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U.S. Outer Continental Shelf Gulf of Mexico Region

2022-2031

Oil and Gas Production Forecast Review

U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

BOEM Bureau of Ocean Energy Management

Cover: Shell's Appomattox Platform. Appomattox is a semi-submersible platform with first production in May, 2019 with a capacity of 200,000 BOPD. Photo from Chron.com (accessed on 12/13/2021).

Executive Summary

This report is an addendum to OCS Report BOEM 2022-022: U.S. Outer Continental Shelf Gulf of Mexico Region, Oil and Gas Production Forecast, 2022-2031 prepared by the Office of Resource Evaluation (RE). The purpose of this addendum is to identify and explain the difference between the 2022-2031 forecast and the annual production since that time (referred to as "the forecast delta").

While effectively capturing the overall production trend, BOEM's GOM forecast overestimated barrel of oil equivalent (BOE) production by 9% in both 2022 and 2023. This report will show that the overestimation of the forecast was due to:

1) A one-year delay in first production of Shell's Vito development.
2) Lower-than-expected completion activity rates in both 2022 and 2023.
3) Increased uncertainty due to recent hurricanes and the COVID-19 pandemic.

The report first gives a methodology refresher (for full details please refer to the original publication linked above). The remainder of the report is split into two sections: *Forecast Deltas by Various Categories* and *Expected Causes of the Forecast Delta*. The former shows the forecast deltas in the total forecasts (in oil, gas, and BOE) and in the Automated Decline Curve Analysis (Auto-DCA) forecasts (in oil and gas). The latter reviews expected causes of the delta with supporting data analysis.

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Methodology Refresher

The forecast was constructed by summing forecast components as shown in the visual below (Figure 1). The forecast components correlated to types of reserves and resources (for detailed definitions of these, please refer to the original publication). Two major categories of uncertainty affecting the forecast were uncertainty in volume (which affects the total area under the forecast curve) and timing (which effects the shape of the forecast curve).

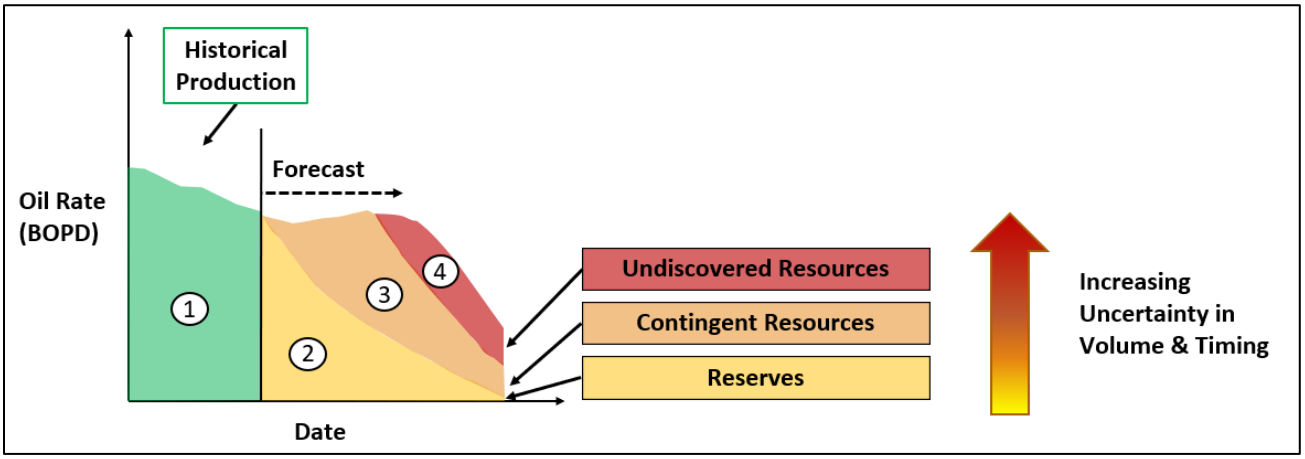

Figure 1: Forecast Components

Two forecast methodologies were used: Decline Curve Analysis (DCA) and production development type curves. DCA is a classic petroleum engineering analysis method which forecasts future production by fitting a model to existing production data. An in-house automated decline curve analysis (Auto-DCA) algorithm was developed which automatically created DCA forecasts for each completion. This analysis became the basis of the reserve's component of the forecast. For the remaining components, volumes were estimated and then made into forecasts via development type curves. The shape of these type curves was defined from historical production profiles for hydrocarbon development in the Gulf of Mexico.

Table 1 on the next page summarizes data sources and methodologies used for each forecast component.

Forecast Component	Forecast Method	Field Types	Data Sources
Reserves	Auto-DCA	Existing Fields	Historical Production Data
Contingent Resources	Volume Estimates + Type Curve	Existing Fields + New Fields	Existing Fields: proprietary estimations Upcoming Fields: public & proprietary estimations
Undiscovered Resources	Volume Estimates + Type Curve	Undiscovered Fields	Historical Trends + Proprietary estimations

Table 1: Methodologies and Data Sources by Forecast Component

Forecast Deltas by Various Categories

The forecast delta is defined as the difference between forecasted production versus actual production. Below, the forecast delta is evaluated for various components of the forecast.

BOE Forecast Delta

The chart below shows historical production at the time of the forecast, the forecast values, and the updated historical production for 2022 and 2023 (Figure 2). For 2022 and 2023, the BOE forecast overestimated production by about 9% in both years, as shown in Table 2.

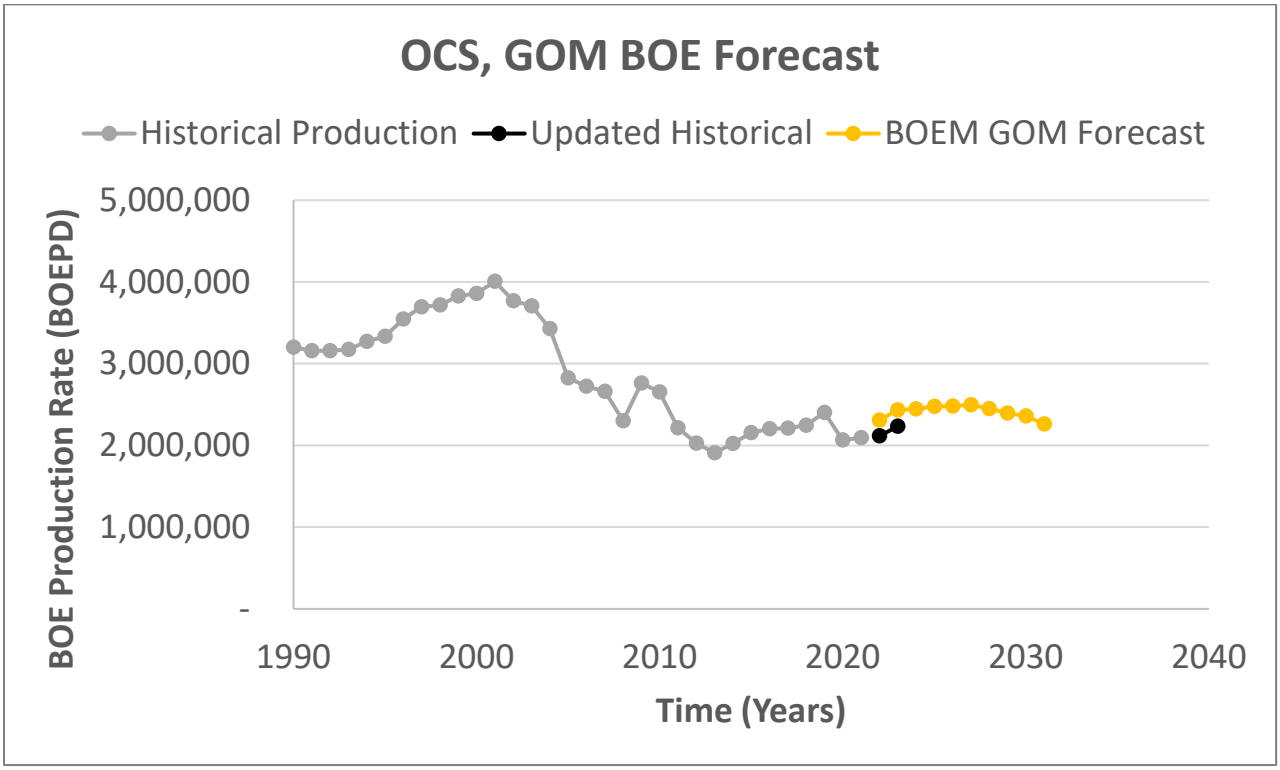

Figure 2: OCS, GOM BOE Forecast

	Predicted (MMBOEPD)	Actual (MMBOEPD)	% Diff
2022	2.31	2.11	9.2%
2023	2.44	2.23	9.1%

Table 2: BOE Forecast Delta

Oil Forecast Delta

The chart below shows historical production at the time of the forecast, the forecast values, and the updated historical production for 2022 and 2023. As shown in Table 3, the oil forecast overestimated production in 2022 and 2023 by 9% and 7% respectively.

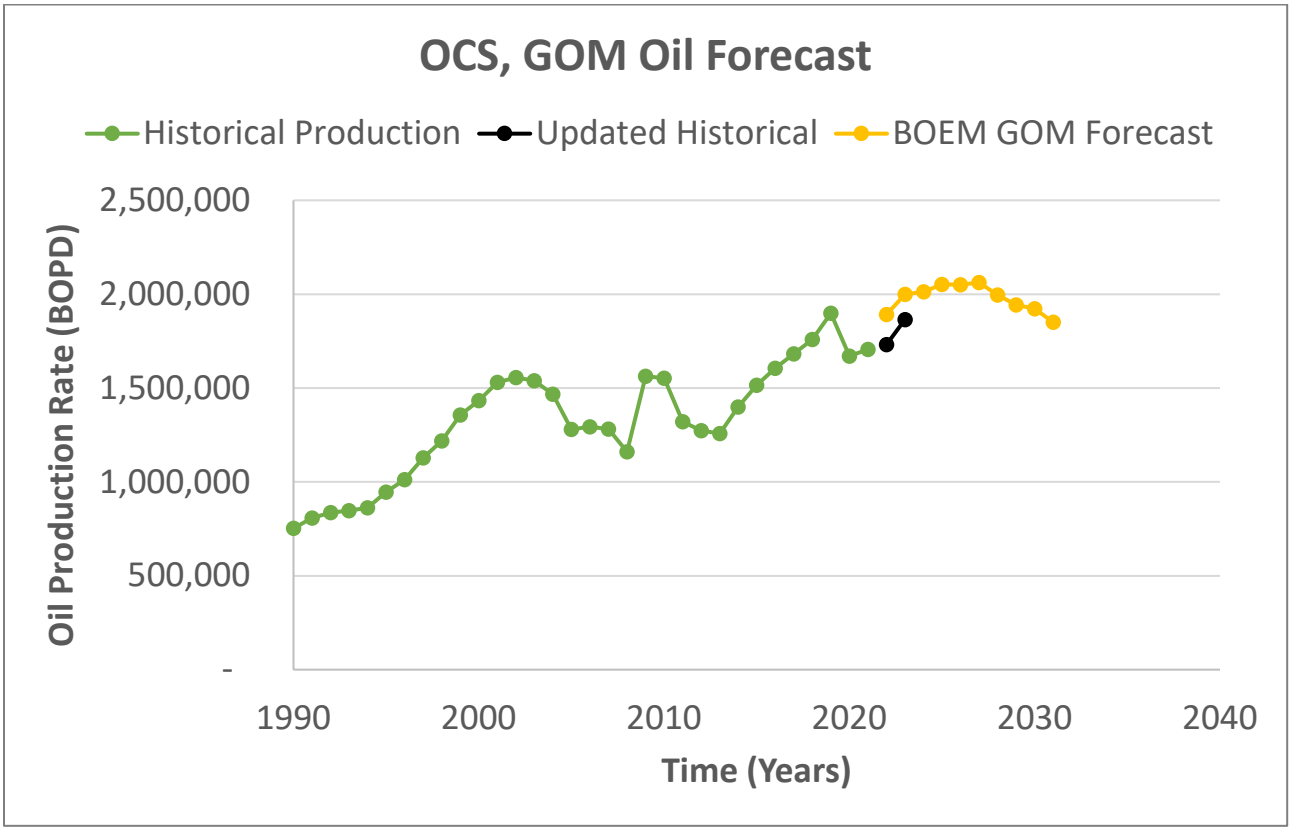

Figure 3: OCS, GOM Oil Forecast

	Predicted (MMBOPD)	Actual (MMBOPD)	% Difference
2022	1.89	1.73	9.3%
2023	2.00	1.87	7.2%

Table 3: Oil Forecast Delta

Gas Forecast Delta

The chart below shows historical production at the time of the forecast, the forecast values, and the updated historical production for 2022 and 2023 (Figure 4). As shown in Table 4, the gas forecast overestimated production in 2022 and 2023 by 9% and 19% respectively.

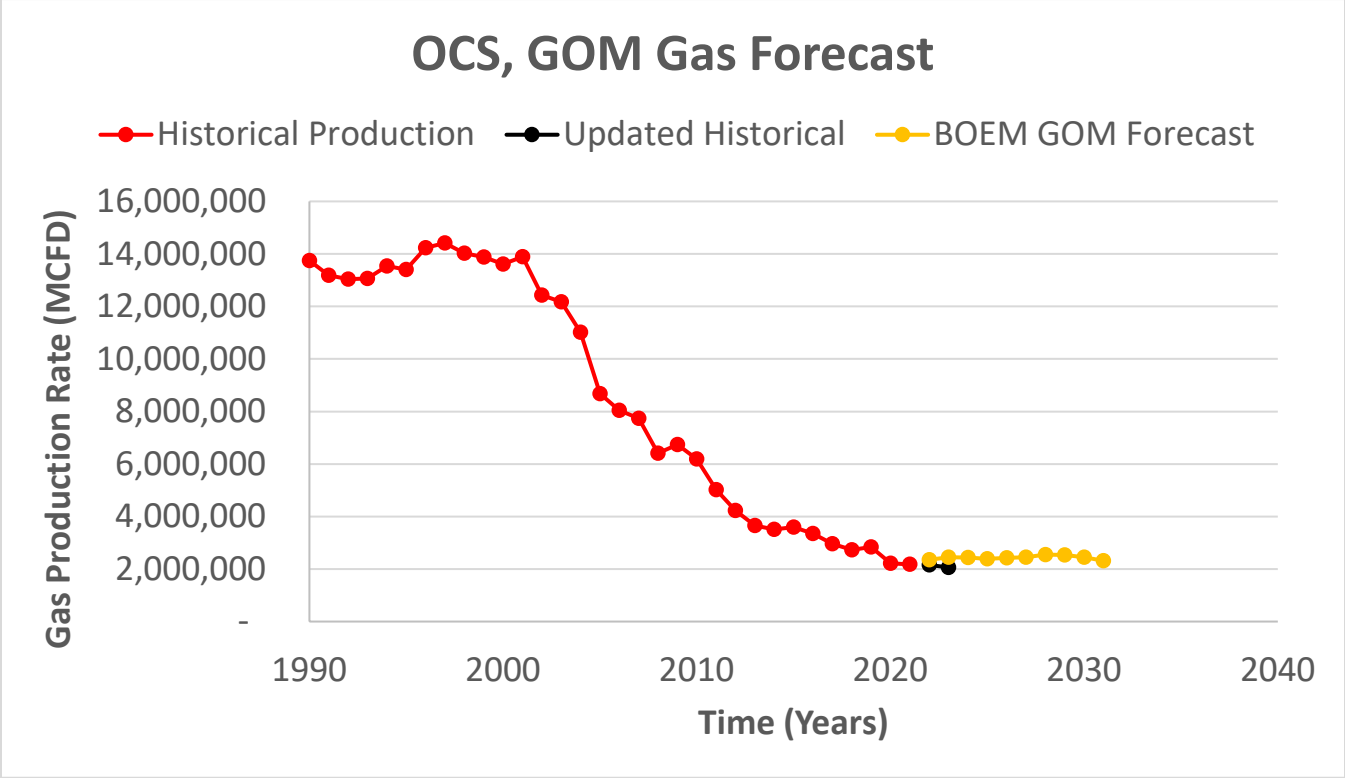

Figure 4: OCS, GOM Gas Forecast

	Predicted (BCFD)	Actual (BCFD)	% Difference
2022	2.35	2.16	9.0%
2023	2.45	2.06	18.7%

Table 4: Gas Forecast Delta

Oil Automated DCA Delta

The chart and table below show that the Auto-DCA forecast of oil production was accurate within 4% in both 2022 and 2023 (Figure 5 & Table 5). In Figure 5, this is indicated by the close alignment between the green and black line which represent the OCS, GOM Oil Production and the Auto-DCA Oil Forecast respectively. (Note: the OCS, GOM Oil Production in Figure 5 excludes completions made on or after August 30th, 2021 as these did not exist at the time that the Auto-DCA algorithm was run.)

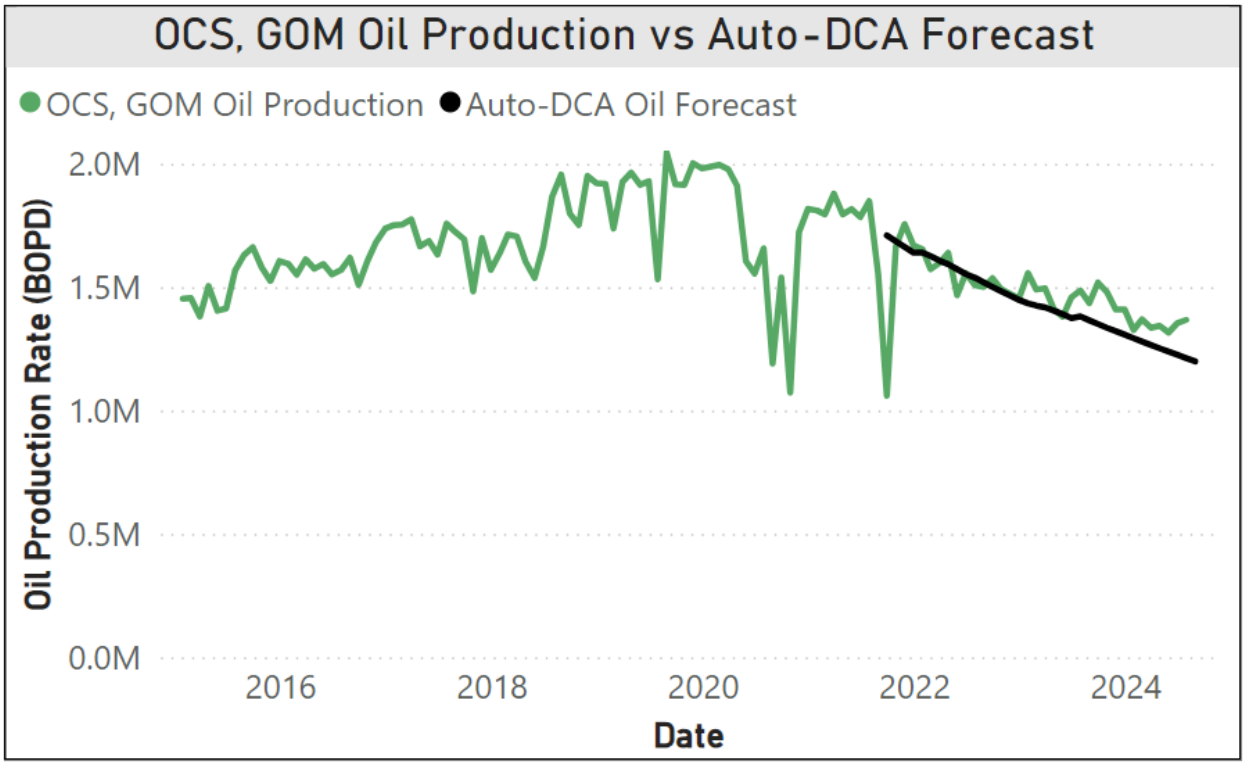

Figure 5: OCS, GOM Oil Production vs. Auto-DCA Forecast

	DCA Forecast (MMBOPD)	OCS, GOM Oil Prod. (MMBOPD)	% Diff
2022	1.55	1.51	2.5%
2023	1.38	1.43	-4.0%

Table 5: Oil Auto-DCA Forecast Delta

Gas Automated DCA Delta

The chart and table below show that the Auto-DCA forecast of gas production was accurate within 3.1% in both 2022 and 2023 (Figure 6 & Table 6). In Figure 6, this is indicated by the close alignment between the red and black line which represent the OCS, GOM Gas Production and the Auto-DCA Gas Forecast respectively. (Note: the OCS, GOM Gas Production in Figure 6 excludes completions made on or after August 30th, 2021 as these did not exist at the time that the Auto-DCA algorithm was run.)

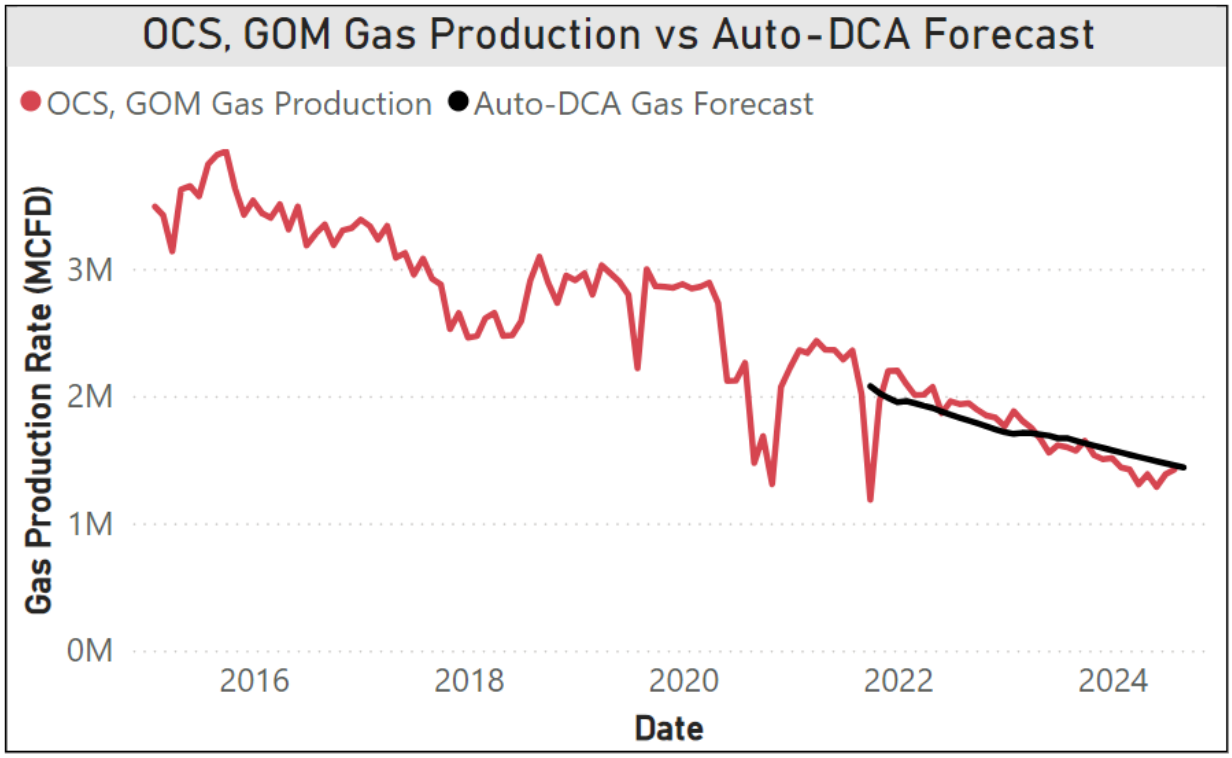

Figure 6: OCS, GOM Gas Production vs Auto-DCA Forecast

	DCA-Forecast (BCFD)	OCS, GOM Gas Prod. (BCFD)	% Diff
2022	1.84	1.90	-3.1%
2023	1.66	1.61	3.1%

Table 6: Gas Auto-DCA Forecast Delta

Expected Causes of the Forecast Delta

Impact of Hurricanes on Forecast Uncertainty

The abnormally active hurricane season in 2020 and one major hurricane (Hurricane Ida) also drove additional uncertainty in this forecast. Major hurricanes cause short-term, long-term, and permanent shut-ins. Short-term shut-ins are caused as the hurricane approaches; long-term shut-ins occur due to the time required to make repairs to damaged facilities; and permanent shut-ins occur when previously producing wells do not justify the expense of the repairs required to return them to production. These shut-ins as well as the costs of facility repairs negatively impact company cashflows which also may cause delays in investment and development activities.

For reference, Figure 7 shows the total shut-in oil production (in millions of barrels of oil, MMBO) from various selected hurricane seasons beginning with the impact of Hurricane Katrina in 2005. The shut-in oil from Hurricane Ida was 30 MMBO (at a time when oil was about $80/barrel) representing about $2.4 Billion in lost revenue for oil and gas operators whose cashflows were further impacted by the cost of hurricane repairs.

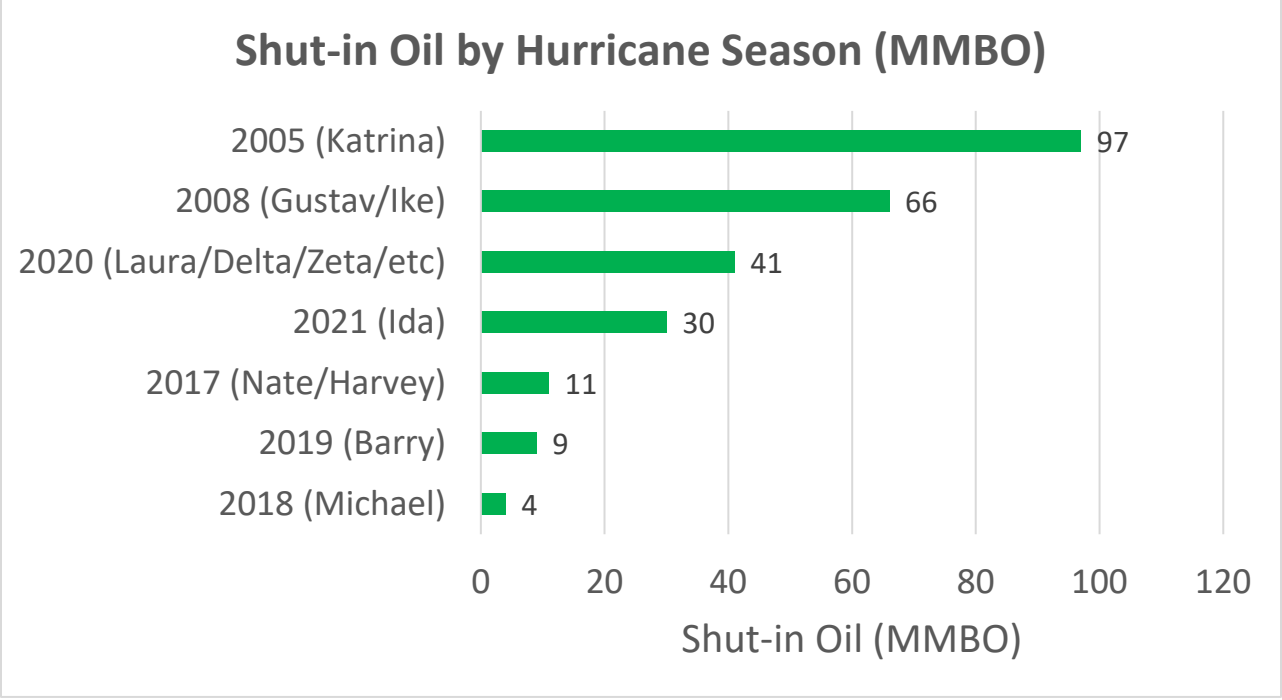

Figure 7: Shut-in Oil by Hurricane Season (MMBO)

Impact of COVID-19 on Forecast Uncertainty

The COVID-19 pandemic had numerous concurrent impacts on the oil and gas sector resulting in increased market volatility and uncertainty which in turn drove uncertainty in the forecast. Global oil and gas demand decreased due to social distancing, travel bans, and work-from-home policies, oil prices temporarily went negative for the first time in history (due to the lack of demand and the cost of oil storage), and global supply chain issues emerged.

New Field Expectations vs. Actuals

The timing of new field developments has a significant impact on GOM production levels. Table 7 compares the expected initial production dates (from the 2021 forecast) to the actual or updated projected dates for key fields.

Field Nickname	Operator	Area	Lease	Initial Production		
				2021 Exp.	Actual or Exp.	Delta (years)
Vito	Shell	MC940	G22919	2022	Feb-23	1
Power Nap	Shell	MC943	G34467	2022	Mar-22	0
Mormont	Murphy E&P	GC478	G35662	2022	Jun-22	0
Shenandoah	LLOG Exp.	WR51	G31938	2023	Q4 2024	2
Rydberg	Shell	MC525	G31507	2024	Feb-24	0
Anchor	Chevron	GC807	G31752	2024	2024	0
North Platte	Shell/Equinor	GB958	G32460	2024	2028	4

Table 7: Differences in First Production Expectations for New Fields

Although most project timelines did not change significantly, the one-year delay in first production from Shell's Vito project had a notable impact on the forecast. In the chart below, the stacked oil production profiles of new GOM fields are plotted for reference (Figure 8). The production of Vito is shown in red. After initial production, Vito quickly reached ~70k BOPD and sustained this rate (except in one abnormally low month). If Vito had started production in 2022 and maintained a rate of 70,000 BOPD, the forecast's overestimation for 2022 would have been reduced from 9.3% to 5.0%.

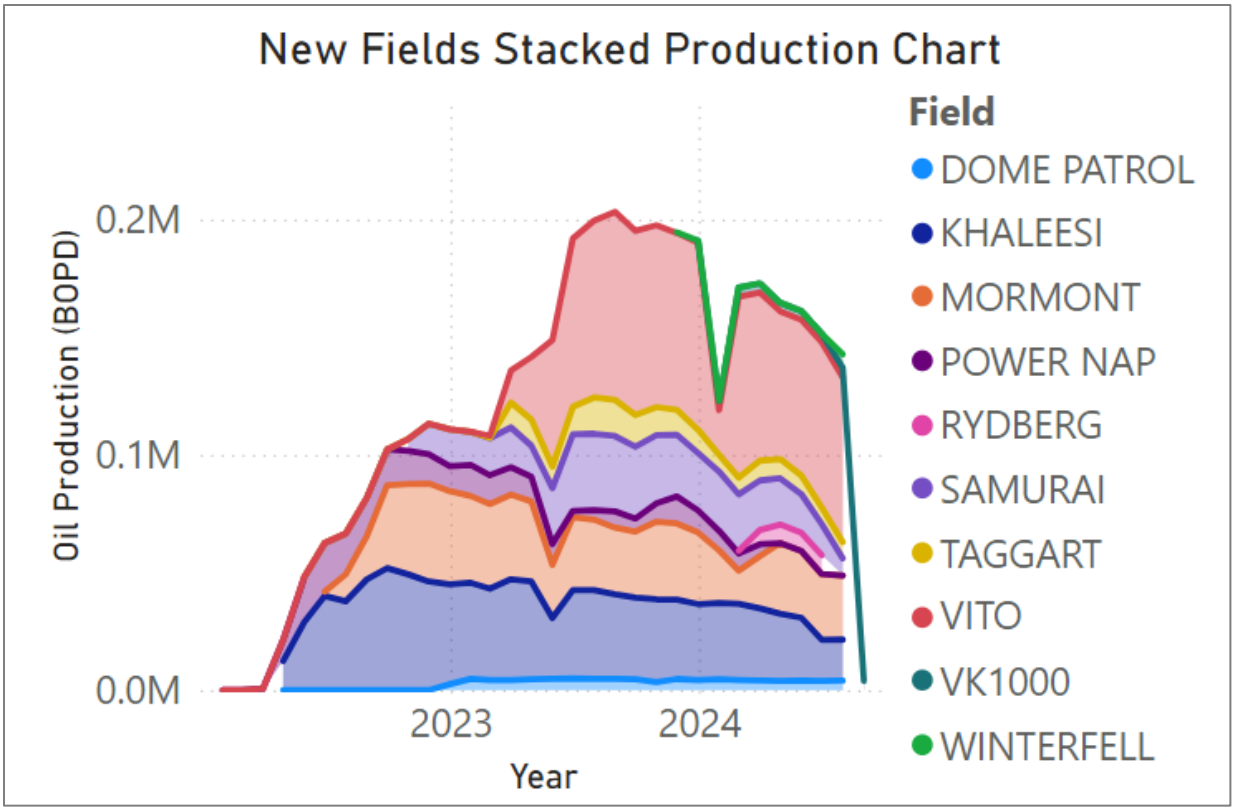

Figure 8: OCS, GOM Daily Oil Production from New Fields

Changes to proprietary BOEM volume estimates were also considered internally as part of this review. While BOEM's estimates increased, these changes had a minimal effect on the forecast overestimation in 2022 and 2023.

Annual New Completion Activity Rate

Figure 9 displays the count of annual new completions in the GOM by water depth category: Deepwater (DW) and Shallow Water (SW). A key assumption in the forecast was that development activity rates would return to pre-2020 levels following the unusual hurricane seasons of 2020 and 2021, but this did not occur.

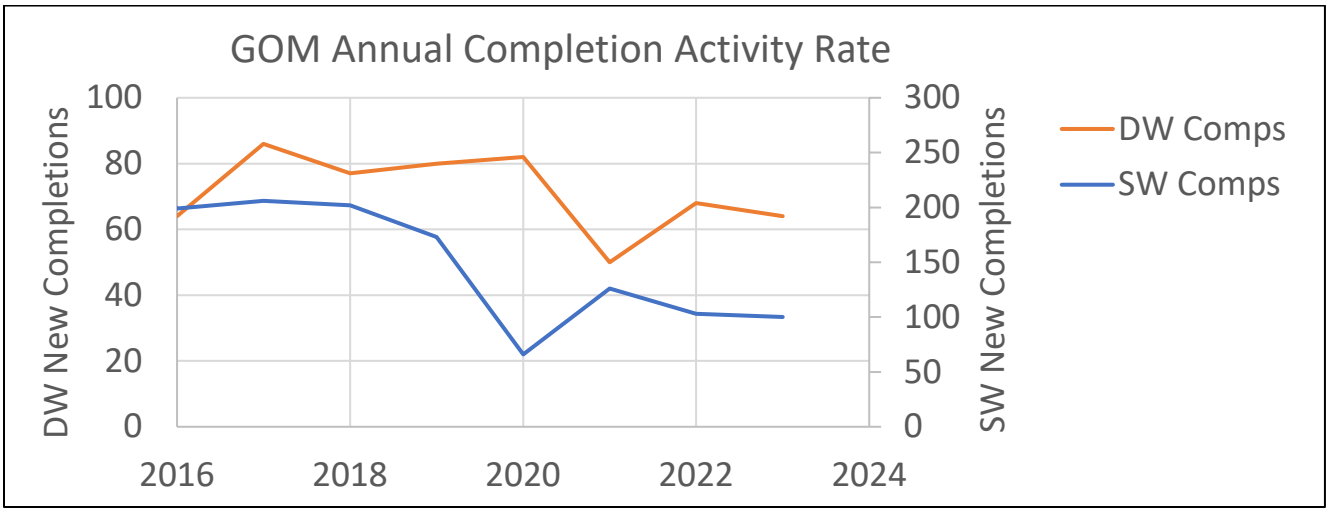

Figure 9: GOM Annual Completion Activity Rate

Tables 8 and 9 below show that the DW and SW activity rates decreased by 21% and 44% respectively. This reduction in new completions is likely a key driver of the difference between the 2021 forecast and actual production values. It is possible that the expense and time required for hurricane repairs as well as lost revenue due to hurricane shut-ins may have contributed to the lower new completion activity rates shown.

Time Period (years, inclusive)	**Activity Rate** (new completions/year)
2016 -2019	76.8
2021-2023	60.7
% Change:	-21%

Table 8: Deepwater Annual Activity Rate Delta

Time Period (years, inclusive)	**Activity Rate** (new completions/year)
2016 -2019	195.0
2021-2023	109.7
% Change:	-44%

Table 9: Shallow Water Annual Activity Rate Delta

Conclusion

BOEM's GOM Forecast overestimated BOE production by 9% in 2022 and 2023 while still effectively capturing the overall production trend.

The analysis above showed that:

1) The Automated Decline Curve Analysis (Auto-DCA) for oil and for gas accurately forecasted production from existing completions, with a margin of error of +/- 4% in 2022 and 2023.
2) The overestimation of total oil production was primarily due to:
    a. A one-year delay in first production of Shell's Vito development.
    b. Lower-than-expected completion activity rates in both 2022 and 2023.
    c. Increased uncertainty due to recent hurricanes and the COVID-19 pandemic.

If the current trend of lower-than-forecasted development activity continues, the gap between forecast production and actual production may widen. However, the outlook for new deepwater fields remains promising, with a strong queue of upcoming projects. While the forecasting methodology employed is robust, the discrepancies highlighted in this addendum underscore the inherent uncertainties in oil and gas forecasting. A probabilistic or case-based approach may help future forecasts better account for these uncertainties by incorporating multiple scenarios for key inputs and assumptions.