scales must be translated into interval calculations, and the chosen combination method must be justified. Thorough definition and interpretation of the relationships between the combined metrics is necessary.

CASE STUDY	**CUMULATIVE VISUAL IMPACT RATING**		
	VISUAL IMPACT CRITERIA	**METRICS**	**CUMULATIVE METRICS**
Hexicon AB (PFOWF)	Magnitude of change to: • Seascapes • Landscape	Major, Moderate, Minor, Negligible	Major, Moderate, Minor, Negligible,

	• Views and Visual Amenity		Neutral, Positive
	Sensitivity of: • Seascape • Landscape • Viewer	Very High, High, Medium, Low, Negligible	
Forewind (Dogger Bank)	Magnitude of change to: • Seascapes • Historic Seascape Character • Views	High, Medium, Low, Negligible	Major, Moderate, Minor, Negligible
	Sensitivity of: • Seascape • Viewer	High, Medium, Low	
CCC	• Visual sensitivity • Seascape/landscape contrast & absorption	N/A	Very large, Large, Moderate, Small, Very small
BOEM – **Seascape/Landscape (SLIA)**	Sensitivity of seascape and landscape	High, Medium, Low	Positive or negative; Major, Moderate, Minor, Negligible
	Magnitude of change to seascape and landscape	Large, Medium, Small	
BOEM – **Visual (VIA)**	Sensitivity of viewer	High, Medium, Low	Positive or negative; Major, Moderate, Minor, Negligible
	Magnitude of change to views	Large, Medium, Small	

Table 7. Comparison of cumulative visual impact rating systems used in each case study

CHAPTER 3: NEW YORK BIGHT CASE STUDY

3.1 Evaluation Criteria

Based on the literature review above, Table 9 summarizes the relevant considerations in OWF VIA. This Chapter first provides an overview of the methodology and considerations in the VIA of the NYB OWF, then discusses the strengths and limitations of the NYB VIA based on the important considerations identified in Table 9.

	IMPORTANT OWF VIA CONSIDERATIONS
EVALUATION OF PERCEPTIBILITY	
Visibility	• Color of turbines in contrast with sky • Glint of sunlight on turbines • Atmospheric haze

	• Type of clouds • Angle/direction of sun • Presence of flashing security lights • Surrounding artificial lights and night sky contrast • Speed and frequency of turbine movement • Even distribution and density of turbines • On-shore obstructions • Contrast with visual elements of the landscape and seascape • Portion/extent of individual turbines visible
Sensitivity	• Factors that contribute to local sense of place • Nature of local cultural connection to the ocean/seascape • Involvement of viewers in the siting process • Viewers' visual experience with other wind farms • Viewers' visual experience with construction of the project • Viewers' aesthetic values • Viewers' local knowledge and contextual values • Viewers' environmental beliefs and opinions about renewable energy • Whether viewers are local residents or visitors • Activity of viewer • Type (duration and frequency) of view of the project
ASSESSMENT METHODOLOGIES	
Public Involvement	1. Which members of the public are consulted 2. Public input in establishing baselines 3. Public input in selection of KOPs 4. Public input during the evaluation phase
Geographic extent/scope	1. Use of line-of-sight viewshed or total area of potential effect (possibly beyond line-of sight visibility) 2. Differentiation of geographic extent subsets based on likeliness of impact or importance of impact receptors 3. Viewshed analysis that includes consideration of elevation data (topography, viewer location and height, and project height), visual obstructions, curvature of the earth, and atmospheric refraction 4. Field verification of GIS viewshed analysis
Observation Point Selection	1. Justification of viewpoint selection 2. Use of viewpoints that adequately represent different possible viewers, different types of views, different types of scenery, and locations of greatest potential impact
Scenario selection	1. Representation of a range of potential impact 2. Consideration of known elements that impact visibility including turbine size, materiality, and arrangement project phases (construction, maintenance, decommissioning, and post-decommissioning), atmospheric and sunlight conditions, turbine blade movement, safety light characteristics, and presence of other artificial lighting

Baseline Assessment	1. Explicit definition and differentiation of character areas used 2. Inclusion of all identified considerations in identifying character areas 3. Inclusion of all identified considerations in describing views 4. Inclusion of all identified assessment metrics
Visualization Techniques	1. Accurate representation of the landscape 2. Accurate representation of relevant visual characteristics of turbines including materiality, size, location, blade movement, flashing lights, and atmosphere
Cumulative Impact	1. Inclusion of metrics for sensitivity, magnitude of change, and cumulative impact 2. Rationale provided for any used to combine ordinal metrics 3. Definition provided for cumulative metrics 4. Consideration of potential future projects 5. Which impact receptors are considered for both visibility and sensitivity 6. Valuation categories that include a range of positive, range of negative, neutral and negative categories

Table 9. All important considerations in OWF VIA identified through literature review

3.2 Project Overview

The New York Bight (NYB) OWF VIA was conducted by Argonne National Lab as part of a multi-pronged programmatic environmental impact statement commissioned by the Bureau of Ocean Energy Management (BOEM). Under direction of the U.S. Department of the Interior (DOI) in 2022, BOEM conducted a competitive leasing process to select lessees for the 6 OWF lease areas previously identified within the New York Bight in the mid-Atlantic (Figure 3). Once the lessees were selected, BOEM initiated the Programmatic Environmental Impact Statement (PEIS) process, which will ultimately be used by the lessees to develop construction and operation proposals for offshore wind energy facilities in the lease areas. The PEIS calls for each of the 6 lease areas to be assessed separately and as a whole for their potential ecological, social, economic, and visual impacts. The

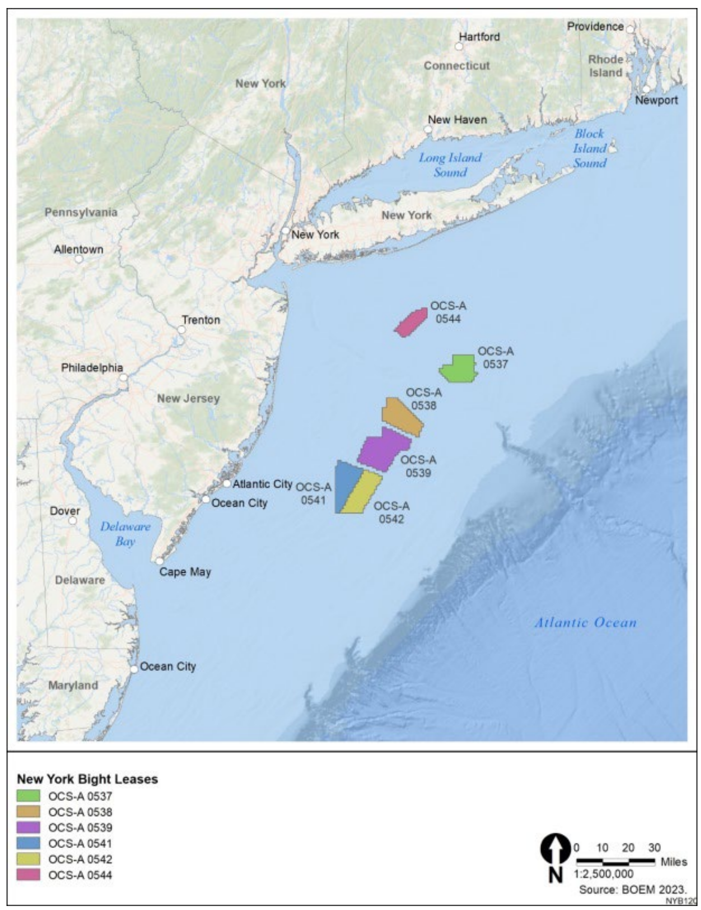


Figure 3. Location of New York Bight offshore wind lease areas, sourced from BOEM (2023)

programmatic VIA conducted by Argonne is therefore just one section of the larger PEIS and relies on certain design assumptions about the hypothetical wind farm installations.

Regulatory Context

The NYB OWF VIA was conducted at the federal level but was also subject to some state regulations. As with all mid-Atlantic OWF lease areas, the NYB area was permitted through the DOI's Outer Continental Shelf (OCS) Renewable Energy Program, created through the federal Energy Policy Act of 2005. Within the DOI, BOEM issues these leases and regulates activities that occur within them, including the review and approval of the PEIS. BOEM is responsible for ensuring its compliance with local and federal policies. At the federal level, the VIA is primarily shaped by EIS procedures outlined/established by the National Environmental Policy Act (NEPA) and SLVIA procedures published by BOEM. The Coastal Zone Management Act also created voluntary partnerships between U.S. coastal states and territories and the federal government, and required that any federal action must comply with the states' policies. Relevant to the NY Bight are the New York and New Jersey coastal management plans/programs. Of the two, the New York State Coastal Management Program specifies regulations on scenic resource and scenic quality management, and includes state as well as local government jurisdiction. Table 10 contains a complete list of laws, acts and ordinances relevant to the NYB.

FEDERAL REGULATIONS
Code of Federal Regulations (CFR) Title 30 of the CFR Part 585, Subpart F, Plans and Information Requirements
Outer Continental Shelf Lands Act (OCSLA), Title 43, Chapter 29, Subchapter I, Section 1301 (1953)
Submerged Lands Act (SLA) of 1953
National Environmental Policy Act (NEPA)
Clean Air Act of 1970
Coastal Zone Management Act (CZMA) (1972)
National Historic Preservation Act 1966
Inflation Reduction Act of 2022
Information Guidelines for a Renewable Energy Construction and Operations Plan (COP). Version 4.0. (2020)
Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States (2021)

STATE REGULATIONS	
Jurisdiction	**Document**
New York State Department of State (NYSDOS)	Long Island Sound Coastal Management Program (1999)
New York State Department of State (NYSDOS)	New York State Coastal Management Program and Final Environmental Impact Statement (NYSDOC 2017) (Policy 24 and 25)
New York State Department of Environmental Conservation (NYSDEC)	NYSDEC Policy DEP-00-2: Assessing and Mitigating Visual and Aesthetic Impacts
New Jersey Coastal Management Program	Section 309 Assessment and Strategy (2021-2025)

New Jersey Department of Environmental Protection	Green Acres Program (2023)

Table 10. New York Bight regulatory context, sourced from BOEM (2023)

Methodological Framework

The NYB VIA closely follows the SLVIA framework established by BOEM, as outlined in the Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States (2021). While there are some minor points of departure, the NYB VIA uses BOEM's SLVIA recommendations for baseline assessment, visualization techniques, and impact assessment. Following the SLVIA framework, the NYB VIA assesses the landscape/seascape impacts separately from the visual impacts.

3.3 Methodology

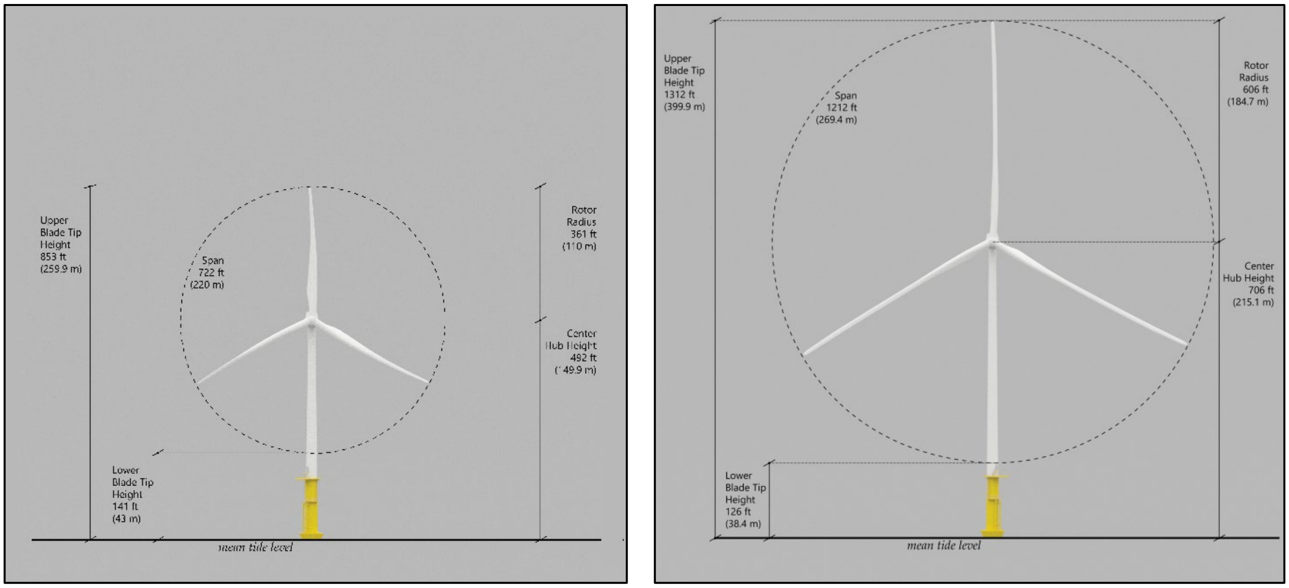
3.3.1 Project Scope

The scope of the NYB VIA was established based on a hypothetical projects' potential design envelope along with a viewshed analysis and identification of key observation points. First, potential design scenarios were determined, and then the geographic extent of *any potential* visual effect was calculated through a topographical viewshed analysis that considered the "worst case" design scenario. An initial list of important observation points within this area was generated and later narrowed down through a series of more refined viewshed and data analyses. The geographic extent, defined as the "geographic analysis area" (GAA) was used to determine the character areas in the SLIA portion of the SLVIA. The final list of important observation points, or "key observation points" (KOPs), were used in the VIA phase. The methodology for each of these steps is described below.

3.3.1.1 Design Envelope & Scenario Selection

Two design scenarios were identified and considered in both the SLIA and VIA phases of the analysis for the stated purpose of showing the maximum and minimum impacts that may occur as a result of the development of the NYB. These scenarios were defined based on the maximum and minimum possible wind turbine heights: 1,312 feet and 853 feet (see Figure 4). All other design elements were assumed to be the same between the two scenarios. For both scenarios, the maximum number of wind turbines (with minimum spacing) was used and the body of the turbines was assumed to be white based on the "worst case scenario" for greatest potential visual contrast. Based on research on standard turbine design and relevant aviation and sea navigation regulations, noticeable navigation lights, markings, and turbine components were also identified (Figure 4 and Table 11).

Aside from turbines, offshore substation platforms were also considered and were represented the same in both scenarios. Since the cable alignment, landfalls, and other onshore projects were not yet know or specified, they were entirely excluded from the analysis.



a **b**

Figure 4. Wind turbine schematic drawings: (a) 853 ft (259.9 m) and (b) 1,312 ft (399.9 m) wind turbines, sourced from BOEM (2023)

TURBINE COMPONENTS	MINIMUM HEIGHT: 853 ft (260 m)	MAXIMUM HEIGHT: 1,312 ft (399.9 m)
Rotor Blade Tip	853 (260.0 m) MLLW[a]	1,312 (399.9 m) MLLW
Two Blade Tips -Wide Vertical Blade	657 (200.2 m) MLLW	1,009 (307.5 m) MLLW
Aviation Obstruction Light (AOL)	382 (116.4 m) MLLW	728 (221.9 m) MLLW
Nacelle	372 (113.4 m) MLLW	718 (218. 8 m) MLLW
Hub	361 (110.0 m) MLLW	706 (215.2 m) MLLW
Mid Tower Light	295.3 (90.0 m) HAT[b]	353 (107.6 m) MLLW
OSP	180.5 (55.0 m) MLLW	295.3 (90.0 m) HAT
Yellow Tower Base and Platform	50 (15.2 m) HAT	50 (15.2 m) HAT

Notes: [a]MLLW = mean lower low water; [b]HAT = highest astronomical tide

Table 11. Noticeable features of wind turbines, sourced from BOEM (2023)

3.3.1.2 Geographic Analysis Area

The GAA was used to establish the extent of any possible visual impacts, including where impacts may be negligible. The GAA was determined through a "Zone of Theoretical Visibility" (ZTV) viewshed analysis. Using standard viewshed analysis tools in ArcGIS, the VTZ was calculated using a Digital Elevation Model (DEM) dataset (i.e. the terrain elevation) and maximum turbine height data only. It did not screen for any other line-of-sight obstructions or visibility factors. The GAA was primarily used to determine the extent of the SLIA. The entire GAA was divided into character areas that were used to analyze the sensitivity of the seascape and landscape around the NYB. Figure 5 shows the GAA identified for the NYB.

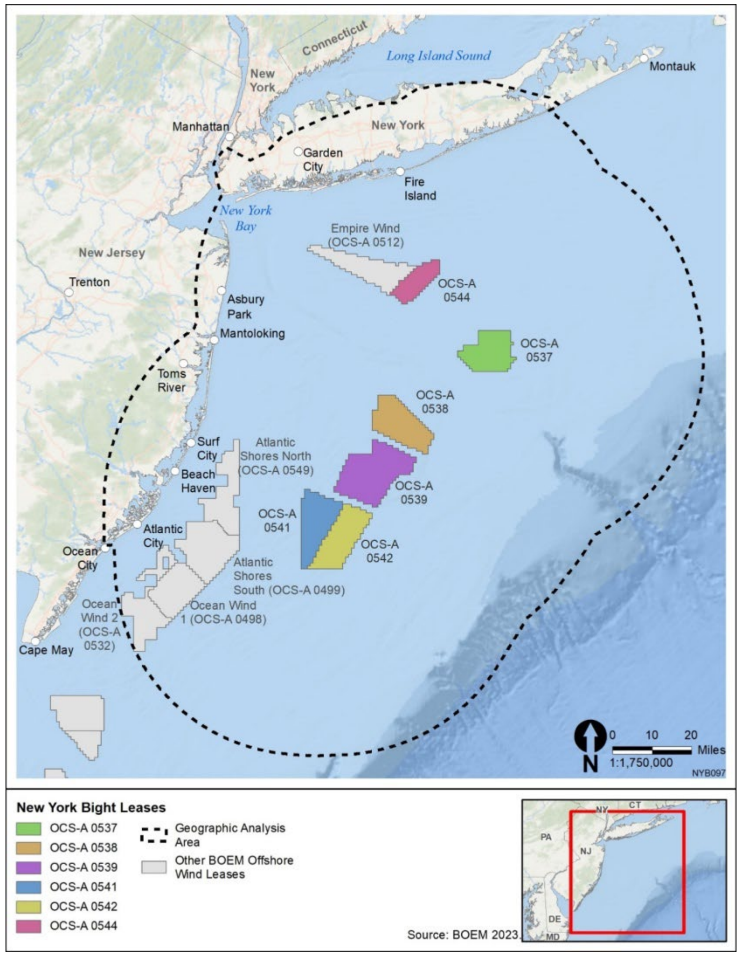


Figure 5. Extents of New York Bight GAA, sourced from BOEM (2023)

3.3.1.3 Key Observation Points

After establishing the GAA, additional GIS viewshed analyses were run with Digital Surface Model data (i.e. the elevation of surface elements such as buildings and trees in addition to topography), maximum and minimum turbine height data, and effects of curvature of the earth. The resulting area was characterized as the "Area of Potential Visual Impact" (APVI), where there was likely to be a line-of-sight from land to the project (i.e. where visual impacts would be non-negligible). The APVI was then used to generate an initial list of KOPs (all points shown in Figure 6 below), which were then refined based on the following factors:

- Representation of a range of character areas identified in the SLIA;
- Stakeholder input;
- Public accessibility to the location;
- Representation of designated cultural resource areas;
- Alignment with VIAs prepared for other nearby offshore wind projects;
- Proportion of the project visible from the location;
- General scenic value of the location.

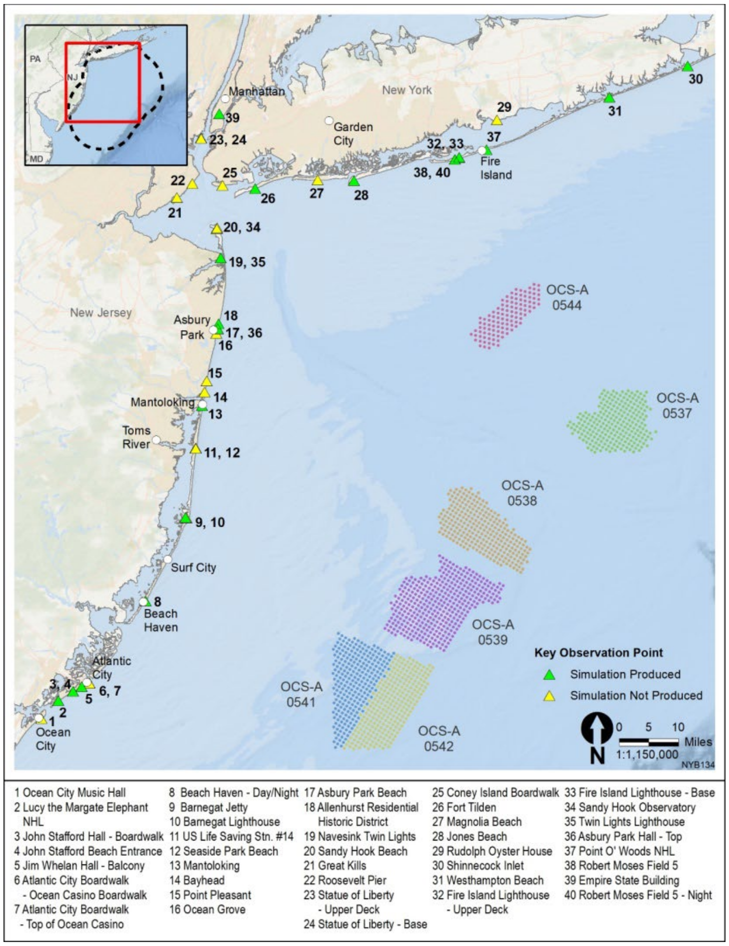


Figure 6. Locations of York Bight KOPs, sourced from BOEM (2023)

The final KOP selection (points marked by green triangles in Figure 6) aimed for an even representation of different types of landscapes, views and cultural resources, and field visits were conducted by professionals to verify the visibility of the proposed project from each viewpoint. While stakeholder input was considered in some early selection stages, the final KOPs were chosen based on professional judgment (by Argonne and approved by BOEM).

3.3.2 Visual Baseline

Following BOEM's SLVIA framework, the NYB VIA established baseline scenery conditions for all landscapes/seascapes within the GAA as well as from each selected KOP against which the potential project impacts were assessed. In the SLIA, character areas that share common attributes were established. The methodology for determining the character areas and describing the baseline visual conditions at the KOPs is described below.

3.3.2.1 Character Areas

Character areas were identified and defined for the entire area within the GAA based on their unique aesthetic, physical, perceptual, and experiential qualities. This process involved identifying stakeholders and conducting a desktop mapping study as well as field surveys. First, initial baseline GIS data was collected to generate preliminary maps and descriptions of areas of similarity. Data used in this assessment included:

- EPA ecoregions;
- Publicly accessible visual and cultural sites identified by the National Registry of Historic Places and BOEM;
- Geology, soils, landform, drainage, and water bodies;
- Vegetation and development land cover types;
- Land use and management types;
- County zoning data;

- Environmental justice communities defined based on definitions given by the states of New York and New Jersey and Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations;
- Important scenic resources including:
  - National Natural Landmarks
  - State/Local Designated Scenic Areas and Overlooks
  - Scenic Area of Local Significance
  - State Designated Scenic Overlooks
  - National Wildlife Refuges
  - State Wildlife Management Areas
  - National Parks
  - State Parks
  - State Nature and Historic Preserve Areas
  - National Forests
  - State Forests
  - National Recreation Areas and/or Seashores
  - State Beaches
  - National or State Designated Wild, Scenic, or Recreational Rivers
  - Highways Designated or Eligible as Scenic
  - National Historic/Recreation/Heritage Trails
  - State Fishing and Boating Access Sites
  - Lighthouses (not NRHP-Listed or State Historic-Listed)
  - Public Beaches
  - Environmental Justice Areas (State and Federal)
  - Ferry Routes (Occur across multiple states)
  - Seaports (Commercial Maritime Facilities)

In addition to this data, more subjective factors were also considered, including:

- Individual noteworthy physical features and elements;
- Distinctive experiential aspects of the landscape;
- Distinctive perceptual aspects of the landscape;
- General character of views.

These qualities were identified by professionals though desktop research and in-person visual assessment of the area of study. Field testing and verification was then conducted to check preliminary area delineations. Each character area (Figure 7) was ultimately described in terms of its predominant visual and perceptual characteristics, overall sensitivity, and broader context. The visual characteristics of the character area were identified as its unique combination of form, line, color, texture, pattern, scale, complexity, and openness. Distinct perceptual characteristics included aspects such as perceived tranquility or wilderness. Representative photographs of each character area were also collected during the field testing.

The character areas were ultimately grouped based on broad landscape types including ocean, seascape and landscape, with seascape character areas further divided into bayside and oceanside subcategories. These broad landscape types were defined as follows:

- **Ocean Character** – based on federal jurisdiction and defined as the area of ocean beginning at 3 nautical miles from the coastline and extending 200 nautical miles to the outer boundary of the US Exclusive Economic Zone.
- **Seascape Character** – defined as areas that are unified by a view of and relationship to the ocean (including bays, inlets, and sounds) up to 3 nautical miles from the edge of the coastline into the ocean. These relationships could be visual, ecological, or experiential.

- **Bayside Seascape Areas** “maintain a view and direct connection to bays and other related saltwater bodies such as inlets, canals, and harbors, etc., and associated features such as marinas, and other rural, residential, or urban developments along the bay and related waterbodies. These areas, however, do not maintain a direct connection to the coastline or ocean itself.”
- **Oceanside Seascape Areas** “are bands of natural and developed areas which maintain clear visibility and connectivity to the ocean. [A]ny area that may contain both bayside and oceanside views is considered a part of the oceanside area.”

- **Landscape Character** – defined as having minimal visibility of or opportunity for interaction with the ocean or seascape at the ground-level (regardless of visibility from skyscrapers). These are also referred to as “inland” character areas.

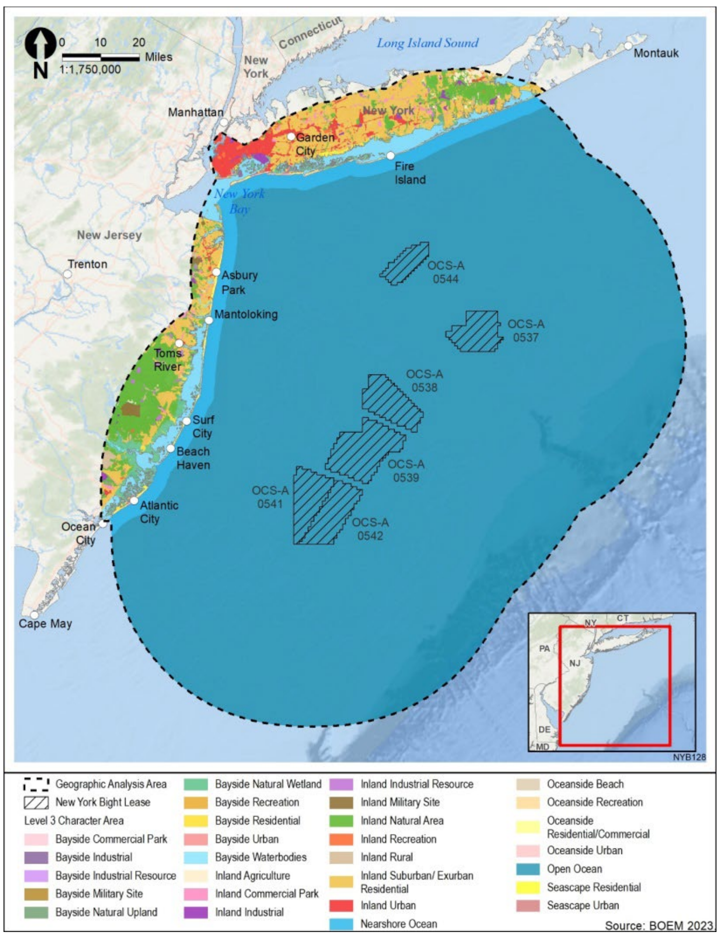


Figure 7. Locations of New York Bight character areas, sourced from BOEM (2023)

In addition to these landscape types, historically significant were also considered separately since they do not describe the nature of the seascape or landscape itself. “*Historic-Like Areas*” are defined as areas that may overlap with a number of distinct land cover and character areas.

3.3.2.2 KOP Existing Conditions

The baseline visual conditions at each KOP were established through a description of the affected environment and distinctive aesthetic and perceptual characteristics recorded by professionals on standardized forms during field surveys.

At each KOP, the date, time, and weather and visibility conditions were noted. Descriptions of the affected environment included information on the KOP’s character area context, impact receptors, and visual context. Here, the impact receptors were defined as the viewer groups, or “the people who interface with the project and experience its effects”, and determined based on the people and activities observed during the field study. Viewer group categories included:

- Tourists and recreational receptors
- Residents

- Travelers/Commuters
- Water-Based

The description of the visual context included relevant information on the viewer position in the landscape, predominant visual characteristics, overall visual contrast and compatibility of elements within the view, and overall character of the ocean/seascape/landscape as subjectively determined by professionals. Aesthetic and perceptual characteristics of each KOPs scenery were described in terms of the form, line, color, texture, horizontal and vertical scale, and movement of the landform, open ocean, inland water, vegetation, and structures identified at the KOP.

Georeferenced panoramic photos were also taken at each KOP using standardized practices outlined in BOEM's SLVIA Guidance (BOEM, 2021), including camera specifications and settings established to provide realistic images that accurately represent what is visible to the human eye.

3.3.3 Visualizations

After the baseline information was collected, simulations of the project in the landscape were created to assess the project's visibility. Simulations of the selected project scenarios in the landscape were created at each KOP (example KOP simulation shown in Figure 8). The simulations were constructed using the panoramic and geo-referenced photos collected during the field study, with accurately placed 3D models of the aboveground and sea surface structures digitally superimposed onto them. This process followed the methodology outlined in Sullivan et al.'s "Evaluating Photo Simulations for Visual Impact Assessment" (2021), and took into consideration the distance of the project, curvature of the earth, and orientation and time of day at which the photo was taken. Notably, effects of atmospheric refraction know to impact visibility were not considered.

Figure 8. Panoramic photosimulation of the view of the NYB OWF from a KOP with red boxes showing extents of magnified views, sourced from BOEM (2023)

For both of the project design scenarios at each KOP, a series of simulations were created to depict a range of visibility conditions, including different lighting and meteorological conditions. One simulation was created to match the time of day and atmospheric condition (such as clear, partly cloudy, overcast, low visibility/hazy, clear, etc.) at the time of the photograph, which was considered the "predicted visibility” at the given KOP. Another was created to match the time of day, but without any atmospheric interference (i.e. clear atmospheric conditions). This simulation was considered the “maximum visibility” scenario. A third and final simulation was created showing night sky conditions without any other light sources in the surrounding landscape or any atmospheric interference.

3.3.4 Overall Impact Rating

It is important to note that most other VIA frameworks use the term “cumulative impacts” to refer to the combination of assessed impact criteria. However, in the context of the NYB SLVIA, “cumulative impacts” is used to refer to the combination of impacts of the selected lease areas under evaluation with adjacent development projects. The NYB SLVIA uses the term “overall impacts” to describe the total impact on each character area and at each KOP.

The overall impact considers sensitivity and magnitude of effect criteria, and combines them into a single impact rating (Table 12) for each character area (in the SLIA phase) as well as each KOP (in the VIA phase) considering both design scenarios. The magnitude and sensitivity metrics use ordinal scales that are treated as interval scales to combine them, as shown in Table 12. The definitions of the overall impact metrics are summarized in Table 13. The overall SLIA and VIA findings were not combined with each other, though the overall impact was verbally summarized across all character areas as well as across all KOPs. All of the ratings were determined through professional judgment.

MAGNITUDE RATING	**SENSITIVITY RATING**		
	High	**Medium**	**Low**
Large	Impact = major	Impact = major	Impact = moderate
Medium	Impact = major	Impact = moderate	Impact = minor
Small	Impact = moderate	Impact = minor	Impact = minor
Negligible	Impact = negligible	Impact = negligible	Impact = negligible

Table 12. Matrix for determining overall impact ratings used in the NYB SLVIA, sourced from BOEM (2023)

OVERALL IMPACT METRIC	**DESCRIPTION**
Major	The project would introduce features that would have dominant levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The project would introduce a visual character that is inconsistent with the character of the unit, which may have a major negative effect to the unit’s features, elements, or key qualities. The concern for change (susceptibility/value) to the character unit is high.
Moderate	The project would introduce features that would have medium to large levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The project would introduce a visual character that is inconsistent with the character of the unit, which may have a moderate negative effect to the unit’s features, elements, or the key qualities. In areas affected by large magnitudes of change, the unit’s features, elements, or key qualities have low susceptibility and/or value.

Minor	The project would introduce features that may have noticeable low to medium levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The project features may introduce a visual character that is somewhat inconsistent with the character of the unit, which may have minor to medium negative effects to the unit's features, elements, or key qualities, but the unit's features, elements, or key qualities have low susceptibility or value.
Negligible	Very little or no effect on ocean/seascape/landscape unit features, elements, or key qualities, either because unit has minimal visibility/susceptibility or lacks value (distinctive character or key features/elements/qualities).

Table 13. Overall impact metric descriptions used in the NYB SLVIA, sourced from BOEM (2023)

3.3.4.1 Sensitivity

Sensitivity factors considered for both SLIA and VIA include susceptibility and value. Susceptibility within the SLIA was defined as the ocean, seascape, or landscape's ability to accommodate the addition of elements or features that affect the scenic character of that area. The value was considered in terms of the opinions of residents and visitors of the character area. Both were determined by professional judgment of the visual elements of the landscape/seascape and assumptions about how people within different character areas value the scenery.

In the VIA, the susceptibility was defined in terms of how viewers regard the visual environment as an asset, what activities they are engaged in, how they are moving through the landscape, and if they are viewing the project from their residence. The view's value was determined based on the following factors:

- The likely number of viewers to the viewpoint
- The scenic designation of the viewpoint
- Association of the viewpoint with historic or culturally important sites
- Appearances of the viewpoint in guidebooks, tourist maps, web sites, online photo collections, and social media
- References to the views/scenery in literature or art
- Provisions for view enjoyment at the viewpoint
- Consultation with visitors' bureaus, tourism service providers, and other local entities

3.3.4.2 Magnitude of Impact

In both the SLIA and VIA, magnitude was defined in term of the size and scale of effect, duration and reversibility of effect, and geographic extent of effect. The size and scale of effect and duration and reversibility of effect as combined to determine the degree of visual contrast. In the SLIA, size and scale of change was defined as the degree of change to character, features, elements, or aesthetic, experiential, or perceptual aspects of the ocean, seascape, and landscape likely to occur from the project impact. In the VIA, it was defined as the degree of visual contrast of visual elements, number of turbines visible and what part of the turbines are visible (blade tip, hub, mid tower), the degree to which the visual contrast and changes are noticeable, the amount of time the view is experienced, and if views are full, partial, or glimpses. Duration and reversibility for both the SLIA and VIA was defined as the length of time over which the impact is likely to occur and the degree to which the currently existing conditions are restored after the impact ceases. The rating for both was based on duration thresholds of short term (less than 5 years), long term (5-30 years), and permanent (more than 30 years), as well as reversibility thresholds of nonreversible, partially reversible, or fully reversible. The overall rating of degree of contrast in both the SLIA and VIA was based entirely on professional judgment. The definition of the degree of contrast metrics used is shown in Table 15 below.

Geographic extent was calculated as the percentage of each character area within the APVI for the SLIA, and the percentage of the view that the project occupies in the VIA. At each KOP, the total number of turbines visible and what part of the turbines (i.e. blade tip, hub, mid tower) were visible was calculated through GIS models using atmospheric refraction coefficients as well as without any atmospheric refraction. The calculations were first run without atmospheric refraction to be consistent with the simulations, then re-run with a standard open ocean refraction coefficient of 0.13. These results were provided side-by-side, but the VIA analysis relied on the calculations without atmospheric refraction in order to be consistent with the simulations. Finally, for each KOP, the percentage of the projects' occupation of the viewers' field of view (FOV) was also calculated using these results (without atmospheric refraction). For each character area, the project's visibility percentage was calculated using GIS models based on the APVI previously established. The geographic extent of visibility of the project within the character area was represented by the percentage of its total area that fell within the APVI. The definition of the geographic extent metrics are shown in Table 14 below.

Table 16 shows the matrix used for combining the geographic extent and degree of contrast metrics in to the cumulative magnitude rating.

GEOGRAPHIC EXTENT METRIC	DEFINITION
Large	Area equivalent to 30% to 100% of the horizontal field of view or character area.
Medium	Area equivalent to 10% to 30% of the horizontal field of view or character area.
Small	Area equivalent to less than 10% of the horizontal field of view or character area.
Negligible	Area equivalent where theoretical visibility does not occur or where field reconnaissance suggests there would be no actual visibility due to the screening effect of micro-topography (not represented in terrain or surface data).

Table 14. Definitions of geographic extent metrics used in the NYB SLVIA, sourced from BOEM (2023)

DEGREE OF CONTRAST METRIC	EQUIVALENT VISUAL PROMINENCE LEVEL	DEFINITION
Large	**6**	An object or phenomenon that constitutes a strong visual contrast and occupies most of the visual field. Views of it cannot be avoided except by turning one's head more than 45 degrees from a direct view of the object. The objector phenomenon is the major focus of visual attention, and its large apparent size is a major factor in its view dominance. In addition to size, contrasts in form, line, color, and texture, bright light sources

		and moving objects associated with the study subject may contribute substantially to drawing viewer attention. The visual prominence of the object detracts noticeably from the existing view elements.
	5	An object or phenomenon that does not appear large but contrasts with the surrounding landscape elements so strongly that it is a major focus of visual attention, drawing viewer attention immediately and tending to hold that attention. In addition to strong contrasts in form, line, color, and texture, bright light sources, such as lighting and reflections and moving objects associated with the study subject, may contribute substantially to drawing viewer attention. The visual prominence of the study subject interferes noticeably with views of existing visual elements.
Moderate	**4**	An object or phenomenon that is obvious and with sufficient size or contrast to compete with baseline visual elements, but with insufficient visual contrast to strongly attract visual attention and insufficient size to occupy most of an observer's visual field.
	3	An object or phenomenon that is easily detected after a brief look and would be visible to most casual observers, but without sufficient size or contrast to compete with key characteristic visual elements to any great extent.
Small	**2**	An object or phenomenon that appears very small and/or faint, but when the observer is scanning the horizon or looking more closely at an area, can be detected without prolonged viewing. It could sometimes be noticed by casual observers. However, most people would not notice it without some active looking, and so it is unlikely to compete with key characteristic visual elements to any great extent.
	1	An object or phenomenon that is near the extreme limit of visibility. It could not be seen by a person who was unaware of it in advance and not looking for it. Even under those circumstances, the object can be seen only after looking at it closely for an extended period and therefore unlikely to compete with key visual elements to any great extent.
Negligible/None	**0**	An object or phenomenon that is not discernible or presents no contrast or apparent change.

Table 15. Definitions of degree of contrast metrics used in the NYB SLVIA, sourced from BOEM (2023)

SIZE AND SCALE RATING	GEOGRAPHIC EXTENT RATING			
	Large	**Medium**	**Small**	**Negligible**
Large	Large	Large	Large	Negligible
	Large	Large	Medium	Negligible
	Large	Medium	Small	Negligible
Medium	Large	Medium	Medium	Negligible
	Large	Medium	Small	Negligible
	Medium	Small	Small	Negligible
Small	Large	Medium	Small	Negligible
	Medium	Small	Small	Negligible
	Small	Small	Small	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible
	Negligible	Negligible	Negligible	Negligible
	Negligible	Negligible	Negligible	Negligible

Table 16. Matrix for combining magnitude ratings used in the NYB SLVIA, sourced from BOEM (2023)

3.3.4.3 Cumulative Impact

Finally, the cumulative impact of the NYB development with expected neighboring offshore wind developments (there are 6 planned lease area developments) was assessed. The cumulative impact was determined by the total number of overlapping lease areas visible based on the APVI viewshed analysis at each KOP. Only the maximum visibility scenarios were considered, and the cumulative impact was not evaluated for the character areas, only the KOPs.

3.4 Discussion

Based on the existing methodologies and relevant considerations of OWF VIA identified in the literature review above, the following discussion of the NYB VIA approach identifies methodological gaps and areas of improvement that are important to address in future VIA of OWF developments in the mid-Atlantic. The evaluation criteria outlined at the beginning of this chapter is used as the baseline against which to assess the strengths and weaknesses of the NYB VIA.

3.4.1 Perceptibility Criteria

3.4.1.1 Visibility Considerations

The NYB VIA includes consideration of the majority of the 12 important visibility considerations identified in the literature review. However, it lacks sufficient consideration of four main elements, including glint on turbines, type of clouds, presence of flashing security lights, and surrounding artificial lights (highlighted in red in Table 17 below). Glint off of turbines is not represented in the visualizations, nor is it verbally described. While the visibility impacts based on cloud type is discussed in KOPs where clouds were present at the time that the baseline photos were taken, the full range of cloud types, their likelihood, and their impacts are not included. The existence and location of flashing security lights is verbally described and included as a negative visual impact based on whether or not that portion of the turbines is visible from each KOP, they are not depicted in any of the visualizations and the degree of their negative impact is not explored. Finally, while night sky scenarios are included in the analysis, there is no discussion of surrounding artificial lights either in the ocean or on land surrounding the KOPs. Especially considering that much of the coast of the NYB is highly developed, it is very likely that other artificially lighting would be present and also the visibility impacts of the NYB.

3.4.1.2 Sensitivity Considerations

The NYB VIA only considers four out of the 11 identified sensitivity factors, though two of these are not relevant at the programmatic stage of this VIA (highlighted in red in Table 17 below). In describing the types of likely viewer groups of the NYB, their past experience with other wind farms and likely aesthetic values, local knowledge and contextual values, and environmental beliefs and opinions about renewables are not considered at all. While the general type of viewer (such as tourists, residents, travelers, and water-based viewers) is considered in relation to the scenic value and duration and frequency of the view from each KOP, the specific potential activity(s), and therefore the visual experience of the viewer is not discussed.

PERCEPTIBILITY CONSIDERATIONS			
Visibility Considerations	**Included in the NYB SLVIA?**	**Sensitivity Considerations**	**Included in the NYB SLVIA?**
Color of turbines in contrast with sky	Yes	Factors that contribute to local sense of place	Yes
Glint of sunlight on turbines	No	Nature of local cultural connection to the ocean/seascape	Yes
Atmospheric haze	Yes	Involvement of viewers in the siting process	*Not applicable*
Type of clouds	No	Viewers' visual experience with other wind farms	No
Angle/direction of sun	Yes	Viewers' visual experience with construction of the project	*Not applicable*
Presence of flashing security lights	No	Viewers' aesthetic values	No
Surrounding artificial lights and night sky contrast	No	Viewers' local knowledge and contextual values	No
Speed and frequency of turbine movement	No	Viewers' environmental beliefs and opinions about renewable energy	No
Evenness of distribution and density of turbines	Yes	Whether viewers are local residents or visitors	Yes
On-shore obstructions	Yes	Activity of viewer	No
Contrast with visual elements of the landscape and seascape	Yes	Type (duration and frequency) of view of the project	Yes
Portion/extent of individual turbines visible	Yes		

Table 17. Inclusion or omission of important visual perceptibility considerations in the NYB SLVIA

3.4.2 Assessment Methodology

3.4.2.1 Public Involvement

None of the important public involvement components are included in the NYB VIA methodology (highlighted in red in Table 18 below). Though some local governments were consulted in the generation of the preliminary KOP selection, no local residents or other local stakeholders where included, and all baseline definitions, evaluation, and cumulative impact assessment were done exclusively by landscape professionals. These landscape professionals are not local to the NYB area and are likely unable to fully understand the nuances of the local cultural values and perceptions of ocean scenery.

PUBLIC INVOLVEMENT CONSIDERATIONS	Included in the NYB SLVIA?
Which members of the public are consulted	No
Public input in establishing baselines	No
Public input in selection of KOPs	No
Public input during the evaluation phase	No

Table 18. Inclusion or omission of important public involvement considerations in the NYB SLVIA

3.4.2.2 Geographic Extent & Scope

Overall, the NYB methodology for determining the scope and geographic extent of the visual assessment is fairly comprehensive (see Table 18 below). It considers line-of-sight viewshed in addition to total area of potential effect, subsets of the total area based on extent of the turbines visible, and field verification of actual line-of-sight at each KOP. While it also includes most of the important data identified for viewshed analyses it does not include expected or standard atmospheric refraction. It also does not include building elevations as part of the elevation data. Especially along he developed coastline around the NYB, views from tall buildings are particularly relevant and an important consideration in understanding visual impact

GEOGRAPHIC EXTENT & SCOPE CONSIDERATIONS	Included in the NYB SLVIA?
Use of total area of potential effect (including beyond line-of sight visibility)	Yes
Differentiation of geographic extent subsets based on likeliness of impact or importance of impact receptors	Yes
Viewshed analysis that includes consideration of elevation data (topography, viewer location and height, and project height), visual obstructions, curvature of the earth, and atmospheric refraction	No
Field verification of GIS viewshed analysis	Yes

Table 19. Inclusion or omission of important geographic extent & scope considerations in the NYB SLVIA

3.4.2.3 Observation Point Selection

The selected NYB KOPs are not adequately representative of potential views and viewers. The types of viewer groups were determined entirely through one-time site visits that may or may not have accurately represented all possible user groups to the site. (Most likely did not since they were conducted during the winter when very few people were present at the sites.) The possible demographics of viewers were also not considered. The types of potential views and scenery were also not adequately represented. All KOPs are only from land even though water-based recreation is an important activity in the NYB. Finally, it is unclear if the KOPs sufficiently represent the sites with the greatest potential impact since there was little to no stakeholder involvement and the landscape professionals were not personally familiar with the NYB area. Almost all the selected KOPs are major tourist destinations, which likely fails to capture sites that have a large impact on locals but not tourists.

OBSERVATION POINT SELECTION CONSIDERATIONS	**Included in the NYB SLVIA?**
Justification of viewpoint selection	Yes
Use of viewpoints that adequately represent different possible viewers, different types of views, different types of scenery, and locations of greatest potential impact	No

Table 20. Inclusion or omission of important observation point selection considerations in the NYB SLVIA

3.4.2.4 Scenario Selection

The scenarios used in the NYB VIA ignore almost all important factors identified as relevant to visual impact of offshore wind (see Table 21 below). Despite explicitly acknowledging the goal of accurately representing the maximum and minimum impact scenarios, the NYB VIA fails to do so. Height variation is the only visual element considered, even though the range of turbine color, spacing, and blade speed, and lighting and meteorological conditions are known and verbally described in the project description. Literature shows that variation in color and blade speed in particular can have a huge impact on visibility, but only the "worst case" color and spacing were used in both the "minimum" and "maximum" scenarios, and blade speed was not considered at all. In fact, the chosen turbine spacing is denser than permits would ever allow. Furthermore, lighting and meteorological conditions were not considered as part of the scenario parameters. Instead, the atmospheric conditions present at the time of the field studies was assumed as the average or representative conditions at each KOP, regardless of identified range of potential conditions. Visibility during construction (or anything other than during operation) as well as presence of other artificial lighting at night were also not considered. Not only is the minimum potential impact scenario is not well represented, but the visibility elements that are included are not sufficient.

SCENARIO SELECTION CONSIDERATIONS	**Included in the NYB SLVIA?**
Representation of a range of potential impact	No
Consideration of known elements that impact visibility including turbine size, materiality, and arrangement, project phases (construction, maintenance, decommissioning, and post-decommissioning), atmospheric and sunlight conditions, turbine blade movement, safety light characteristics, and presence of other artificial lighting	No

Table 21. Inclusion or omission of important scenario selection considerations in the NYB SLVIA

3.4.2.5 Baseline Assessment

The main limitation of the NYB's VIA baseline assessment is its identification and description of the baseline character areas. Much of this is due to reliance on limited quantitative data and descriptions developed exclusively by professionals who are not intimately familiar with the local region. Consideration of environmental justice (EJ) factors is an example of the data limitations seen in this VIA. Federal regulations require that the presence of disproportionately high and adverse impacts is identified for minority and low-income populations based on "the racial and economic composition of affected communities, health-related issues that may amplify project effects to minority or low-income individuals, and public participation strategies, including community or tribal participation in the NEPA process." However, the NYB VIA approach limits its consideration of impacts on vulnerable communities to census data on low income, minority, and low income plus minority communities, and evaluates this date solely on the quantitative number of communities within affected area and percent of area of communities within the viewshed. It does not consider qualitative variations in types of environmental injustice such as distribution of different environmental hazards or the specific racial composition in its definition of EJ communities, and does not provide an interpretation of the implications for different visual experiences of different demographic identities in each character area. Furthermore, though some (brief and incomplete) in-person visits to the area were made to verify the identified character area baselines, some cultural and individual identity characteristics and culturally-accepted spatial delineations were likely missed since local residents were never consulted.

Notably, the NYB VIA does include comprehensive definitions of all character areas used, and its visual baseline description and assessment follows standard VIA methodology.

BASELINE ASSESSMENT CONSIDERATIONS	Included in the NYB SLVIA?
Explicit definition and differentiation of character areas used	Yes
Inclusion of all identified considerations in identifying baseline character areas	No
Inclusion of all identified considerations in describing views	Yes
Inclusion of all identified assessment metrics	Yes

Table 22. Inclusion or omission of important baseline assessment considerations in the NYB SLVIA

3.4.2.6 Visualizations

While the NYB VIA closely follows the industry standard of best practices for capturing realistic photos of the existing landscape, the visualizations used to represent the project in the landscape do not accurately convey many important visual characteristics. They do not depict any atmospheric refraction effects, and only off-shore project elements were considered (though it was acknowledged that landfall elements will be included in future VIA based once the lessee has submitted a design proposal). Most importantly, the static photo simulations are not able to convey the movement of turbine blades or flashing navigation lights, both of which are conditions that are guaranteed to occur, and research shows that they have a significant impact on project visibility.

VISUALIZATION CONSIDERATIONS	Included in the NYB SLVIA?
Accurate representation of the landscape	Yes
Accurate representation of relevant visual characteristics of turbines including materiality, size, location, blade movement, flashing lights, and atmosphere	No

Table 23. Inclusion or omission of important visualization technique considerations in the NYB SLVIA

3.4.2.7 Cumulative Impact

The cumulative impact metrics used in the NYB are generally comprehensive and thorough. It uses metrics common in other OWF VIA, and a full range of valuation categories are considered. Both human and landscape receptors are considered in assessment of visibility and sensitivity. The cumulative impact also includes consideration of potential additional OWF projects adjacent to the area of study, though only from KOPs and not in relation to character areas.

The one fundamental weakness is the use of mathematical combination of ordinal scales to determine cumulative impact. While description of the cumulative metrics is provided, there is no analysis or justification of the methods used to combine the ordinal scales of sensitivity and magnitude into cumulative impact.

CUMULATIVE IMPACT RATING CONSIDERATIONS	Included in the NYB SLVIA?
Inclusion of metrics for sensitivity, magnitude of change, and cumulative impact	Yes
Rationale provided for methods used to combine ordinal metrics	No
Definition provided for cumulative metrics	Yes
Consideration of potential future projects	Yes
Which impact receptors are considered for both visibility and sensitivity	Yes
Valuation categories that include a range of positive, range of negative, neutral and negative categories	Yes

Table 24. Inclusion or omission of important cumulative impact rating considerations in the NYB SLVIA

CHAPTER 4: CONCLUSIONS

Overall, there are significant limitations to the current OWF VIA approach demonstrated in the NYB. Not only are there fundamental flaws and gaps in the methodological framework used for assessing cumulative visual impact, but the visibility and sensitivity factors considered in determining visual perceptibility are insufficient. With BOEM overseeing all regulatory adherence for the offshore wind lease areas in the mid-Atlantic, it is reasonable to expect that future VIAs conducted for the other mid-Atlantic lease areas will follow methodological procedures similar to those found in the NYB VIA. As the first utility-scale offshore wind projects slated to be built in the U.S., the success (or failure) of the NYB and similar mid-Atlantic OWFs will likely play an important role in the future of wind energy in the U.S. Therefore, it is crucial that VIA for these OWFs is conducted accurately and comprehensively, and in order to do so, the following improvements must to be made in the future.

4.1 Better Understanding of Viewer Sensitivity

Identify viewer types and identities

In order to determine how much different viewers might care about changes to the scenery, viewer identities and groups should be clearly defined. Viewers are currently identified only through generalized data at a very high level through limited tourist and socio-economic data. A much more thorough understanding of viewer types and identities is needed at each KOP, as well as a deeper understanding of regional identities within the area of potential visual impact. Site-specific data should be gathered at KOPs that better captures the demographic identity of visitors to the site, whether they are local or non-local to the area, and what they are specifically doing while experiencing the view. Within the area of potential visual impact, regional identities should be more closely considered in establishing character areas. More specific patterns in demographic identity, the duration and frequency or view of the project, and the range of activities people are doing while experiencing the view all need to be better understood.

Identify viewers' scenic values

In order to understand viewer opinions about the nature of change to the scenery, a much more rigorous understanding of viewers' scenic values is also needed. This should be done by identifying aesthetic values and other contextual factors including:

- Factors that contribute to locals' sense of place;
- Local cultural connection to the ocean/seascape;
- Viewers' visual experience with other wind farms (onshore and offshore);
- Viewers' aesthetic values;
- Viewers' local knowledge and contextual values;
- Viewers' environmental beliefs and opinions about renewable energy.

This information can be used to more accurately describe the scenic values and viewers' sensitivity to certain visual changes at KOPs as well as patterns in viewers' scenic values across the area of potential impact.

4.2 Better Understanding of Project Visibility

Accurately represent turbines in the landscape

The current assessment misses key considerations which should be included to accurately assess the visual change and contrast created by the project. A more realistic depiction of the project in the landscape that shows the glint of sunlight on turbines, presence of flashing security lights, speed and frequency of blade movement, and surrounding artificial lights should be used. More consistently considering atmospheric refraction and typical atmospheric conditions is also crucial to accurately assessing the projects' visibility.

Include a useful and realistic range of design scenarios and viewing conditions

While the current goal of depicting a minimum as well as maximum visibility scenario is useful, the current selection of project design elements and viewing conditions for each scenario is not sufficient to accurately assess the realistic potential range of visibility of the project. In order to do so, the most common atmospheric conditions as well as the known potential variation in all project elements with maximum and minimum impact on visibility should be determined and used to define the scenarios.

4.3 Methodological Improvements

Public involvement

If the VIA's findings do not represent the aesthetic experience of people who will actually be viewing the project, they cannot be considered accurate. Rather than rely on judgments from non-local landscape professionals, future approaches must include public involvement representative of likely viewers—specifically in KOP selection, character area definition, and cumulative impact assessment—in order to accurately determine how viewers may be impacted.

Visualization techniques

Static images of the project modeled in the landscape used in current VIA are not sufficient to depict the many important dynamic visibility elements described above. Instead, visualization techniques such as movie clips that show the model of the project accurately located in the landscape with moving parts such as spinning blades, flashing lights, and sun glints should be used. If technological barriers prohibit this, research should be done on methods of depicting these dynamic elements alongside more traditional static simulations.

Cumulative ranking metrics

Current ranking metrics are flawed due to reliance on unsubstantiated mathematical combination methods to add ordinal scales and draw empirical conclusions about cumulative impacts. Future VIA must provide more thorough analysis and justification of any methods used to combine ordinal scales, but particular attention must be paid to the validity of mathematical combination methods, translation of ordinal scales into interval calculations, and treatment of ordinal metrics as interval scales.

4.4 Summary

By more comprehensively and accurately understanding the visibility of the project and the sensitivity of the viewers, as well as addressing three main limitations in existing VIA methodology, significant improvements can be made in the accuracy and effectiveness of VIA of future OWF in the mid-Atlantic. Such improvements may have a positive impact on the success of these projects and the future of offshore wind in the United States.

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