Energy Consumption and Fishing Efficiency for Lobstermen

An Intensive Workshop for the Lobster Trade Adjustment and Assistance Program

Workshop Outline

Part 1: Explore efficiency and environmental impacts; it’s not just fuel prices....

Part 2: Fuel efficiency
- Diesel pricing and cost trends
- How you can improve fuel efficiency

Part 3: Operational efficiency
- Trap saturation
- Bait and Soak time
- Getting the most from your GPS
Part 1: Exploring options to increase profitability and reduce environmental impacts of lobster fishing

Prepared and presented by
Steve Eayrs
Fishing Gear Technologist

Key operational inputs and outputs of a lobster fishing business

Inputs
- Fishing boat
- Fuel
- Fishing gear
- Time
- Labor
- Bait

Fishing activity

Outputs
- Profits
- Seafood
- Employment
- Marine impact
- Waste
- Oil & gas discharge
- Ghost fishing
How do define efficiency?

Fishing efficiency = catching efficiency × gear efficiency × time efficiency

= catch (# lobsters) × # lobsters attracted to trap × time fished / total time at sea

where,

catch = catch of lobsters

time fished = time trap is on the seabed

total time at sea = travel + searching + setting + fishing + hauling + handling times

What is an Environmental Management System (EMS)?

An EMS is:

• a systematic and holistic process used to identify, manage and reduce environmental impact of fishing activity
• a continuous process of improvement and refinement
• a tool to help an industry meet current and future challenges, and therefore should include risk assessments, goals, objectives, milestones, thresholds, & responses
• helps flag areas requiring additional resources and effort
• helps identify and address regulatory and non-regulatory responsibilities
• profit driven (reduce costs, enhance product value)......but which simultaneously has positive environmental outcomes

* the environment is considered to be the physical surroundings and conditions that affect the lives of people
Based on a ‘plan, do, check, act’ activity cycle

**Plan**
- delineation of project scope (what do you want to do?)
- assessment & review of environmental impacts & related legislation
- establishment of goals & priorities for action

**Do**
- development of an environmental policy & management program (objectives, targets, roles & responsibilities, & implementation of prioritized actions)

**Check**
- performance measurement

**Act**
- documentation of performance & outcomes
  - provide evidence of steps to improve performance
  - serve as a platform for future corrective action
  - demonstrate evidence for any Quality Assurance program

Quality Assurance programs and other EMS outcomes

- One measure of the success of an EMS is the ability to satisfy the requirements of a quality assurance program
  - Code of Conduct
  - ISO 14001 or MSC require 3rd party certification
  - Eco-labeling schemes/product branding
- Seafood quality, traceability, and marketing
- Boat and Workplace safety
- Employee training and career development (e.g. crew sharing policy)
- Marine pollution
- Any issue pertaining to fishing that fishermen would like to tackle jointly and coherently
### Risk assessment...in response to a perceived or real threat

**Likelihood levels of impact**

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Score</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely</td>
<td>6</td>
<td>It is expected to occur</td>
</tr>
<tr>
<td>Occasional</td>
<td>5</td>
<td>May occur</td>
</tr>
<tr>
<td>Possible</td>
<td>4</td>
<td>Some evidence to suggest this may possibly occur</td>
</tr>
<tr>
<td>Unlikely</td>
<td>3</td>
<td>Uncommon, but has been known to occur</td>
</tr>
<tr>
<td>Rare</td>
<td>2</td>
<td>May occur in exception circumstances</td>
</tr>
<tr>
<td>Remote</td>
<td>1</td>
<td>Never heard of, but not impossible</td>
</tr>
</tbody>
</table>

**Consequence levels of impact**

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Score</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>0</td>
<td>Very insignificant impacts. Unlikely to be measureable</td>
</tr>
<tr>
<td>Minor</td>
<td>1</td>
<td>Possible detectable but minimal impact on structure or function</td>
</tr>
<tr>
<td>Moderate</td>
<td>2</td>
<td>Max acceptable level of impact, recovery measured in months or years</td>
</tr>
<tr>
<td>Severe</td>
<td>3</td>
<td>This level will result in wider and longer term impacts, recovery measured in years</td>
</tr>
<tr>
<td>Major</td>
<td>4</td>
<td>Very serious impacts with relatively long time frame likely to be needed to restore to acceptable level, recovery measured in years to decades</td>
</tr>
<tr>
<td>Catastrophic</td>
<td>5</td>
<td>Widespread and permanent/irreversible damage or loss will occur, unlikely to ever be fixed</td>
</tr>
</tbody>
</table>

**Risk ranking category**

<table>
<thead>
<tr>
<th>Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Negligible risk</td>
</tr>
<tr>
<td>1-6</td>
<td>Low risk</td>
</tr>
<tr>
<td>8-12</td>
<td>Moderate risk</td>
</tr>
<tr>
<td>14-18</td>
<td>High risk</td>
</tr>
<tr>
<td>20-30</td>
<td>Extreme risk</td>
</tr>
</tbody>
</table>

### Energy audits - a 3-stage process

- **Stage 1**
  - Broad overview of energy consumption, operational inputs and outputs
  - Is the consumption excessive? When is it excessive?

- **Stage 2**
  - Detail evaluation including mapping of relative sources of consumption
  - Identify major consumers and recommend options

- **Stage 3**
  - Detailed focus on major sources of consumption
  - Costed recommendations for potential savings
Stage 1

• Commence operational overview
• Fuel use and catch by month provides a limited insight into best and worst performing months
• But which months are better or worse?
• Fuel to catch ratio (gal/lb) provides an answer to this question
• At $3.50/gal, it costs almost 7¢ in fuel per pound of landed catch in May
• In Aug this cost increases to 50¢ per pound of landed catch. Is this 7-fold increase satisfactory?
• What is the upper acceptable threshold?

Stage 1

• Evaluating catch value and fuel cost per month provides an additional insight into best and worst performing months
• Each month looks pretty good
• But, let's look at other costs…. 

• Given fuel is on average 38% of total costs, catch value must be 62% greater than fuel costs to break even each month
• Profits from other months must therefore subsidize profitability in Aug
Stage 2

Input Energy
- Diesel (98%)
- LPG (2%)

Cook seafood products (1.9%)
- Domestic hot water (0.1%)
- Heat (2%)

IC engines (88%)
- Propulsion (68.6%)
- Trawl winches (4.7%)
- Steaming (0.2%)
- AC/DC (24.5%)
- Hydraulics (4.9%)

Stage 3 - Modifications to reduce fuel and payback periods

- In this example:
  - Reduce service speed most effective in reducing consumption and with quickest payback period
  - Reducing the operational profile of the hull also has a rapid payback period

- A formal audit should be able to provide similar information irrespective of the fishing operation

- At this stage of the audit a fisherman should be in an excellent position to make informed decisions about energy use and conservation in his fishing business
Part 2: Fuel efficiency

What determines the cost of diesel?

What We Pay For In A Gallon Of Diesel (January 2011)
Retail Price: $3.39/gallon

- Crude Oil: 61%
- Refining: 15%
- Distribution & Marketing: 10%
- Taxes: 14%
History of diesel fuel costs

Future projections

From the U.S. Energy Information Administration
Main causes of fuel inefficiency

- Vessel operations
  - Working against tide
  - Traveling too fast (high rpms)
- Vessel maintenance
  - Hulls & engines
- Hull designs
  - Wider is not better (L:W)
- Propellers
  - Type
  - Pitch
  - Maintenance

What can I do to save fuel?

- Focus on short term
- What is practical?
- What is affordable?
- What is measurable?
- What will give the best rate of return?
What can I do to save fuel?

Fuel Meters

• What do they do?
• What information can you get from them?
• What kinds are available?
• What do they cost and what are installation costs?

What do they do?
• Fuel flow or consumption meters allow a vessel operator to;
  – Monitor fuel
  – Ration fuel consumption
  – Monitor real-time fuel consumption;
  – Test engine fuel consumption
What can I do to save fuel?

Fuel Meters

What kinds are available?
• Float and gauge
  – Indicates fuel remaining in tank
  – Poor accuracy
  – Relatively inexpensive usually part of a standard electronics array
• Fuel flow/consumption meters and management systems
  – show exactly how much fuel you’ve used, and how fast you’re using it at your engine.
  – receive immediate and accurate data
  – More expensive than float and gauge $300 - $3,000.00

What can I do to save fuel?

Fuel Meters

Types of fuel flow or consumption meters?
• Fuel flow
  – Provides real-time fuel consumption and fuel usage rates as well as vessel rpm’s.
  – Lower cost alternative to fuel management system
• Electronic fuel management system
  – Monitors fuel use and records data for long-term usage and evaluation statistics.
  – More costly to purchase and install.
What can I do to save fuel?

Change Operator Behavior

• Use a fuel consumption meter or management system to;
  – Understand the benefit of reducing RPM’s to minimize fuel consumption when steaming to fishing grounds and returning to shore.
  – Make better overall operation decisions to maintain and enhance fuel efficiency.

(10% reduction in RPM’s from full throttle can reduce fuel consumption by 20%)

What can I do to save fuel?

Maintenance

• Hull Fouling – significantly increases vessels drag and fuel consumption by up to 24%
• Propeller Fouling – a fouled propeller can increase fuel consumption by 14%
What can I do to save fuel?

**Maintenance**

**Recommendations**

- Annual hull and propeller cleaning
- Anti-fouling paint on hull (smoother the less drag)

---

What can I do to save fuel?

**Engine Maintenance**

- Do you have a regular engine maintenance schedule?
  - fuel filters
  - oil changes
- How regularly are your engine stacks cleaned?
What can I do to save fuel?

**Propellers**

**Key element – diameter and pitch**

- Wider diameter can improve fuel economy
- Studies demonstrated 30% reduction in fuel consumption at cruising speed, and a 27 percent increase in bollard pull (maximum towing force) with a larger diameter propeller.

---

What can I do to save fuel?

**Propellers**

**How Diameter and Pitch Affect Performance**

- Propeller diameter increases with the size of the vessel
  - Larger vessel → larger diameter
    - Producing more power or propulsive force
- Pitch
  - Check to see that you have the right pitch for your boat and the way you use your boat.
    - A vessel that stops and starts may benefit from having a lower pitch. A vessel that operates more continuously may benefit having a higher pitch.
What can I do to save fuel?

Propellers

How to Pick the Right Replacement Prop

1. Find the recommended prop diameter. This should be included in your owner's manual. It is also usually stamped near the original prop's shaft hole (if you are replacing an older prop).
2. There are two numbers. The first is the recommended diameter (in inches). The second is pitch (how far the boat travels with each revolution).
3. Use a measuring tape to measure the distance from the edge of one blade to the center of the shaft hole. This will give you the prop's radius.

4. Multiply this number by (2) to obtain the prop's diameter. Match this to your manufacturer's recommendations to ensure your new prop is a perfect fit.

5. Check the pitch of your new prop. This is stamped either on the package or near the shaft hole. Match this to your manufacturer's recommendations.
Bulbous Bows – *How do they Work?*

The vessel hull pushes water aside as the vessel moves through the water
- This creates a "bow wave"

- **Bow Waves**
  - Produce drag on the vessel causing the engine to work harder (i.e. burn more fuel) to move through the water

---

Bulbous Bows – *How do they Work?*

- **Hull Speed**
  - The length of the bow wave matches the length of the vessel hull
  - Therefore, the boat operates in the trough of the wave
Bulbous Bows – *How do they Work?*

- Bulbous Bow
  - Creates its own wave
  - Farther forward “out of phase” with the natural bow wave
  - Reduce or cancel a portion of the bow wave resulting in reduced drag on the vessel
What can I do to save fuel?

**Bulbous Bows**

- Effective at reducing resistance at cruising speeds 6 – 10 knots
- Improved fuel efficiency & reduction in pitch motion
- Bulbs need to be tailored to boat hull characteristics
- Est. cost is $120-140,000 (ouch! Probably not feasible)
- Estimated savings of 15% on annual fuel bill because of improved efficiency at cruising speed

What can I do to save fuel?

**What Can You Do In the Short-term?**

- Install a Fuel Meter
- Pull Back on Throttle
- Plan your routes
- Regular Hull Maintenance
- Regular Engine Maintenance
- Propeller
  - Check size / type / condition / pitch
  - Replace or repair?

(= Est. Fuel Savings 20% + Improved Vessel Performance)
**What can I do to save fuel?**

**What Can You Do In the Longer-term?**

- New vessel construction
- Designed for energy efficiency & performance

---

**Part 3: Other ways to increase operational efficiency...**

**Trap Saturation**

- So you have 800 traps, do you need them all, or should you be using more?
- How to evaluate trap efficiency and identify if trap saturation is occurring
What happens when you increase the number of traps?

- **Trap efficiency** (Lobsters per trap): Low → High as # of traps increases.
- **Fuel costs**: Low → High as # of traps increases.

What can happen when you use fewer traps?

- **Bait costs**: Low → High as # of traps decreases.
- **Labor costs**: Low → High as # of traps decreases.
What can happen when you use fewer traps?

Net profits vs. number of traps:

- Low number of traps: Low net profits
- High number of traps: Low net profits
- Optimal number of traps: High net profits

Are you here? Or here?
What can I do to save fuel?

Improve Trap Efficiency (example)

• Monhegan Island example

Case Study: Monhegan Island

• Monhegan Island Conservation Area (MILCA)
  – Seasonal winter fishery since 1907
    • Remains as the only area closed to fishing during summer and fall
  – Was officially recognized as a conservation area in 1998
    • Limited to 17 lobstermen
    • 95 km² immediately surrounding Monhegan Island, ME.
Case Study: Monhegan Island

• Lobstermen wanted to expand their seasonal fishery
  – From 6 month fishery (December – May)
• Worked with Maine Department of Marine Resources
  – To look at the effect of trap density on trap efficiency (# lobsters/trap)
  • Could they as a fishing community fish fewer traps more efficiently?

How does trap density relate to lobster catch?

• Set traps at varying densities
  – Low (50/km2)
  – Medium (167/km2)
  – High (500/km2)
• Soak time
  – Set at 4 days
• Recorded
  – Total catch, catch per haul and catch/trap
How does trap density relate to lobster catch?

Higher trap densities
  – Always had Lower catch rates

Medium trap densities
  – Total catch was essentially the same as for high density

Trap Hauls
  – Medium trap densities most efficient

Conclusions

Monhegan Island Conservation Area (MILCA)
  • Season extended from 6 to 8 months (October – May)
  • Trap limits were reduced from 600 to 300 trap per fishermen
  • Bait costs were reduced
  • Fuel costs were reduced
  • Higher catch per trap rates compared to previous seasons
So, how can you use this information?

• Consider your situation
  – What do you know about lobster behavior and trap efficiency in your area?
  – How do you think the optimal trap number changes during the season?
  – What are your neighbors doing?

• Consider your options
  – Where do you think you are with respect to your optimal trap number?

• Use trial and error

---

GPS, Navigation & Mapping

Getting the most from your technology
Shane Bradt  
Extension Specialist in Geospatial Technologies

**focus:** assessing GIS and GPS technology and developing educational materials for a wide variety of applications

**web:** http://gisworkshops.org  
**twitter:** http://www.twitter.com/gisworkshops  
**facebook:** http://facebook.com/gisworkshops

**email:** sbradt@ceunh.unh.edu  
**phone:** 603-862-4277

**address:** UNH Nesmith Hall 224  
131 Main Street  
Durham, NH 03824

---

**GPS Basics**

- developed by the US Dept. of Defense
- satellite-based
- designed to provide positioning and timing information:
  - 24 hours/day, 7 days/week
  - under any weather conditions
  - anywhere in the world
GPS Basics

- 24 satellites in constellation
- transmit a uniquely coded radio signal
- equipped with onboard atomic clock

How does GPS work?

1. the receiver picks up the signals from the satellites
2. uses signal travel time to calculate distance to the satellites
3. triangulates to determine position of the receiver
How does GPS work?

1. The receiver picks up the signals from the satellites

2. Travel time of signal from satellite used to calculate distance

3. Receiver triangulates to determine position of the receiver
3. Receiver triangulates to determine position of the receiver

How does GPS work?
How does GPS work?

3. Receiver triangulates to determine position of the receiver

You are here!
1. Geodetic
   High quality surveying of fixed positions

2. Mapping
   Collection of GPS data with large amounts of auxiliary data and strict data quality control

3. Handheld
   Collection of GPS data with good data quality for more limited budgets

How accurate is GPS?

**Contributions of Error**

- Satellite constellation: 3 m
- Weather:
  - Atmosphere: 3 m
  - Weather: 1 m
- Receiver noise: 1 m

**Total Error**: 8 m
How to increase GPS accuracy?

**Differential Correction**

- **base stations** measure inaccuracies and send out correction signal
- **8-9m**: typical handheld GPS accuracy **without corrections**
- **3m**: typical handheld GPS accuracy **with corrections**
- **WAAS**: Most common handheld correction

---

**GPS vs. LORAN**

<table>
<thead>
<tr>
<th>GPS</th>
<th>LORAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on satellite derived system available worldwide</td>
<td>Based on radio signals near continental US (+more)</td>
</tr>
<tr>
<td>Abs. accuracy 3-15 m</td>
<td>Abs. accuracy 150-450 m</td>
</tr>
<tr>
<td>Rep. accuracy 3-15 m</td>
<td>Rep. accuracy 20-100 m</td>
</tr>
<tr>
<td>Easily converted to other mapping systems</td>
<td>Difficult to convert to other mapping systems</td>
</tr>
<tr>
<td>Poor resistance to jamming</td>
<td>Good resistance to jamming</td>
</tr>
<tr>
<td>No lightning interference</td>
<td>Lightning interference</td>
</tr>
<tr>
<td>Ensured future availability</td>
<td>Future availability uncertain</td>
</tr>
</tbody>
</table>
Transiting with GPS

Using Waypoints

Go to waypoint “A”
Go to waypoint “B”
Go to waypoint “C”
Go to waypoint “D”
Go to waypoint “E”
Go to waypoint “F”
Transiting with GPS

Using Waypoints: Routes

Make route "X" using the following points in this order: A, B, C, D, E, F

Navigate route “X” from A to F

Transiting with GPS

Using Tracks

Navigate track
How to navigate with GPS

Point-to-Point

Route

Track

Common uses of GPS in fisheries

**Navigation**
Using waypoints or tracks to move to fishing locations

**Documentation**
Tracking of fishing effort (trap locations and transiting)

**Enforcement**
Vessel Monitoring System (VMS) for NOAA Fisheries -NMFS

**Safety/Rescue**
Emergency Position Indicating Radio Beacon (EPIRB)

What can we do with this?
What can GIS show?

GIS is used throughout NOAA Fisheries in every regional office, science center and lab and across every program.

- Habitat Protection, Conservation and Restoration
- Stock Assessment
- Fishery Management (fishing effort)
- Protected Resource Management
- Socioeconomic Analysis
- Ecosystem Dynamics

Habitat Protection, Conservation and Restoration

Habitat Areas of Concern

Restoration Center Project Mapper
monthly otter trawl and gillnet fishing effort for seven major groundfish species over a six-month period

Get the most from your existing equipment: Combining GPS with GIS
Combining GPS with GIS
Combining GPS with GIS

Shane Bradt
Extension Specialist in Geospatial Technologies

Thank You!

web: http://gisworkshops.org
twitter: http://www.twitter.com/gisworkshops
facebook: http://facebook.com/gisworkshops
e-mail: sbradt@ceunh.unh.edu
phone: 603-862-4277
Thank you!!