Ecosystem effects of the *Deepwater Horizon* acting through gulf menhaden

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OILING \rightarrow \text{SEA BIRD MORTALITY}

\begin{align*}
\text{Sea bird numbers} & \quad \text{DECREASED} \\
\text{Predation pressure} & \\
\text{Menhaden numbers} & \quad \text{INCREASED} \\
\text{Grazing pressure} & \\
\text{Food Supply} & \quad \text{DECREASED}
\end{align*}

Ecological Importance of Gulf Menhaden before DWH

Consume ~ 64% of Primary Production Available at Trophic Level 3.0 within ~ 28,000 km²:

Assume 1° production is 500 g C m⁻², trophic transfer efficiency is 20 - 25%, then production available at trophic level 3.0 is:

\[
500 \text{ g C m}^{-2} \times 0.20 \times 0.25 = 25 \text{ g C m}^{-2}
\]

Gulf menhaden production is ~ 16 g C m⁻², so

\[
16/25 = 64\%
\]

SEDAR 32A ASPIC Model: Gulf menhaden carrying capacity:

76% (Pre-DWH)
Coastal Surface Oil Contamination from Deepwater Horizon & Subsurface PAH Contamination
LDWF Recruitment Index for Gulf menhaden

ZONE 1
Mean=3.8
SD=3.6

ZONE 2
Mean=10.9
SD=6.1

ZONE 3
Mean=14.8
SD=8.6
Le Cren’s Condition Index & Age Structure for Gulf Menhaden

2011

2012

B

West of MR  East of MR

West of MR  East of MR

Condition Index

Age Class %
Annual Average Weight at Age 1 and at Age 2 of Gulf Menhaden

Data from NMFS
Gulf Menhaden Oil Yield at Daybrook Fisheries, 1971 - 2014
After Deepwater Horizon (2011):

Gulf Menhaden Consumed 104% of Primary Production Available at Trophic Level 3.0 within ~ 28,000 km²:

Assume 1° production is 500 g C m⁻², trophic transfer efficiency is 20 - 25%, then production available at trophic level 3.0 is:

\[ 500 \text{ g C m}^{-2} \times 0.20 \times 0.25 = 25 \text{ g C m}^{-2} \]

Gulf menhaden production is ~ 26 g C m⁻², so

\[ \frac{26}{25} = 104\% \]

(2012: 23/25 = 92%)
Long-Term Ecological Effects of the Deepwater Horizon on the Gulf Menhaden Population

- Population is now at habitat carrying capacity

- Top-down control was important for limiting population abundance

- While abundant, fish are often less nutritious for predators that consume them

- High abundance increases predation pressure by Gulf menhaden on planktonic larvae of other species
Long-Term Risks of Ecological Effects to the Gulf Menhaden Fishery

- Greater variability of oil yields
- Increased risk of population crash
Gulf Menhaden Fishery Management Challenge:

*How to manage stock reduction to below habitat carrying capacity*