

# Review of LNG Vaporization Technologies and Impacts to Ichthyoplankton

**Justin Farrell**

Research Associate

Louisiana Sea Grant College Program

# Quick recap



- **LNG 101**
- **Regulatory framework**
- **Case Studies (3)**
- **Balanced Ocean Policy**
- **Vaporization & Ichthyoplankton**

# Vaporization Technologies

- Open Rack Vaporization
- Submerged Combustion Vaporization
- Intermediate Fluid Vaporization
- Mustang SMART™

# Open rack vaporization (ORV)

- Open-loop system
- Uses ambient temperature seawater drawn from the GOM to regasify LNG
- Primary Benefit
  - Lower operation cost
  - Uses ‘renewable’ resource (ambient seawater)
  - Fewer fossil fuels burned, fewer greenhouse gas emissions (CO<sub>2</sub>, CO, NO<sub>x</sub>)

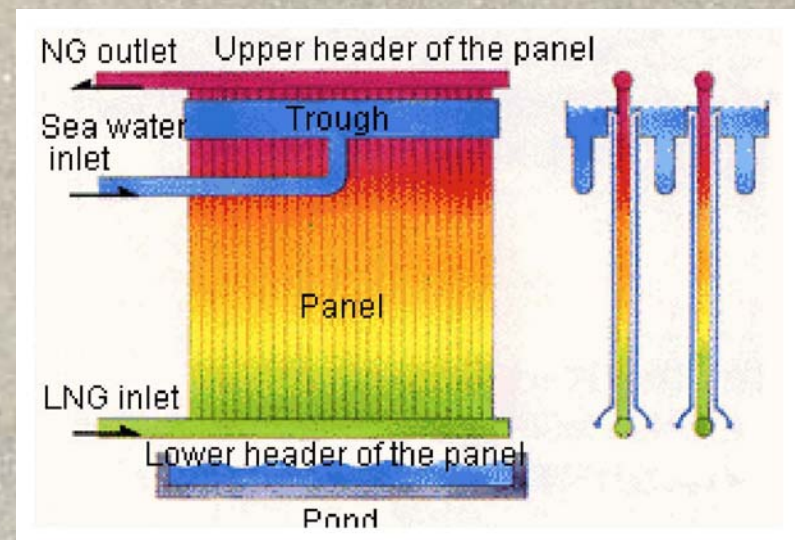
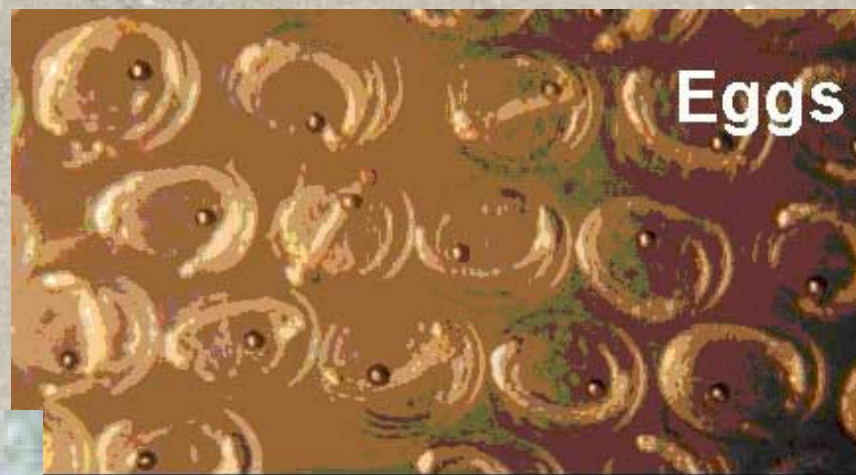


Chart courtesy SPP Co., LTD

# Ichthyoplankton



Eggs

Source: NOAA Seemap



Larvae

Source: NOAA



## ORV- cont.

- Primary impacts = Plankton populations (ichthyoplankton, phytoplankton, and zooplankton)

- Impingement

- *Organisms trapped against the intake screens*

- Entrainment

- *Organisms sucked into the intake*

- Subject to **Thermal Shock** (-19 degrees F; due to thermal exchange)

- Subject to **Chemical Shock** (sodium hypochlorite to prevent biofouling; 0.1 mg/L)

- **Assumes 100% mortality**

# Ichthyoplankton impacts



Impact of vaporization on spp. in annual equivalent yield for MPEH™

Resource Area	Specific Impact	SCV Low NOx	SCV/SCR	ORV	ORV/WHR	IFV Boiling/condensing	
Biological resources	Annual Equivalent Yield (lbs)	Gulf menhaden	0	0	14,000	10,000	10,000
		Red drum	0	0	4,000	3,000	3,000
		Red snapper	0	0	370	280	280
		Brown shrimp	0	0	17,000	13,000	13,000
		White shrimp	0	0	1,200	890	890

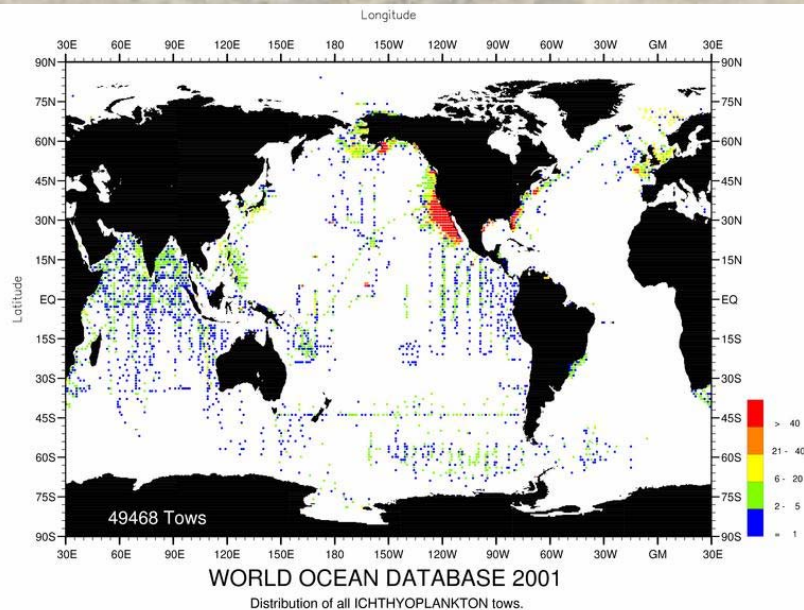
Source: MPEH™ (Freeport-McMoRan) FEIS

# Mitigating ORV Impacts



- Limiting intake rates
  - 0.5 ft/s
- Varying intake depth
- Marine Life Exclusion Systems

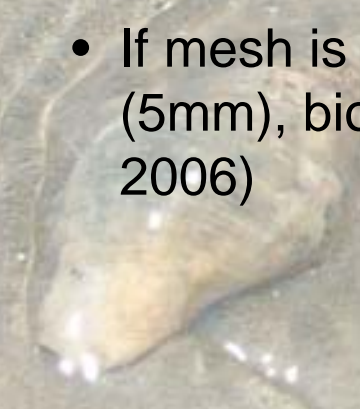
## Ichthyoplankton tows



- Aquatic filter barriers (AFB)
- Wedgewire screen barriers

# Marine Life Exclusion Systems

- Aquatic filter barriers (AFB)
  - Polyethylene/polypropylene mesh fabric
  - Similar to fish net barrier concept
    - Typically high impingement reduction, but little entrainment reductions due to larger openings (4-32mm)
    - If mesh is reduced to a size that excludes larval fish & eggs (5mm), biofouling & debris clogging is a concern (USCG 2006)



# Gunderboom MLES™



- Piloted in Chesapeake Bay
- Deemed BAT for Clean Water Act 316(b)

- Biofouling and debris clogging
- Maintenance and cleaning
- 0.5 mm not installed offshore

Gunderboom, Inc. | In partnership with seventy percent of the Earth - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.gunderboom.com/mis/mles.html

Paws Login Yahoo! Login 2theadvocate.com

**GUNDERBOOM**  
In Partnership with Seventy Percent of the Earth

- Home
- News & Publications
- Contact Us / Request Information

EPA 316(b) Compliance	Intake Impingement & Entrainment	Underwater Wildlife Acoustic Damage	Bacteria & Turbidity Protection	Clean, Safe Water Recreation
MLES™ Marine Life Exclusion System	SAS™ Sound Attenuation System	PCS™ Particulate Control System	RPS™ Reservoir Protection System	BPS™ Beach Protection System

**Gunderboom® MLES™ Marine Life Exclusion System**

Provides Affordable compliance under the Clean Water Act, Section 316(b).

The Gunderboom MLES™ reduces the impact of intake structures on aquatic organisms by preventing entrainment and impingement, while protecting the structure from marine life intrusion. The MLES™ also reduces operating and maintenance costs and helps prevent plant shutdowns.

**Best Technology Available.** Gunderboom's MLES™ is a water-permeable barrier that keeps fish eggs, larvae and other aquatic organisms a safe distance away from an industrial intake structure. Engineered, manufactured and supported by Gunderboom, the MLES™ preventing both impingement and entrainment of ichthyoplankton and juvenile aquatic life. State and federal agencies have deemed the MLES™ as the Best Technology Available under the Clean Water Act, Section 316(b).

[Continue >](#)

[Terms of Use](#) | [Privacy & Security](#) | [Web Site Comments](#)

Copyright © Gunderboom, Inc. All Rights Reserved.

[www.gunderboom.com](http://www.gunderboom.com)

Done

start | 1 Microsoft ... | 2 Firefox | 2 Windows ... | TCS LNG (5-8... | FARRELL\_T... | 1:54 PM

# Marine Life Exclusion Systems- cont.



- Wedgewire screen barriers
  - Cylindrical filters consisting of wire wound around support rods forming gaps b/w the wires
    - Impingement greatly reduced (Weisberg et al. 1984)
    - Entrainment reduced when mesh is smaller than organisms (variable)
  - Concerns:
    - Biofouling
    - Storm Damage
    - Damage from floating objects

# Submerged combustion vaporization (SCV)

- Closed-loop system
- Combusted fuel gases are sparged into a submerged water bath to vaporize LNG
- Primary Benefits
  - Reduces impingement & entrainment of marine species
  - Lower total water discharges
  - Relatively quick start-up
  - Inland areas

SCV conventional

SCV ultra-low NOx

SCV w/ scrubber

SCV w/ SCR

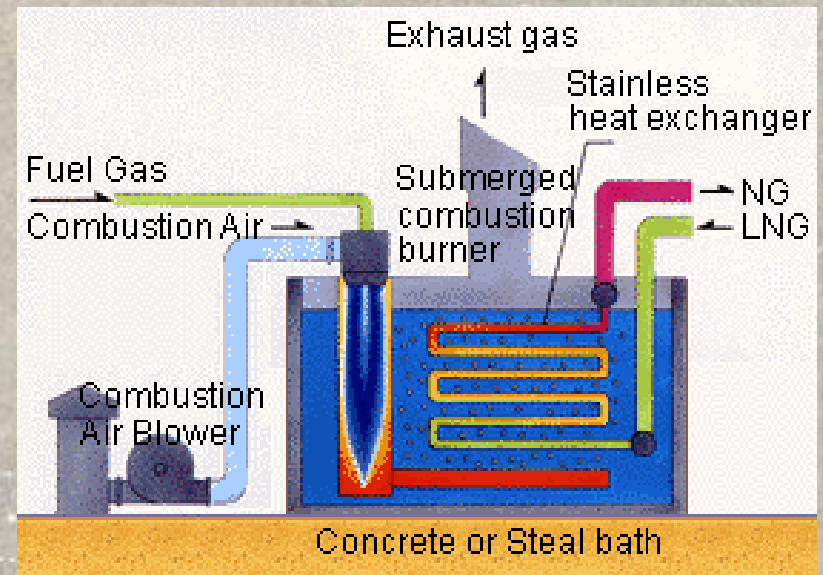


Chart courtesy SPP Co., LTD

## SCV- cont.

- Primary impacts
  - Larger land use footprint
  - Burns fossil fuels
  - Increased CO, CO<sub>2</sub>, NO<sub>x</sub> emissions
  - More costly, e.g. Shell Gulf Landing
    - 1.2-1.6% of its LNG in regasification
    - At a cost of \$20-43M/yr
    - \$321-670M over the 30-yr life

Impacts generally associated with source of heat, **rather than process itself...**

# Mitigating SCV Impacts

- Low NOx burners
- Scrubbers
- Selective catalyst reduction (SCR)
- Waste heat recovery



# Intermediate Fluid Vaporization (IFV)



- Different methods of using an intermediate fluid to vaporize LNG to reduce or eliminate seawater usage
- Primary Benefits
  - Reduced impingent/entrainment (but still a consideration)
  - IFV boiling/condensing considered comparable to ORV with waste heat recovery (WHR)



**IFV indirect**

**IFV  
boiling/condensing**

**IFV Rankine cycle**

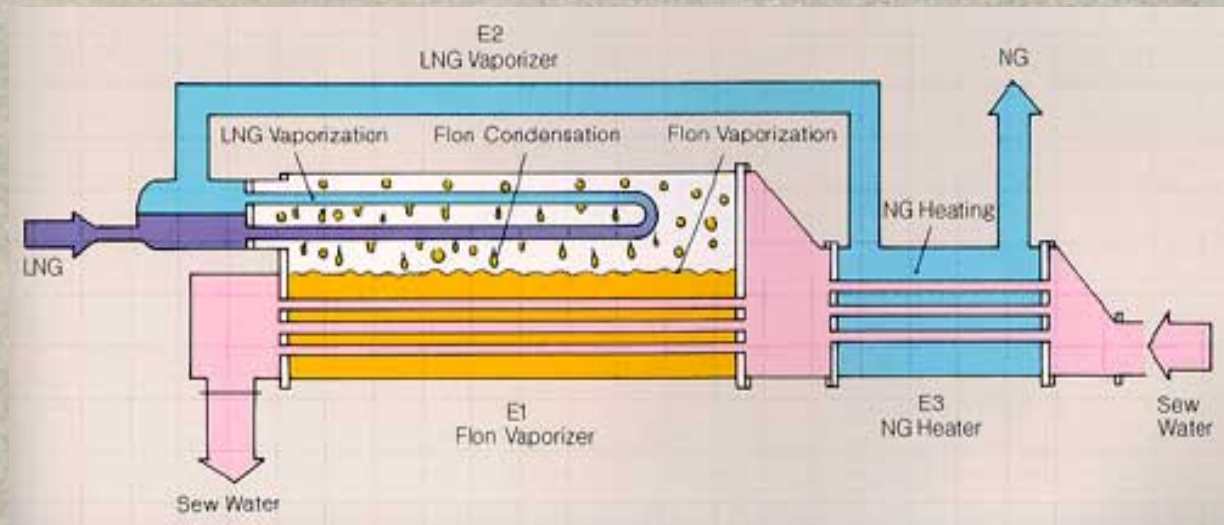


Chart courtesy Kogas LNG Technology Research Ctr

# Mustang LNG SMART™ Vaporization



- Fin-fan heaters warm intermediate fluid using ambient heat from the air
- Primary Benefits
  - Reduced CO<sub>2</sub> and NO<sub>x</sub> emissions
  - Reduced fuel gas usage
  - Reduced OPEX costs
  - Reduced impacts to marine life
- Not “proven, commercially viable” (USCG)
- Larger footprint, addtl. offshore platforms

LNG SMART™ VAPORIZATION



# MPEH™ & CZMA



- MAY 2005

- Louisiana & Alabama's Governor's Office state publicly that ORVs cannot be supported

- MAY 2006

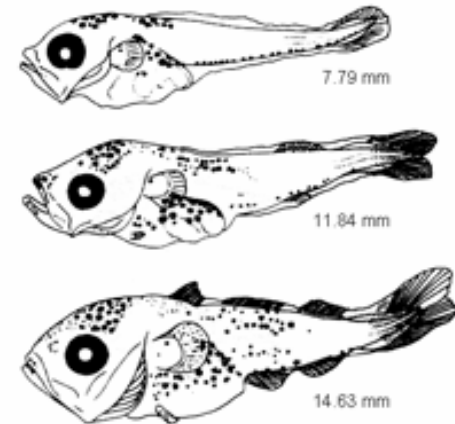
- Freeport McMoRan's MPEH™
  - Blanco Veto (CZMA)

*“I don’t think science has a whole lot to do with this decision right now.”*

- Eric Smith, Professor & Assoc. Director  
Energy-Tulane Energy Institute

# *Uncertainty...*

- Cumulative Impacts of multiple ORV-approved terminals
- SEAMAP data
  - Limited info on vertical & seasonal distribution
  - Gear mesh size (sampling bias)
- Current policy is *‘err on the side of caution’*



# Other issues....

- **Storage**
  - Salt caverns
  - Mined Rock
- **Public Perception**
  - Safety, equity
- **Revenue sharing**
- **Pipelines**

## Questions?