Fishers Island Ferry District

Fleet Assessment

July 2023

Elliott Bay Design Group
Architectural & Engineering Services for the Marine Industry

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Attachments

Cover Photo by Jane Ahrens

1 EXECUTIVE SUMMARY

A Fleet Assessment was conducted for Fishers Island Ferry District (FIFD) to develop and evaluate potential future fleet scenarios for their ferry service between Fishers Island, NY and New London, CT. The Fleet Assessment reviewed current vessels, terminals, and operating schedule to inform recommendations for future fleet and conceptual vessel arrangements.

The Fleet Assessment resulted in the following recommendations for the FIFD fleet over the 30-year planning horizon:

- Re-power the SILVER EEL
- Replace the MUNNATAWKET with a double-ended vessel
- Retain the RACE POINT

This fleet composition is anticipated to provide the greatest flexibility and resilience to the Fishers Island community.

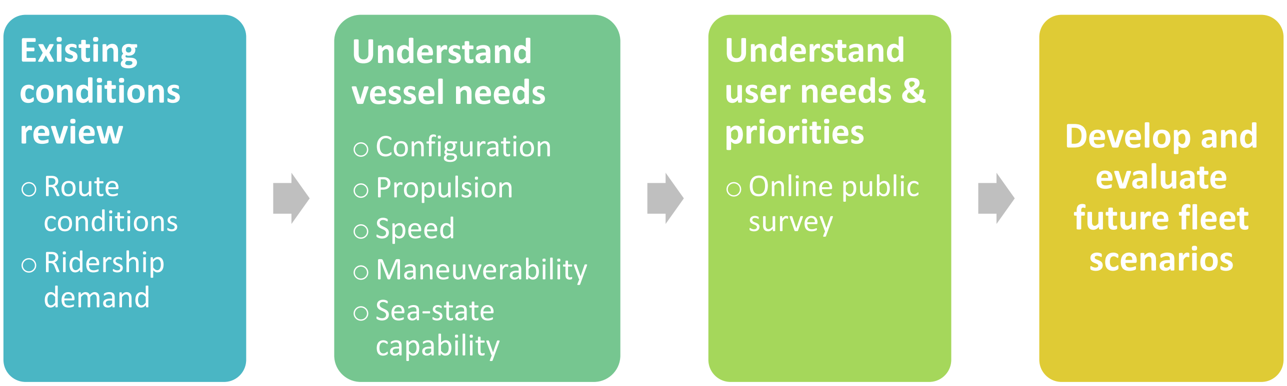
2 INTRODUCTION

The Fleet Assessment was conducted with the goal of evaluating the current FIFD fleet composition and vessels, terminals, and operating schedule to begin the planning process for future vessel replacement. While the current vessels have served FIFD well, there are areas such as vehicle loading, passenger comfort, and disability access where improvements can be made.

Fleet Assessment was informed by a site visit to review existing conditions, evaluation of operating needs and vessel alternatives, and an online public survey to gather feedback from ferry users.

The process used to conduct the Fleet Assessment and develop recommendations is summarized below:

Figure 1: Fleet Assessment Process



3 FIFD OVERVIEW

ROUTE - The Fishers Island Ferry serves Fishers Island from the mainland terminal of New London, CT, carrying passengers, vehicles, and cargo. Figure 2 shows a map of the route along with a summary of route characteristics.

Figure 2: Operating Route between New London, CT, and Fishers Island, NY

TERMINALS – The Fishers Island Ferry serves two terminals, one in New London and one on Fishers Island. Terminal characteristics are summarized below—additional detail is included in Attachment 2 Operations Model.

The New London Terminal is located on the Thames River, a short river and tidal estuary in Connecticut. The terminal is generally sheltered and offers a relatively wide turning area with few operational restrictions. The New London terminal includes two operating berths, which also provide overnight moorage for the two vehicle ferries. The ferry terminal is located adjacent to the New London Union Station, providing connections to regional train and bus service.

The Silver Eel Cove Terminal is the ferry's access on Fishers Island. During summer months, traffic from private vessels may interfere with maneuvering, otherwise maneuvering in the cove is relatively unobstructed. The SILVER EEL ties up overnight at the New London City Pier, adjacent to the New London terminal.

VESSELS - FIFD currently operates two single-ended vehicle ferries year round. Additionally, FIFD operates a passenger-only fast ferry during the summer months. The vessel characteristics of the current fleet are summarized below in Figure 3.

Figure 3: Fishers Island Ferry Fleet

MV MUNNATAWKET
- Year Built: 1977 (repowered 2019)
- Length: 132 feet
- Speed: 10 knots
- Passengers: 209
- Vehicles: 24

MV RACE POINT
- Year Built: 1985 (repowered 2021)
- Length: 162 feet
- Speed: 11 knots
- Passengers: 246
- Vehicles: 34

MV SILVER EEL
- Year Built: 2017
- Length: 38 feet
- Speed: 31 knots
- Passengers: 18

SERVICE LEVELS - The route between Fishers Island, NY and New London, CT is approximately 6.5 nautical miles. The route currently operates year-round, with up to 7 round trips daily in the summer and 5 in the winter. The first trip daily is reserved for supplies and workers leaving from New London, CT to Fishers Island, NY. Hazardous goods are transported on Wednesdays, leaving New London at 10 a.m. and returning on the 2 p.m. sailing.

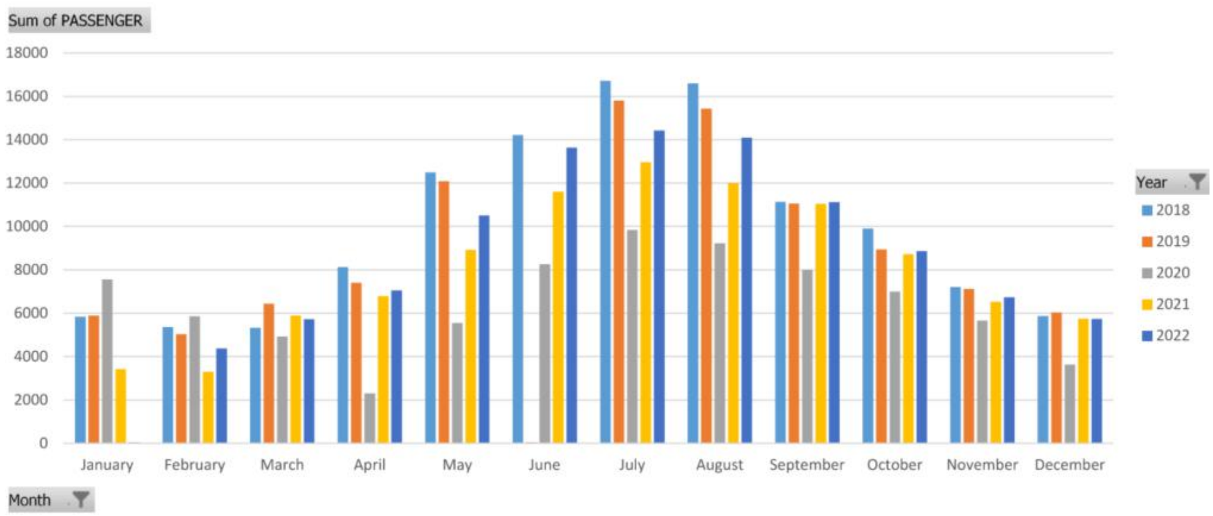
Summer: There is a minimum of four daily round-trip sailings during the Summer Peak Schedule. Four additional sailings on Friday afternoon and three on Sunday are scheduled to accommodate weekend visitors.

Winter: During the Winter Season, per the 2018 Schedule, there are four daily round-trip sailings with five round-trip sailings on Friday and Sunday. Severe weather patterns during the winter months are more likely to cause cancelled sailings or foul weather routing than during other parts of the year.

SYSTEM DEMAND AND CAPACITY – Seasonal Demand Fishers Island has approximately 250 year-round residents, and between 2,500 and 3,500 residents during the summer months (May through August). During the school year, 28 children travel by ferry to school on the island. Island businesses rely on FIFD to regularly transport employees, supplies, and mail.

FIFD transports approximately 100,000 to 120,000 passengers and 36,000 vehicles annually. There is significant seasonal variability for both vessel and passenger demand. During peak summer months, (May – August) FIFD transports approximately 14,000 passengers per month. The baseline ridership for the rest of the year (November – March) is roughly 5,500 passengers per month. Figure 4 shows the monthly passenger ridership for 2018 through 2022, demonstrating the increase during summer months.

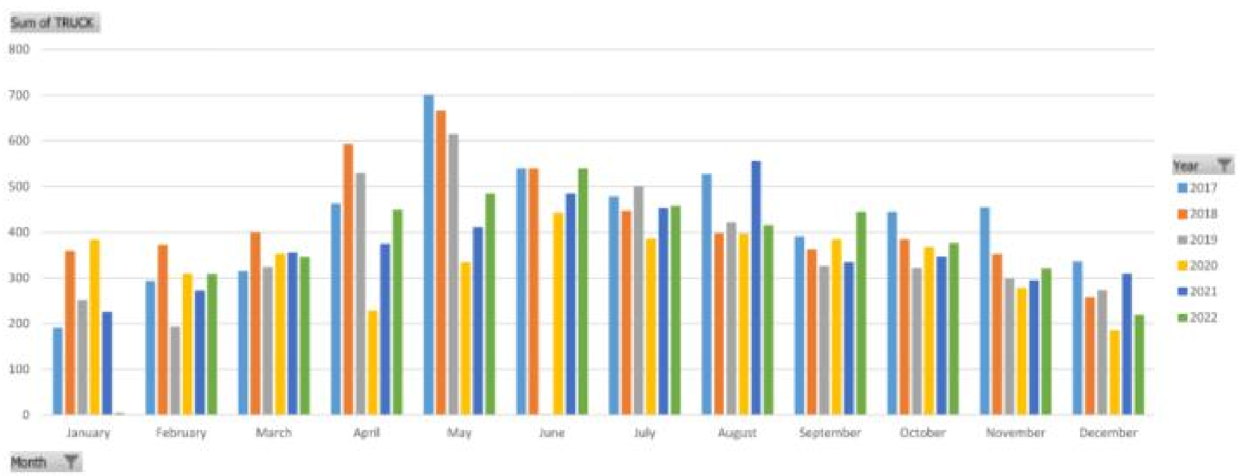
Figure 4: Annual Passenger Demand Trends



Like passenger demand, vehicle demand varies from winter to peak summer service. During the winter, FIFD transports roughly 1,480 cars per month versus 3,850 vehicles per month in the summer (May – August). In 2019, FIFD provided over 36,600 one-way vehicle trips.

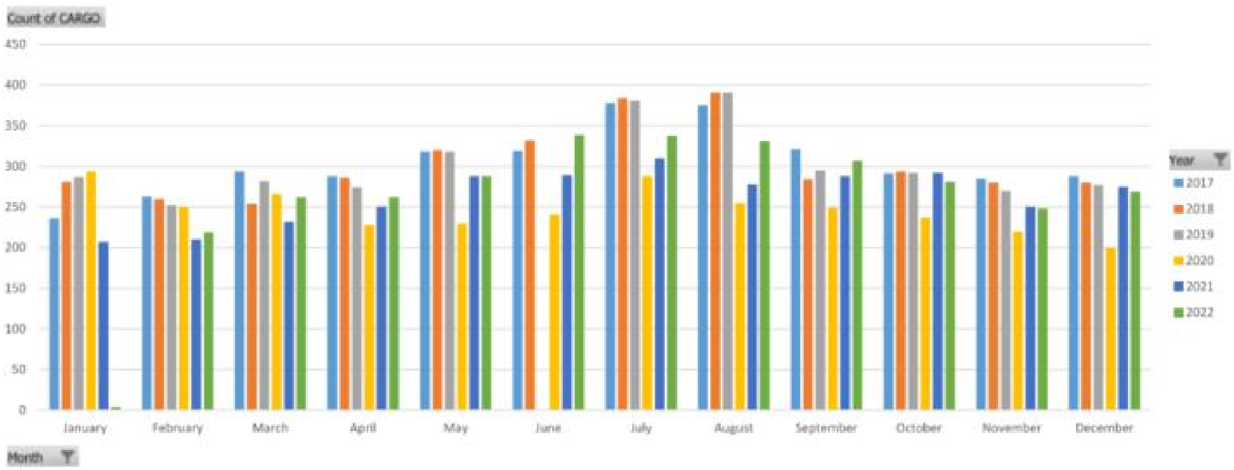
Unlike passenger and vehicle demand, commercial traffic (truck and cargo) is relatively consistent throughout the year, as shown in Figures 5 and 6. Truck traffic increases by roughly 60% from winter to summer, 330 per month in the winter to 520 per month during summer peak.

Figure 5: Annual Truck Demand Trends



Cargo volume transported by FIFD is the most seasonally consistent of all user categories, with data indicating 260 units/month in the winter and 340 units/month during peak season.

Figure 6: Annual Cargo Demand Trends



Most ridership during the winter season is characterized by year-round residents traveling to and from the mainland, with little variation between levels of demand per day of the week. Truck and cargo traffic during the winter is concentrated heavily during the weekdays, with only the occasional weekend trip.

Daily demand in the summer is characterized by year-round passengers, in addition to seasonal island residents and visitors. Average passenger demand per sailing during summer peak is almost double winter demand, with the highest passenger volume on Thursdays. Vehicle ridership correlates strongly with passenger trends.

Truck traffic and cargo increases during the summer to accommodate increased seasonal visitors and tends to occur during the weekdays when regular vehicle demand is lower.

4 COMPARISON TO PEER FERRY OPERATORS

To provide context for fleet assessment and planning, FIFD operations were benchmarked against similar ferry operators. Ferry services selected for comparison provide both vehicle and passenger service and serve coastal islands of similar populations; however, direct equivalency is challenging due to the differences in funding, ridership, and operating profiles.

Ferry operators used for the purposes of comparison are located in the maps shown in Figure 7 and Figure 8, and include the following:

1. Casco Bay Lines – ME
2. Maine State Ferry Service – ME
3. Pierce County Ferry – WA
4. Skagit County Ferry – WA

A comparison of service and fleet characteristics, annual ridership, expenses and revenue by category, and recent grant funding awarded for capital projects is included in Attachment 5.

Compared to the other four operators, FIFD recovers the highest portion of operating costs from fares and other ferry revenue. Comparison also highlights the grant funding opportunities used in recent years by operators to fund vessel and terminal projects.

Figure 7: Maine Peer Ferry Operators

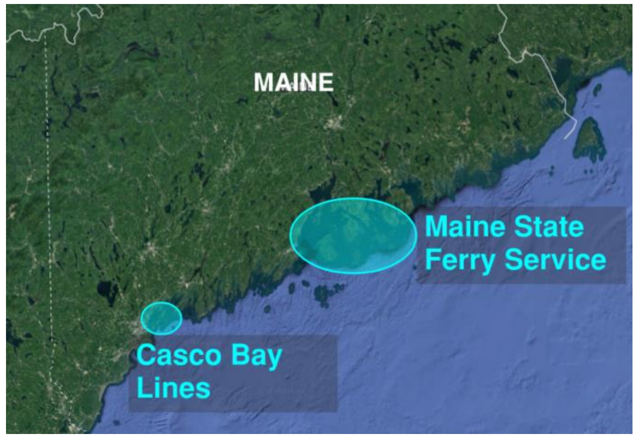


Figure 8: Washington Peer Ferry Operators

5 NEEDS ASSESSMENT

5.1 PUBLIC SURVEY FINDINGS SUMMARY

FIFD conducted a public survey to gauge the ferry transportation needs and priorities for future vessel planning according to Fishers Island residents and ferry users. The survey was available online between May 12 and June 5, 2023. The survey was publicized on the FIFD website, included in updates to riders, and posted on vessels. The survey received 529 total responses, from user groups as broken out in Table 1 *(note that respondents were able to select more than one user group)*.

Table 1: Survey Respondents by Category

USER GROUPS	PERCENT OF TOTAL RESPONSES	NUMBER OF RESPONSES
Year-round Fishers Island resident	24.8%	130
Seasonal Fishers Island resident	59.5%	312
Visitor (recreational)	8.0%	42
Fishers Island School (student, family, or staff)	3.6%	19
Commercial commuter	3.6%	19
Commercial freight user	2.9%	15
Other (please specify)	4.4%	23

Respondents were asked to provide feedback related to the current FIFD fleet, vessels, and service schedules, as well as priorities for future improvements. In general, responses from year-round island residents were roughly similar to those from all other users; however, year-round residents indicated less interest in fast ferry service and more interest in increased auto ferry service. Additionally, year-round island residents indicated more frequent experiences of missing their desired sailing due to full reservations or full sailings when waiting in standby. Key findings are summarized below, and full survey responses are included in Attachment 6.

Fleet Mix

When asked if they would prefer more auto ferry service, more passenger ferry service, or no change to the current mix of service, responses were nearly evenly split (Figure 9). When looking at responses from year-round Fishers Island residents only (Figure 10), respondents were more likely to be interested in increased auto ferry service rather than fast ferry service.

Figure 9: Fleet Mix Responses (Question 31)
All Responses

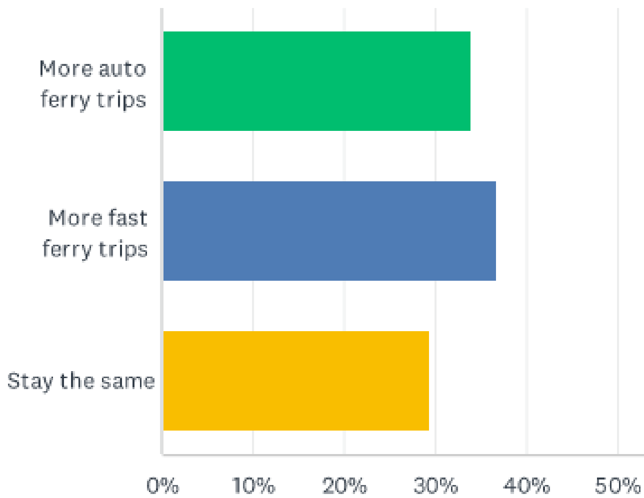
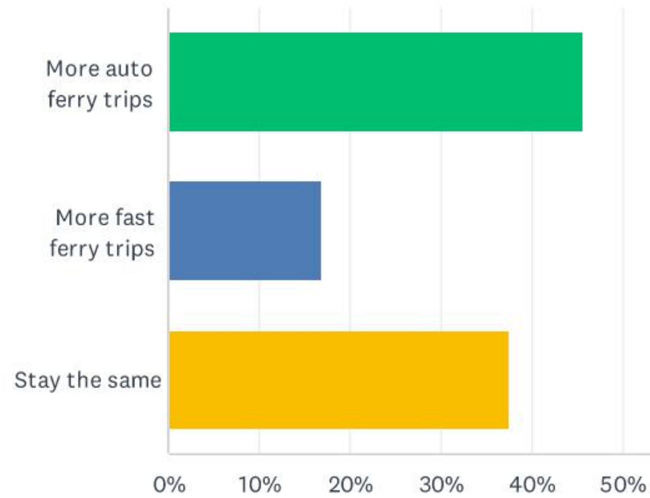


Figure 10: Fleet Mix Responses (Question 31)
Island Residents Only



Future Auto Ferry

Respondents were asked to prioritize nine different vessel characteristics for future auto ferry service. The top three priorities, listed in order, include:

1. Faster crossing time
2. Minimize operating costs
3. More frequent service

Future Passenger Ferry

Slightly more than half of all respondents indicated that the Silver Eel meets the needs of seasonal fast ferry service. When asked to prioritize eight different vessel characteristics for future fast ferry service, respondents indicated the top three priorities listed in order below:

1. More frequent service
2. Faster crossing time
3. Minimize operating costs

Priorities for Future Ferry Service

Survey respondents indicated their top two biggest challenges with current FIFD ferry service as follows:

- **Inconvenient sailing times** (23.0% of respondents)
- **Too few sailings** (21.8% of respondents)

Participants were asked to provide up to two preferred arrival times for each route segment.

- The top three preferred arrival windows in Fisher Island are **9-11 a.m.**, **11–1 p.m.** and **7-9 p.m.** The current schedule does have arrival times in two of the three preferred arrival windows.
- The top two preferred arrival windows in New London are **8-9 a.m.**, **9-11 a.m.**, and **4-5 p.m.**; The current schedule only matches one of the preferred arrival windows.

Figure 11 compares scheduled 2023 peak season arrival times[1] to the preferred peak season arrival windows indicated in survey responses, with the top three choices highlighted.

Figure 11: Current vs Preferred Ferry Schedule Peak Season (Monday through Friday)

	Arrive Fisher Island		**Arrive New London**	
	2023 Peak Schedule	*Preferred time from survey*	*2023 Peak Schedule*	*Preferred time from survey*
5-6 am		3.63%		7.10%
6-7 am		8.10%		12.22%
7-8 am	7:45	17.04%		18.47%
8-9 am		13.41%	9:00	22.44%
9-11 am	10:45	20.67%		19.03%
11 am -1 pm		19.83%	12:00	17.33%
1-3 pm	1:15 2:45	15.08%	2:30	14.20%
3-4 pm		13.13%	4:00	16.48%
4-5 pm	4:15	11.73%		20.17%
5-6 pm	5:45	12.57%		13.92%
6-7 pm		15.92%	7:00	10.51%
7-9 pm	7:15	21.79%	8:15	11.93%
(Th/Fr only)	9:15	N/A	10:15	N/A

Figure Notes:
1 Scheduled arrival times assume a 45 minute sailing time

In open-ended write in responses, many ferry users indicated the need for an expanded service schedule, especially for earlier arrivals in New London. Respondents also commented on the challenges of the ferry arrival times not coordinating with connecting trains.

[1] Peak 2023 Ferry Schedule. https://www.fiferry.com/schedules/. Accessed 13 June 2023

6 FLEET AND VESSEL DESIGN ASSESSMENT AND FINDINGS

Based on findings from review of existing conditions, the project team developed a computer model of the FIFD operation covering three seasons: Summer, Winter, and Shoulder. This model was used to evaluate potential fleet scenarios for considerations such as changes in load/unload times, vessel operational speed, seasonal schedules, and implementation plans. Outputs from the model included notional service schedules by season and both capital and operating cost estimates over a 20-year horizon.

Using information from the operating model, the project team evaluated the potential benefits and cost considerations for vessel design alternatives, including vessel configuration (single-ended or double-ended) and propulsion types. The evaluation was based on operational considerations for the Fishers Island Ferry System to support selection of a vessel configuration best suited for their operation as they consider future vessel replacement.

6.1 VESSEL CONFIGURATION

Fleet Assessment evaluated use of a double-ended vessel in place of the current single-ended vessels used by FIFD. It was found that a single-ended vessel requires a higher transit speed to maintain schedule than a double-ended vessel, due to the added time required for vessel maneuvering when arriving at the dock, and the longer dwell time required for vehicle loading and unloading as drivers back their vehicles onto the vessel.

Key findings from comparison of vessel configuration options are summarized below. Detailed evaluation approach, assumptions and findings are included in Attachment 2.

- A double-ended vessel would eliminate the need for drivers to back their vehicles onto the vessel, significantly reducing loading time.
  - Because of the reduced loading/unloading time, a double-ended vessel can maintain the current sailing schedule sailing at 6.6 knots rather than 8.7 knots. This allows greater operational flexibility to accommodate unexpected delays or save fuel.
  - Alternatively, the shorter trip time offered by a double-ended vessel could allow for one additional round-trip sailing to the daily peak season schedule.
- For this analysis, it is assumed that a new vehicle ferry would have similar capacities to the RACE POINT. However, a double-ended vessel would not have the same positioning restrictions for trucks as the current single-ended vessel.
- A single-ended vessel is most similar to the existing FIFD fleet and is known to perform well in wind and wave conditions.

Table 2 provides a summary of the comparison of the two vessel types, with check marks indicating which option was found to be advantageous under each point of comparison.

Table 2: Vessel Configuration Comparison

	Single-Ended (CURRENT VESSELS)		Double-Ended	
Maneuvering requirements	Turns and backs into terminal		Sails directly in and out of terminal without turning	✓
Estimated time for arrival maneuvering, unloading, loading and departure	33.5 minutes		18.5 minutes	✓
Required transit speed to maintain current schedule	8.7 knots		6.6 knots	✓
Potential daily round trips	5		6	✓
Suitability for wind and wave conditions	More suitable	✓	Less suitable	
Familiarity for crew	Current arrangement	✓	Would require training	
Estimated capital cost	$16M	✓	$16.75M	

6.2 ALTERNATIVE PROPULSION OPTIONS

A detailed evaluation of alternative propulsion options was conducted and is included in Attachment 3. This analysis considered four different propulsion systems for the next ferry for FIFD—one traditional diesel-mechanical system (similar to the existing ferries), two hybrid systems (one diesel-mechanical and one diesel-electric), and one alternative fuel system:

1. Diesel Mechanical – Propulsion system currently in use by the FIFD fleet.
2. Diesel Mechanical Hybrid with Energy Storage System (ESS) – On-board batteries are charged with excess power from the diesel engines, to provide power for hotel loads or propulsion.
3. Diesel Electric Hybrid with ESS and Shore Power (SP) – On-board batteries are fully charged while loading and unloading at the New London Terminal with enough power to supply hotel, auxiliary, and maneuvering loads, with some power provided during transit from a diesel generator.
4. Methanol Fueled – Assumes use of methanol engine instead of diesel mechanical.

The study examined these propulsion options in terms of capital cost, operating/fuel costs, and emissions. The study includes a sensitivity analysis of key cost factors, including fuel price and battery energy storage system (ESS) cost. The operating costs included below are intended to provide a relative comparison of the annual propulsion system costs based on the existing vessel operating profile, and do not reflect comprehensive vessel operating costs.

Table 3 provides a summary of the comparison of the four propulsion options. Detailed evaluation approach, assumptions and findings are included in Attachment 3.

Table 3: Vessel Configuration Comparison

	Diesel Mechanical (CURRENT VESSELS)	Diesel Mechanical Hybrid with ESS	Diesel Electric Hybrid with ESS & SP[1]	Methanol
Capital Costs	$12.8M	$13.9M	$14.0M	$13.3M
Estimated Annual Fuel Cost	$120,000	$133,000	$110,000 (fuel) $56,000-101,000 (electricity)	$168,000
Estimated Annual Maintenance	$61,000	$29,000	$33,000	$61,000
CO_2 emissions *(compared to baseline)*	100%	110%	92%	62%
Key Findings	**PREFERRED** **Opportunities** • Best match with the equipment installed on the RACE POINT • Simple system, least expensive to purchase and install **Challenges** • Limited opportunity for installation of batteries in the future • No environmental benefits	**Opportunities** • Known, diesel system with potential for future repower **Challenges** • Complex system with minimal environmental and operational benefits • Slightly higher fuel consumption	**PREFERRED*** *(if emissions reductions are priority)* **Opportunities** • Emissions reductions • Reduced maintenance costs • Access to additional grant opportunities **Challenges** • Requires installation of shore charging system • Higher operating costs for fuel and electricity • Complex system	**Opportunities** • Highest potential emissions savings **Challenges** • Not currently available in the U.S. • Complex system

[1] *Shore power vessel costs do not include capital costs for shore power infrastructure.*

6.3 FLEET PLANNING SCENARIO COMPARISON

The Fleet Assessment reviewed two vessel replacement scenarios to understand their impact on the transportation services provided to the Fishers Island community. For replacement of the vehicle ferries it is assumed they will be replaced with a double-ended vehicle ferry with similar passenger and vehicle capacities to the RACE POINT.

1. Replace the MUNNATAWKET at the end of its useful service life in 2028 with a new double-ended ferry. Repower the SILVER EEL to continue its current level of service
2. Replace the MUNNATAWKET slightly after the end of its useful service life in 2030 with a new double-ended ferry, replace the RACE POINT in 2031 with a new double-ended ferry. Retire the SILVER EEL without replacement.

A comparison of the two fleet scenarios is presented in Table 4, with full assessment presented in Attachment 4.

Table 4: Fleet Scenario Comparison

	CURRENT FLEET	SCENARIO 1	SCENARIO 2
Vehicle Ferry #1	RACE POINT	Retain	Replace with new double-ended ferry
Vehicle Ferry #2	MUNNATAWKET	Replace with new double-ended ferry	Replace with new double-ended ferry
Passenger Ferry	SILVER EEL	Repower SILVER EEL	Retire SILVER EEL
Total Estimated Capital Costs[1]		$16.9M	$33.5M
Key Findings		RECOMMENDED **Opportunities** • Increased passenger, vehicle, and truck capacity • By keeping the RACE POINT in service, FIFD would retain a known asset with proven rough weather performance. **Challenges** • Inefficiencies of having three different vessel types	**Opportunities** • Optimal scheduling and operational efficiency • Cost efficiencies when soliciting shipyard bids **Challenges** • Likely decreased service reliability during rough weather • No Fast Ferry service option

[1]Estimated capital costs for vessel construction only, not inclusive of costs for design, bid and construction support, and warranty

Based on comparison of the two scenarios, Scenario 1 is recommended based on its ability to provide the greatest flexibility and resilience to the Fishers Island community. The increased operational cadence with the double-ended ferry will be more capable during single-vessel operations than the RACE POINT. Until the double-ended ferry has proven itself during a winter season, the RACE POINT will provide the robust service it is known for.

6.4 VESSEL REPLACEMENT FUNDING OPPORTUNITIES

A number of federal and state grant programs are available to support new vessel construction and repowering of existing vessels. The highest yield grants are likely to be competitively awarded and may involve several year lead times for application development review and award.

In recent years, increased grant funding aimed at reducing carbon emissions has been made available to ferry operators to support planning or construction of electric or hybrid vessels or those using alternative fuels. Additionally, emissions reductions benefits may be used as a scoring criteria for other grants. Many of these grants can also be used to support design and construction of shoreside charging infrastructure. A list of potential federal grant opportunities is included in Table 5.

Table 5: Potential Grant Funding Opportunities

Funding Source / Grant Program	Eligibility	Allowable Expenditure
FHWA / Construction of Ferry Boat and Ferry Terminal Facilities Program	Ferry Services included in biennial National Census of Ferry Operators	Capital costs related to the purchase, lease, or construction of new ferries and ferry facilities, and/or construction and preventive maintenance activities for existing ferries and facilities
FHWA / Congestion Mitigation and Air Quality (CMAQ) Program	Transportation projects that demonstrate emissions reductions and are located in or benefit a U.S. Environmental Protection Agency-designated nonattainment or maintenance area	Transportation projects and programs that serve to reduce traffic congestion and improve air quality.
USDOT / Rebuilding America Infrastructure with Sustainability and Equity (RAISE) Discretionary Grants	State or local governmental agency with a transportation function	Planning and construction of surface transportation projects with significant local or regional impact including ferry vessels and terminals
FTA / Section 5307, Urbanized Area Formula Grant Program	Designated small and large urbanized areas	Capital projects
FTA / Passenger Ferry Grant Program – Section 5307	Direct recipients of Section 5307 funds, States and federally recognized Tribes that operate a public ferry system in an urbanized area	Capital expansion replacement, or rehabilitation of ferries, terminals, and related infrastructure; related equipment providing passenger ferry service
FTA / Electric or Low-Emitting Ferry Pilot Program	Direct recipients of Section 5307 or Section 5311 funds	Capital projects that include the purchase of electric or low-emitting ferry vessels that reduce emissions

7 RECOMMENDATIONS

The Fleet Assessment considered the current vessels and operating needs of the FIFD ferry service. Considering the recent repower of the RACE POINT, the resulting recommendation is to re-power the SILVER EEL and replace the MUNNATAWKET with a double-ended ferry while retaining the RACE POINT. This fleet composition is anticipated to provide the greatest flexibility and resilience to the Fishers Island community.

Based on public feedback received from the online survey which indicated interest in adjusted or additional sailing times, it is recommended that a detailed schedule assessment be conducted when the vessel replacement occurs to assess the best use of the faster trip time provided by the double-ended ferry and develop a service schedule that best meets the needs of the Fishers Island community.

Photo by John Haney

ATTACHMENT 1

Kick-off Meeting Notes

Fishers Island Fleet Assessment

KICK-OFF INTRODUCTION MEETING

December 13, 2022 – Fishers Island Board Member meet and greet

December 14, 2022 – Fishers Island meeting with Island business owners

MINUTES

1. Introductions (attendees list follows for each meeting)
   - John Waterhouse of EBDG provided a brief welcome and intro to all and started introductions.
   - Fishers Island –
     - Geb introduced the Fishers Island board of directors and provided a brief history of Fishers Island Ferry.
   - Elliott Bay Design Group
     - John Waterhouse introduced the EBDG team.

2. General – EBDG

   Structure
   - The Fisher Island Ferry District would be funding the new vessel, using its own bonding capacity.
   - All Fishers Island Ferry workers are employees of the Town of Southold.
   - Fishers Island Ferry also takes care of numerous other operations on the island including the airport and various properties including 160 acres of open space.
   - The island community fully supports the ferry and does provide significant funding. The ferry is their lifeline to the island and mainland.
   - Fares are set by the board of directors.

   Vessel Schedule
   - There are two schedules, Summer, and Winter.
   - Pre covid they had four schedules, Summer, Winter, Spring, and Fall with peak and off-peak fares.
   - Adjustments can be made to the schedule on an as needed basis. The board will approve or deny any changes.
   - Emergencies always take a priority.
   - There is currently a 5% fuel charge that does not fluctuate.
   - The first trip of every day is for supplies and includes workers, school children and the general public leaving from New London, CT to Fishers Island, NY.
   - Wednesdays include hazardous goods trip days. Full and empty gas, propane, heating oil and fuel trucks and full garbage trucks leave Fishers Island on the first trip and return on the 5pm trip. All waste including steel, bottles cans, trash and construction debris is collected in 20cy dumpsters and taken off island. Usually, each morning there is a truck

taking out to the island an empty dumpster and removing a full one. There is a limit of 16 passengers on these trips.
- During the winter months they remove the midday trip in exchange for the 10 am and 2 pm.

Vessel Needs and Wants
- Different vessel designs were discussed with the board members. Drive-on, Drive-off, and their current vessel design.
- Design constraints were discussed. The vessel can be no longer than 164 feet due to the basin on Fishers Island (Silver Eel Cove).
- Bringing the new vessel up to ADA guidance would be ideal.
- More deck space for larger work trucks and commercial trucks.
- Bigger and lower windows.
- Outdoor seating.
- New England charm.
- More speed for a faster trip. There are no speed constraints in the harbors, just minimal wake.
- A Passenger-Only, passenger vehicle trip and a freight-only vessel/trip.
- An elevator. There are many older island residents who would like to get out of their cars for the trip and see the view.

Customers
- During the school year there are approximately 28 children that travel to school on the island daily via ferry.
- There are approximately 250 year-round residents on the island.
- In the summer the island has approximately 2,500 to 3,000 people.
- There are four or five business on the island that have their employees commuting on the ferry daily.
- Businesses on the island also receive freight daily for their operations. Includes but not limited to mulch, food, mail, and construction materials.

Service Delivery
- The ferry only cancels trips due to weather. On rare occasions trips are canceled due to maintenance. Currently it is a one boat schedule so the other vessel can be put into service when there are mechanical issues.
- Trips will often get a short delay in the summer due to the loading of freight.
- One of the biggest fears the crew has is a fire on the vessel. There is currently no fire suppression system on any of the vessels in their engine rooms.

Crewing
- Approximately 50 staff for the summer season.
- Year round there are approximately 20 – 22 fulltime and 15 – 18 part time.
- During the winter approximately 36 - 38 staff member's total.
- The vessel crew is four deck hands and a captain. Sometimes they run the vessel with a captain and two deck hands which is the minimum the Coast Guard allows.

Operations
- A big hurdle and headache especially during the summer season is ticketing.

- A ticketless system is desirable. With a physical ticket you need to keep half for a round trip ride. It causes issues when a passenger loses the ticket half for the return trip back to New London after a summer weekend trip.
- All vessel types have the same ticket.
- Presently speaking with Hornblower and Rocket Rez about new ticketing systems.

Terminals

- The Fishers Island terminal has two berthing locations. They change docking locations based on the wind and weather conditions.
- At the Fishers Island terminal, they have a large warehouse used to sort the mail which goes directly to the Post Office and other goods for the island residents to pick up UPS and FedEx.
- The New London terminal is located near the Amtrack train station and the new United States Coast Guard Museum that is being built. With this new construction there may be the opportunity to upgrade the electrical system at the ferry terminal.
- The Fishers Island terminal has vessel size constraints due to the multiple docks with pleasure vessels berthed in the harbor during the summer.
- Upgrades to the terminal ramps will occur after a new ferry is designed.

Maintenance

- The crew keeps up with their training as well as training with local authorities (EMT etc.).
- The crew keeps a daily log of items for the vessel and crew.
- They have a good relationship with the Coast Guard. Items do not pop up unexpectedly during inspections due to their daily maintenance plans.
- The crew and staff keep up with general maintenance on the vessel. They do have the regular shipyard periods and rely on vendors for specific items/services.

Island Business Owners' Specific Feedback

- The school kids love taking the ferry.
- It would be great to add additional earlier routes to the schedule so kids and teachers can leave the island right after school.
- A faster ferry would be much appreciated. Currently, there are two private charter boats that many of the teachers are taking to get home faster.
- The school is very much in favor of a faster passenger only ferry. It would help keep kids in school. Many students leave only due to the commute time.
- More deck space on the ferry is necessary. More commercial vehicles could then get over in one trip.
- During the summer months many of the islands' vendors need to take multiple trips to get one weeks' worth of supplies over due to limited deck space.
- There needs to be a dedicated ferry in the afternoon for freight. The Fishers Island Oyster company is the only company on the island exporting items from the island and daily.
- Earlier ferry leaving the island especially for the fuel trucks. It makes for a very long day of traveling back to the island and easier to schedule trips for refueling on their operations side.
- Many times, the pallets of goods come over from New London mixed with multiple business supplies in them. Then the business owner needs to track down where their products is that they paid for.

- Packages get scanned at New London then customers think it will be over to the island on the next boat. Sometimes it is on a boat later in the day due to space. Which causes frustration.
- A dedicated freight boat would be ideal. There are staffing issues though to run a designated freight boat.

ATTENDEES: DECEMBER 13, 2022

Fishers Island Ferry District, Management

- Geb Cook, District Manager
- David McCall, Island Manager
- Jon Haney, Marine Manager (and Capt)

Fishers Island, Crew Members

- Jesse Marshall, Captain
- John Paradis, Engineer

Fishers Island, Board Members

- Jim Reid
- Diana Shillo
- Heather Burnham
- Andrew "Ace" Ahrens

Elliott Bay Design Group

- John Waterhouse, Principal in Charge
- Joey Cardella, Project Manager
- Catherine Hale, Project Engineer

KPFF

- Mike Anderson (Virtually)

ATTENDEES: DECEMBER 14, 2022

- Fishers Island Ferry District, Management
    - Geb Cook, District Manager
    - Jon Haney, Marine Manager (and Capt)
- Fishers Island, Crew Members
    - Jesse Marshall, Captain
    - John Paradis, Engineer
- Fishers Island, Board Members
    - Tom Cashel
    - Andrew "Ace" Ahrens
- Elliott Bay Design Group
    - John Waterhouse, Principal in Charge
    - Joey Cardella, Project Manager
    - Catherine Hale, Project Engineer

ATTACHMENT 2

Operations Model Memo

Elliott Bay Design Group

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STATE OF WASHINGTON
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REGISTERED
PROFESSIONAL ENGINEER

5/12/2023

NEW VEHICLE FERRY

Operations Model

Prepared for: Fishers Island Ferry District | Fishers Island, NY

Ref: 22075-100-068-0 Rev. - May 12, 2023

PREPARED BY

ELLIOTT BAY DESIGN GROUP
P.O BOX 45790
SEATTLE, WA 98145

GENERAL NOTES

1. The operational models are based on the historical operational data provided by Fishers Island Ferry District. The results are intended to provide a high-level forecast of how the ferry system can meet the forecasted needs of the Fishers Island community.

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
-	Initial Issue	5/12/23	JEJ

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1. EXECUTIVE SUMMARY

The intent of this report is to compare the characteristics of conceptual vessel arrangements for operation between New London, CT and Silver Eel Cove, NY. The report provides a summary of the key operational considerations for Fishers Island Ferry District to contemplate as they select a vessel configuration best suited for their operation.

Route profiles were developed based on the estimates of the distance and time required for loading the vessel, maneuvering, and transit. Transit speed and sprint speed estimates were made for both single-ended and double-ended vessels. A double-ended vessel has greater reserve speed, which is useful to accommodate unexpected delays without impacting the 45-minute one-way trip schedule.

In developing the route profiles referenced above, it was found that a single-ended vessel requires a higher transit speed to maintain schedule than a double-ended vessel, due to the added time required to turn a single-ended vessel around and back into or out of the terminal. As a result, the notional single-ended vessel is estimated to burn approximately 12% more propulsion fuel per day than a double-ended vessel in average summer wind and wave conditions.

Operationally, a single-ended vessel is similar to the existing vessels in the FIFD fleet. This may help reduce the time required for crew members to become familiar with the operation of the new vessel. A single-ended vessel also has a single operating station with a closer view of the bow end of the vessel from the Pilothouse.

A double-ended vessel has good maneuvering characteristics and requires the FIFD Captains to be familiar with fewer vessel maneuvers at the terminals. However, a double-ended vessel is potentially at a greater risk of green water on deck during winter operations due to increased wind and wave conditions.

2. INTRODUCTION

Fishers Island Ferry District (FIFD) is considering construction of a new vessel for their operation between Fishers Island, NY. And New London, CT. This new vessel is to be designed to meet the requirements of USCG Subchapter K and carry at least 34 vehicles and 250 passengers. The vessel will be 160' in length x 32' in breadth x 10' depth.

Currently, FIFD operates two single-ended vehicle ferries and a passenger-only fast ferry on this route. The vehicle ferries carry 24 and 34 cars and up to 210 and 245 passengers, respectively. The fast ferry carries up to 18 passengers.

The purpose of this document is to offer a summary of the key operational considerations pertinent to a single-ended and double-ended vessel on this route, and to highlight advantages and disadvantages offered by both.

3. ROUTE

The route is an approximately 6.5 nautical mile trip between New London, CT and Fishers Island, NY. Current operations on this route continue year-round, with up to seven round trips in the summer and five round trips in the winter, with special sailings for cargo and hazardous materials. The route is a USCG Lakes, Bays, and Sounds route in partially protected waters.

3.1 ROUTE PROFILE

Elliott Bay Design Group (EBDG) developed route profiles for both a single-ended and double-ended vessel. The route profiles inform the selection of a transit speed to meet the schedule required of the new vessel. For both vessels, and all seasons, each leg of the trip must be completed within 55-minutes to reasonably accommodate the current sailing schedule.

Due to the increased time required to load and unload passengers, the summer route profile requires a greater transit speed than the winter.

The vessel characteristics influencing the route profile are provided in Table 1. The characteristics were assumed to be the same for both a single-ended and double-ended vessel. Note that calculated values are approximations.

Load Step	Single Ended (minutes)	Double Ended (minutes)
Loading	12	8
Departure	1.5	1
Transit	45	45
Arrival Maneuvering	5	1.5
Unloading	15	8
Trip Total	**78.5**	**63.5**

Table 1: Voyage profile for a one-way trip

3.2 LOAD/UNLOAD TIME

This study allowed 15-minutes for the vessel to load and unload in the summer, this is slightly longer than the time observed for the RACE POINT to account for the increased passenger count.

Using knowledge gained from past projects and EBDG's understanding of current loading and unloading times for the RACE POINT, the 15-minute time allowance is comprised of the following components:

- 5 minutes loading/unloading vehicles
- 5 minutes loading/unloading passengers
- 5 minutes loading/unloading cargo

In deriving these times, it was assumed that the vessel has full ridership and a full load of vehicles. To account for the reduced ridership in the winter months, EBDG analyzed data for the RACE POINT during the months of October through March. The 97th percentile of ridership was conservatively selected for these months. EBDG found that due to reduced passenger loading in the winter, the load/unload cycle would be reduced by approximately three minutes in the winter.

For a Ro-Ro vessel, either single or double-ended, the loading time will likely be significantly reduced by eliminating the need for drivers to reverse their vehicles.

3.3 TERMINAL MANEUVERING

When operating a single-ended vessel departure, landing and maneuvering times make up a sizable portion of the schedule time. As maneuvering times account for a substantial percentage of the overall schedule, the impact on the required transit speed becomes significant.

In the case of a single-ended propulsion, double-ended loading vessel, the vessel will be oriented bow-in at the New London terminal and stern-in at Fishers Island. Thus, the vessel will have to 'back-out' of the New London terminal and 'back-in' to the Fishers Island terminal. However, for the return trip from Fishers Island to New London, a vessel with single-ended propulsion but double-ended loading would not have to turn around at either terminal.

A single-ended, transom loading only, vessel similar to the RACE POINT will have to perform the same docking maneuver at both terminals. A double-ended vessel will not require these additional maneuvers.

To determine the time required to turn, it is necessary to do two things:

- Define a likely rotational speed of the new vessel.
- Understand the likely approach Captains would take to turn the vessel around at both terminals.

The rotational speed of the vessel used in this study was determined from video footage of the RACE POINT turning at the Fishers Island terminal. It is assumed to be representative of both terminals and vessels. From this footage it appears the RACE POINT turns at approximately 1.5 degrees/second. For the purposes of this study, it is assumed that the new vessel will maintain this angular velocity and therefore require the same amount of time to turn as the existing fleet.

3.4 NEW LONDON TERMINAL

Located on the Thames River, the New London terminal is generally sheltered and offers a wider turning area with few operational restrictions. A short dolphin approach guides the vessels to the terminal.

This is where the vessels are berthed when not in use. There is shore power available to provide electrical power to the vessel when the engines and generators are shut down.

3.5 SILVER EEL COVE TERMINAL

The Silver Eel Cove Terminal on Fishers Island has a narrow channel approach before widening in way of the terminal landings. During summer months there may be private vessels in the cove which further restrict the maneuvering area. Depending on the prevailing weather the vessels may either berth with the transom against the quay wall or along the quay wall with the transom to the south-east.

3.6 VESSEL ACCELERATION

An estimate of the acceleration was developed by scaling data from a previous EBDG vessel design. It is anticipated that both a single-ended and double-ended vessel will accelerate at approximately 0.20 feet/second^2. This method was also used in developing a reference route profile for the RACE POINT. It is estimated that accelerating to cruising speed takes approximately 90-seconds.

3.7 SUMMER OPERATIONS

Per the 2018 Peak Schedule there is a minimum of four daily round-trip sailings. There are four additional sailings Friday afternoon and three Sunday to accommodate the additional traffic of weekend visitors. There are also special sailing schedules on holidays to accommodate influxes of visitors, such as ten round trip sailings on Labor Day.

According to the trip logs, weather does not appear to be a concern during the summer months. Most delays appear to be coordinating with local transit (trains), slow drivers, and other anomalies generally done at the discretion of the crew as a part of customer service (waiting on late arrivals).

3.8 WINTER OPERATIONS

Per the 2018 Winter Schedule there are four daily round-trip sailings with five on Friday and Sunday. Thanksgiving weekend has additional sailings on Wednesday and Sunday. And there are fewer sailings on Christmas and New Year's Day.

Cancelled sailings are more likely to occur in the winter months with more severe weather. Not only is there an increased likelihood of a sailing being cancelled but occasionally there is foul weather routing taken. This routing, which increases the distance and time for each sailing, is necessary for the safety and comfort of the passengers and crew.

3.9 REQUIRED TRANSIT SPEED

Table 2 summarizes the required transit speeds calculated for both the notional single-ended and double-ended vessels in summer. The transit speed was found by calculating minimum speed needed to complete the route in 78-minutes after subtracting the time required for maneuvering, docking, and loading/unloading.

	Sailing Route (N Miles)	Transit Time (minutes)	Required Speed (Knots)
Single Ended	6.5	45	8.7
Double Ended	6.5	59.5	6.6

Table 2: Required vessel transit speed to meet a 45-minute one-way sailing

To maintain the same sailing schedule of the current fleet a double-ended vessel can sail at 6.6 knots rather than 8.7 knots. This allows greater operational flexibility by either 'slow-steaming' to save fuel or could allow FIFD to revisit their sailing schedule to reduce wait times.

4. SYSTEM DEMAND AND CAPACITY

FIFD provided approximately five years' worth of operational data. This data included sailing times, passenger counts, auto and truck counts, as well as vehicles left at the dock. With this data we were able to construct reasonable approximations of the annual operating profile of the FIFD.

4.1 PASSENGER DEMAND

On an annual basis FIFD transports approximately 100,000 to 120,000 passengers. The data set provided includes 2020, which faced many challenges. But this varies significantly from month-to-month from a baseline full-time resident usage to a peak summer-time vacation destination.

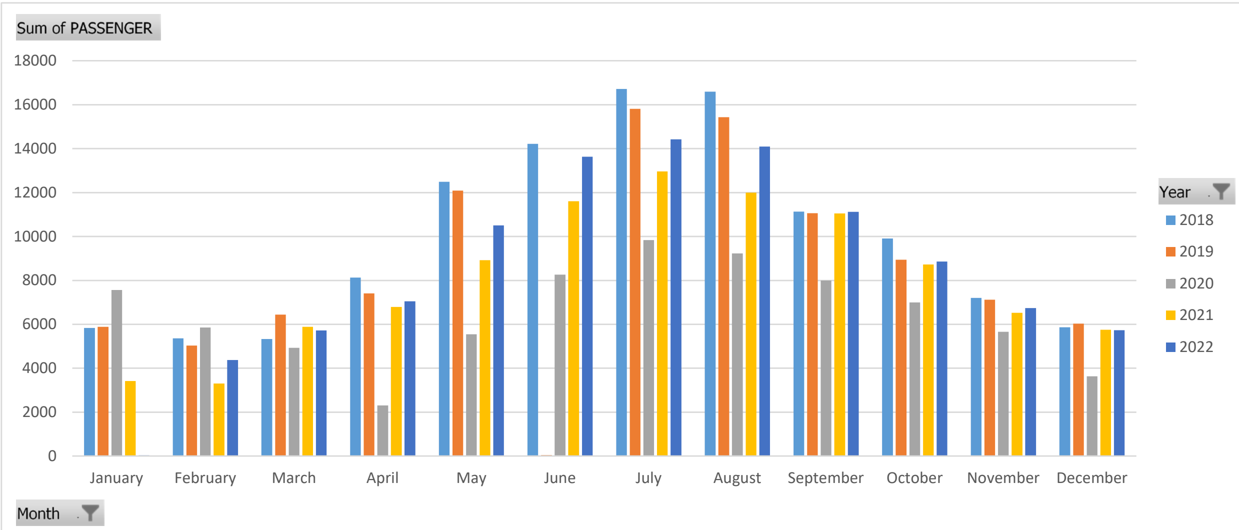

Figure 3: Monthly passenger totals as reported by FIFD

During the summer peak (May-August) FIFD transports approximately 14,000 passengers per month. The baseline usage (November – March) is approximately 5,500 passengers per month. Based on a summer sailing schedule of about 14 trips per day and winter sailing schedule of 10 trips per day the ferries are transporting approximately 41.3 and 20.8 passengers per sailing, respectively.

4.2 VEHICLE DEMAND

Similar to the passenger demand there is significant variability in demand. During the winter FIFD transports approximately 1,480 autos per month. This increases to 3,850 autos per month during the summer (May-August), a 160% increase! Note that these are only the vehicles identified as 'autos' within the data.

4.3 TRUCK/CARGO DEMAND

Truck and commercial traffic, while still seasonal, does not fluctuate to the extent of the people and autos. The winter truck traffic is approximately 330 trucks per month ramping up to a peak of 520 trucks per month, an almost 60% increase.

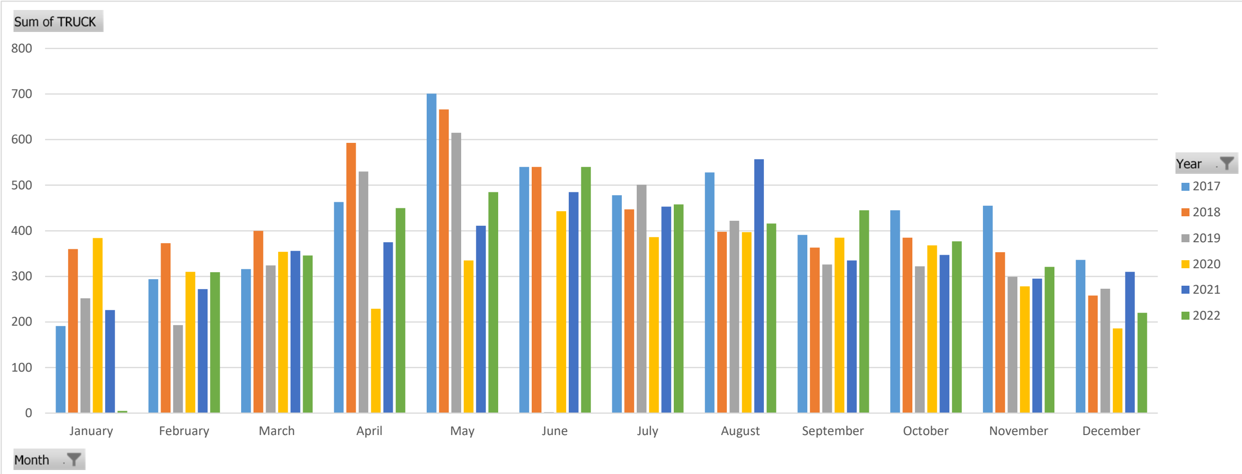

Figure 4: Annual monthly truck totals

The cargo volume transported by FIFD is even less seasonal. The data indicates 260 units/month in the winter and peaking at 340 units/month in the summer.

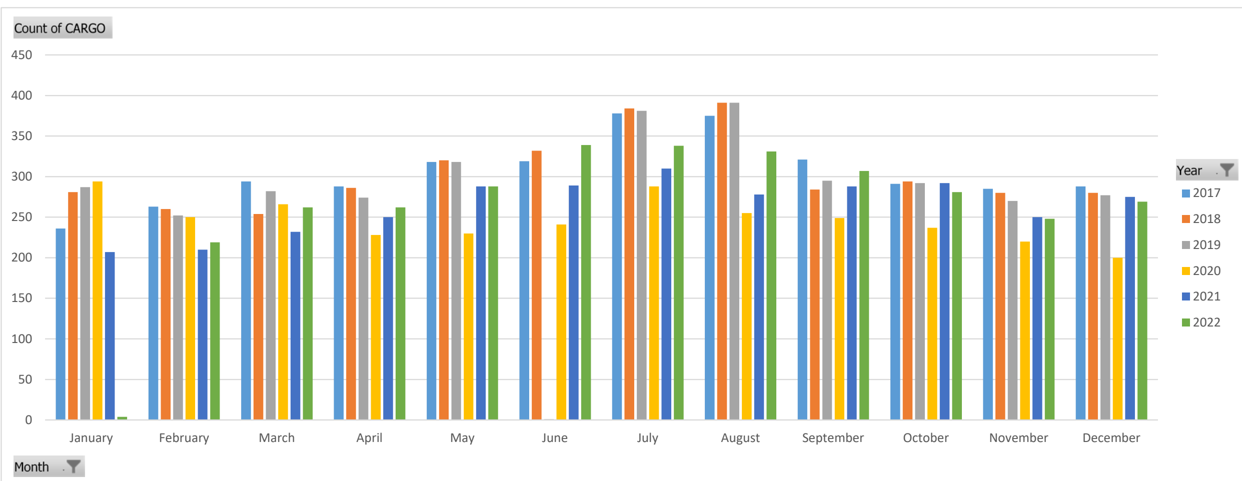

Figure 5: Annual monthly cargo totals

4.4 WEEKLY DATA

In terms of a weekly cadence there are also similar trends for passenger, auto, truck, and cargo. The following sections report the average count *per trip*. In other words, the average demand on the vessel capacity for every sailing.

This data is best shown per season to best understand the capacity performance of the FIFD.

4.4.1 WINTER SEASON BY DAY

The winter season is characterized by the full-time residents. As such the demand for passenger service seems to be driven by commuters traveling to and from the island.

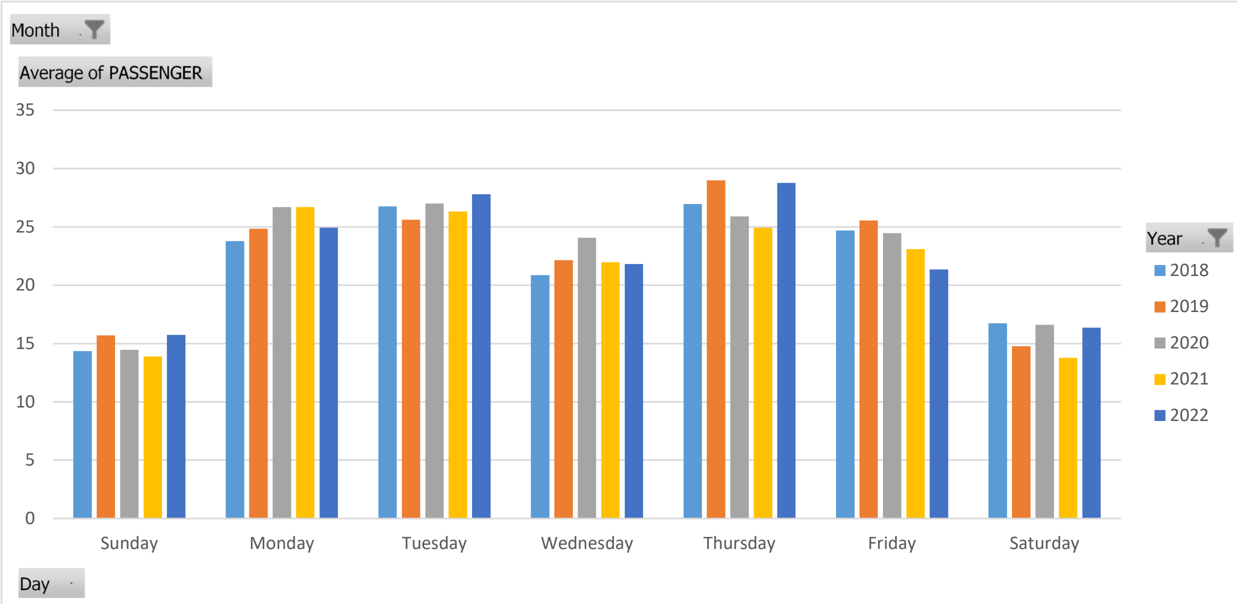

Figure 6: Average passenger demand per sailing during winter

The daily demand for personal vehicles during the winter season is very flat with only a couple of vehicles difference between the highest and lowest demand days – Sunday and Wednesday, respectively.

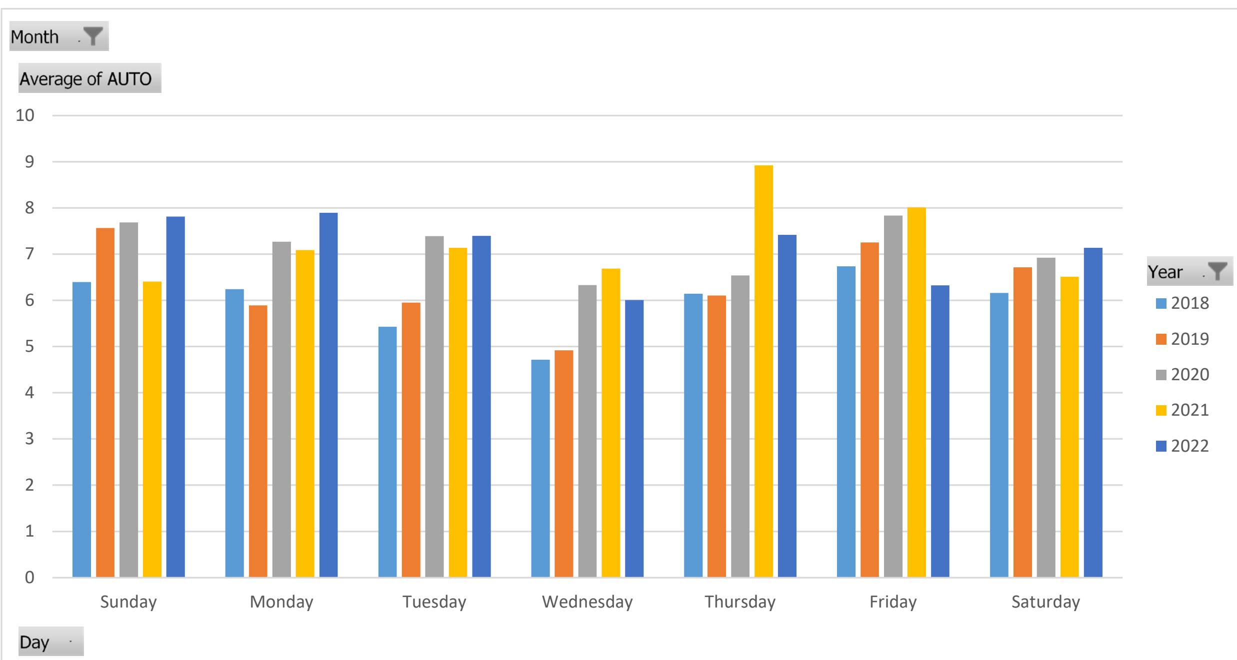

Figure 7: Average car demand per sailing during winter

Truck traffic is largely managed during the weekdays with only the occasional truck making a trip on the weekend.

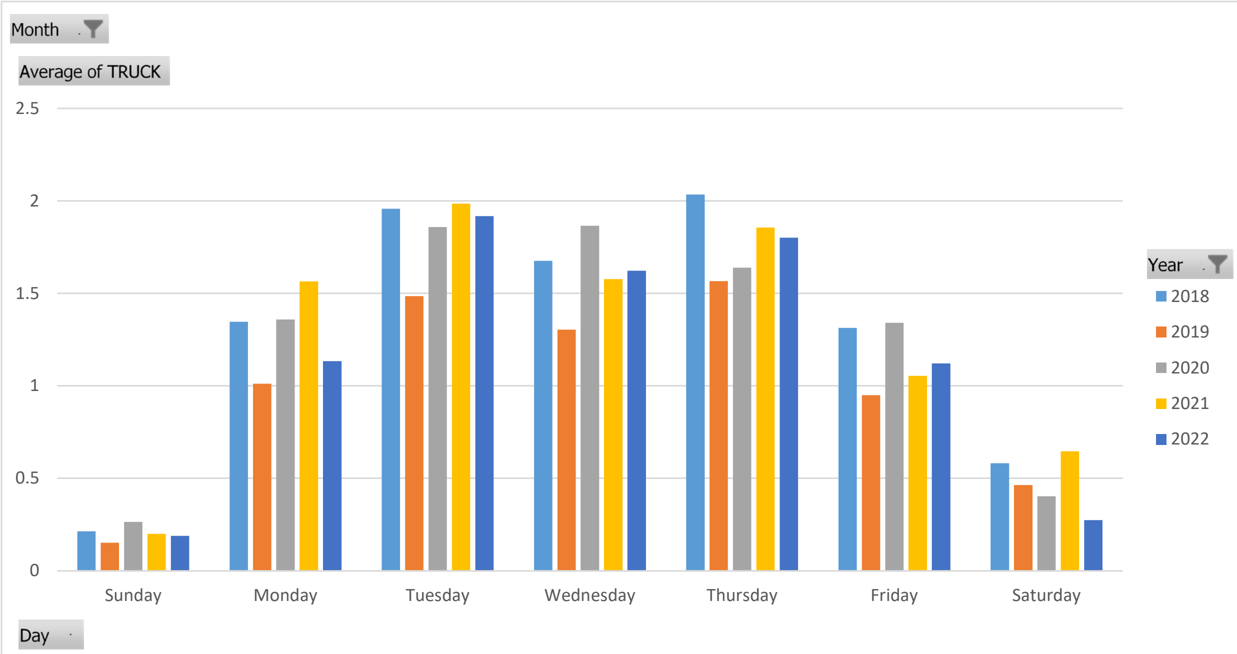

Figure 8: Average truck demand per sailing during winter

4.4.2 SUMMER SEASON BY DAY

The summer season places peak strain on FIFD resources. Between vacationers and provisions being transported to the island it is difficult to balance the various needs and demands of the community.

Passenger volume is highest on Thursdays. However, Monday, Tuesday, Sunday, and Friday are only a couple of passengers shy, on average. Both Wednesday and Saturday see decreased volume with Wednesday being the least traveled day by far.

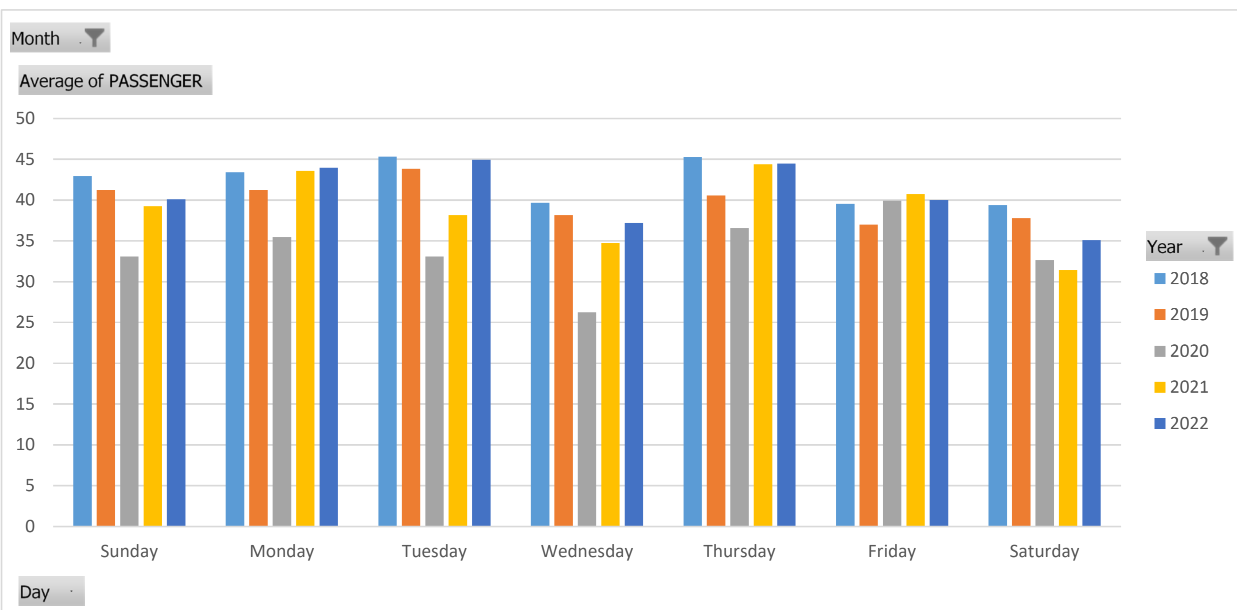

Figure 9: Summer season passengers per sailing

The summer season brings additional passengers to the island. The average passenger demand nearly doubled from 22 passengers/sailing to 41.5. However, the vessels are rarely passenger count limited.

Similarly, the vehicle counts increase significantly during the summer. As we saw, the winter sailings see approximately 6.4 vehicles per sailing while that number shoots to 11.4 in the summer. The peak vehicle days are Sunday, Monday, and Thursday ,respectively, and correlate strongly with the passenger trends.

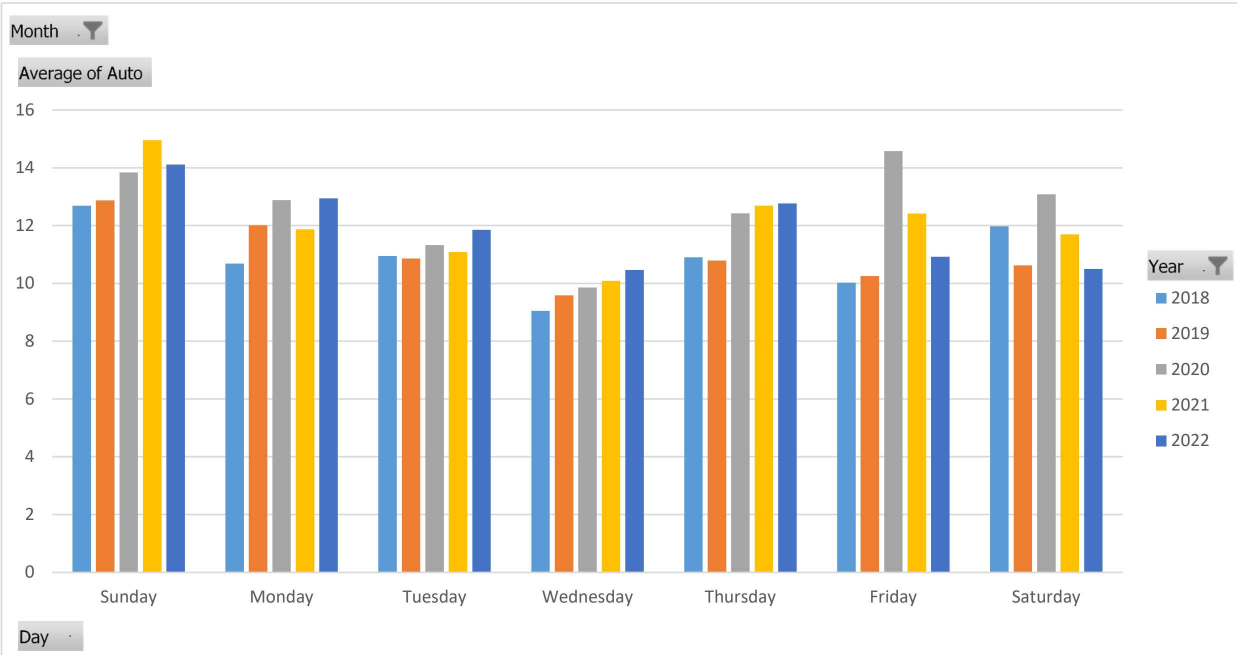

Figure 10: Summer season car counts per sailing

Truck traffic also increases from less than 2 trucks per trip to about 2.5 during weekday sailings. It is inferred that provisioning for the island occurs during the lower demand of weekdays. Given the trends identified previously Saturday could also be a reasonable day for additional truck traffic, if needed.

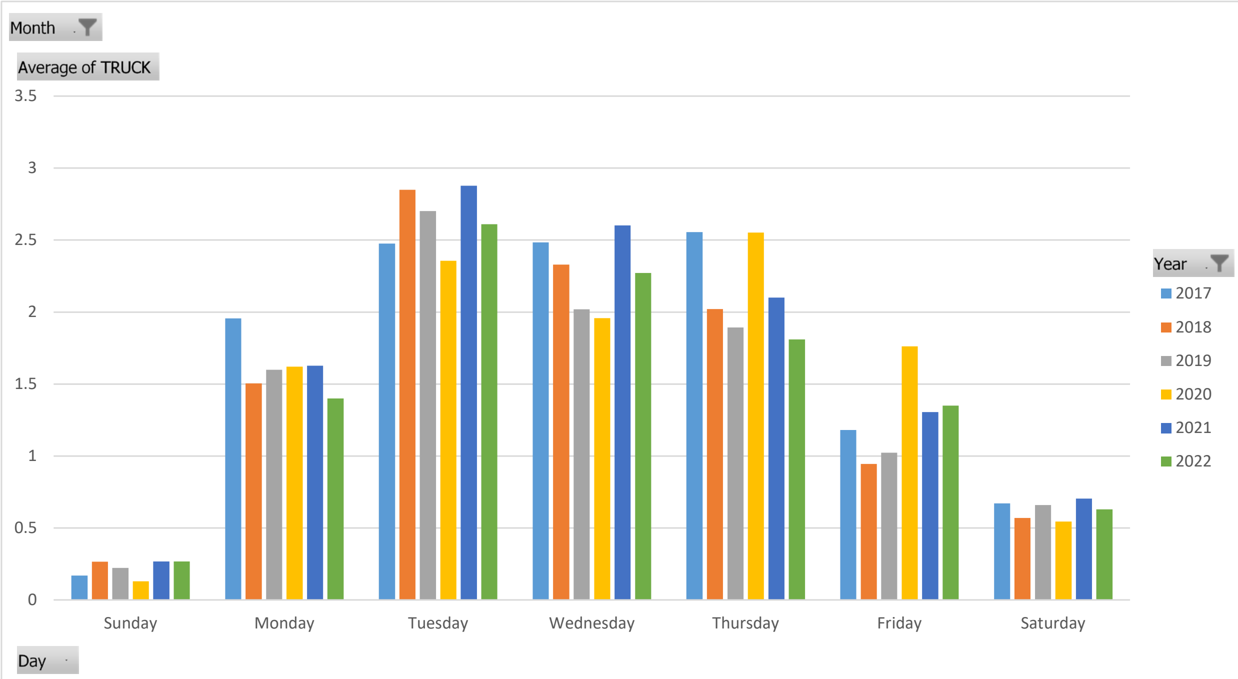

Figure 11: Summer season truck counts per sailing

4.5 DAILY SAILING SCHEDULE

An attempt at modeling the FIFD data as a daily schedule was made. Unfortunately, the formatting and data clean-up of that information was time prohibitive.

4.6 VEHICLES LEFT

To the credit of FIFD the data for vehicles left is spotty. It is difficult to determine any meaningful trends from this data set. Unlike the previous sections, all data reported here is the total number of vehicles left for a given time period and does not represent the average number of vehicles left at the dock for a given sailing.

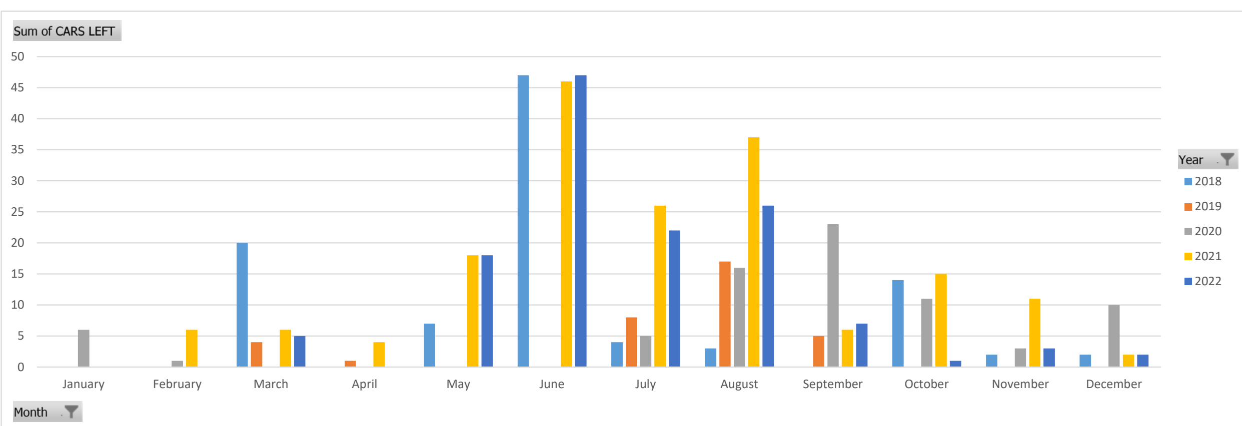

Figure 12: Cars left, by month, on an annual basis

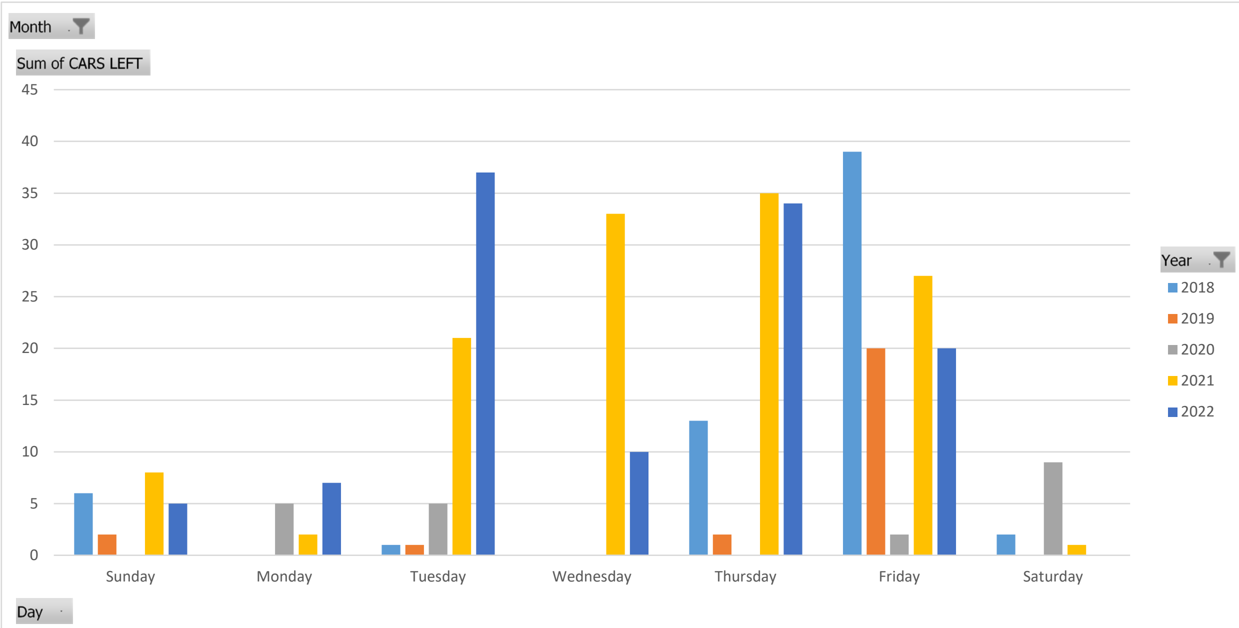

Figure 13: Cars left, by day, during the summer schedule (May – August)

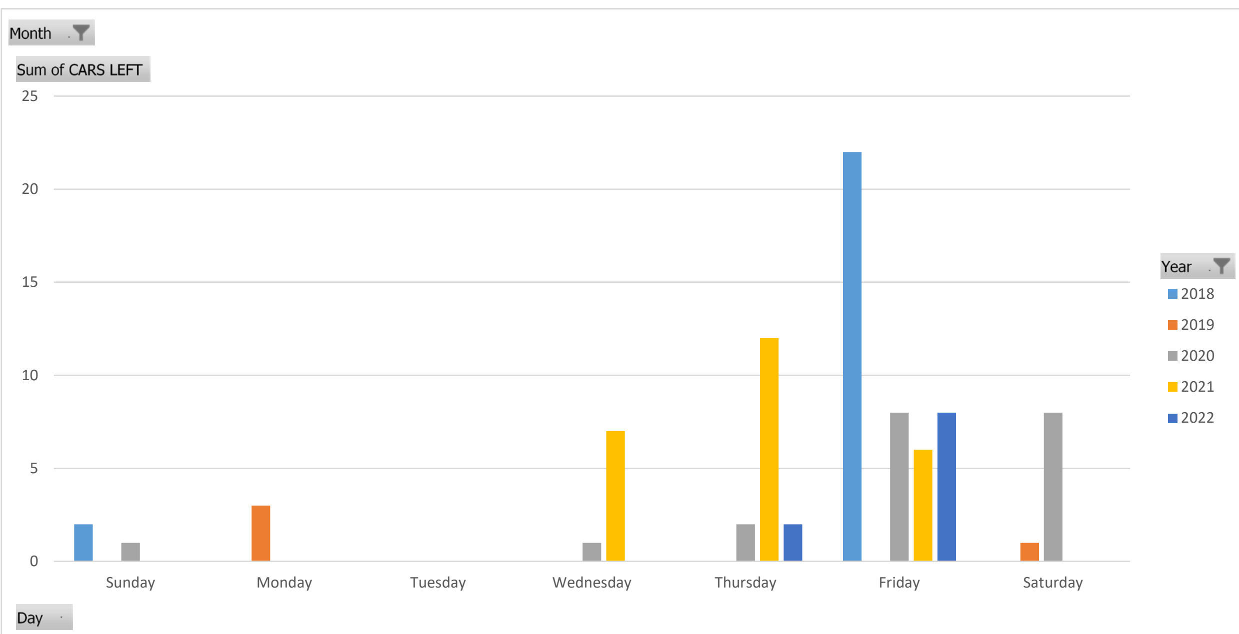

Figure 14: Cars left, by day, during the winter schedule (November – March)

The only immediately obvious trend is that Fridays appear to be the peak day for cars to be left behind. By inspection this makes sense, an unlimited number of travelers from the mainland can flood the New London terminal. Meanwhile, Sunday and Monday sailings are constrained by the population leaving the island.

5. VESSEL OPERATIONS

5.1 MANEUVERABILITY

Maneuverability is critical for safe and efficient operation of ferry vessels, especially when the terminals are constrained. The discussion of maneuvering characteristics below assumes fixed pitch propellers.

For this route, a single-ended vessel is assumed to have a bow thruster, two propellers, and two rudders. With this configuration a single-ended vessel would exhibit better maneuvering characteristics at high speed because there are two rudders available to generate a turning moment. At lower speeds, a double-ended vessel can use both its forward and aft rudders to provide precise control over the bow and stern of the vessel. The forward rudder also gives a double-ended vessel the ability to "crabwalk" to counter the effects of cross currents at low speeds.

Slowing or reversing fixed pitch propellers requires the shaft rotation to be slowed and then stopped with a shaft brake, the gear box shifted into reverse, and the shaft rotation to be increased to develop thrust. On a single-ended vessel this process must be completed frequently, shifting the propellers between forward and reverse while the vessel is maneuvered into the terminal. The time required for reversing the propellers limits the responsiveness of the vessel during maneuvering. On a double-ended vessel, the forward propeller can be shifted into reverse while the vessel is still being driven by the aft propeller. This improves the response time of the vessel as the Captain can have more immediate control over the forward or aft force on the vessel without waiting for the propellers to reverse. Further, it can reduce the number of gear box shifts, reducing maintenance and prolonging the life of the propulsion machinery. While similar processes can be used on a single-ended vessel (for example, the port propeller could be maintained in forward rotation and the starboard in reverse), this induces a turning moment on the vessel which must be countered by the rudders or bow thruster.

The maneuvering characteristics of a single-ended vessel can be greatly improved with a bow thruster. However, this added equipment leads to additional maintenance requirements. Many of the same maneuvering benefits offered by a bow thruster are available with a double-ended configuration without the added equipment and subsequent maintenance requirements.

5.2 CREWING REQUIREMENTS

Differences in crew requirements between single-ended and double-ended vessels are not anticipated. Based on a passenger count of 245, EBDG expects that both vessel arrangements will require a Master, Mate, and three Deckhands similar to the RACE POINT.

5.3 FLEET CAPACITY

The following analysis of fleet capacity assumes sailings similar to the FIFD provided 2018 sailing schedule. In that winter schedule the ferries ran about four round-trip sailings per day. The summer schedule has one vessel running four round-trip sailings with a 2nd vessel also running four round trips during peak hours.

5.3.1 CURRENT FLEET

The current sailing schedules for FIFD indicate four, maybe five, round trips per vessel per day. At the RACE POINT's highest capacity this translates to a maximum daily capacity of:

Passengers 1,960
Vehicles 272
Trucks 24

When the MUNNATAWKET comes online the system capacity is not quite doubled due to the smaller vehicle deck area. The maximum system capacity becomes:

Passengers 3,920
Vehicles 464
Trucks 24

These are round trip totals. However, typically the traffic is heavily biased in one-direction such as Thursday and Friday travel to the island and Sunday and Monday travel from the island.

It is also important to note that the vehicle and truck capacity is a mix of these two values. If there were three trucks onboard for a sailing, the vehicle capacity would be reduced.

5.3.2 POTENTIAL FLEET

For this analysis, it is assumed that a new vehicle ferry would have similar capacities to the RACE POINT. However, due to its faster load/unload times it can add one additional round-trip sailing to its daily schedule.

Passengers 2,450
Vehicles 340
Trucks 30

If a two double-ended fleet is selected these numbers simply double.

It is also important to note that the theoretical truck capacity is much larger than shown here. Without the positioning restrictions of the forward house a single sailing could carry more than the assumed three trucks. But these vessels would still be constrained by the "lane-feet" on deck and the vehicle count would be reduced by any trucks on board.

6. CONCLUSIONS

This report provides a comparison of the key operational characteristics of a notional single and double-ended vessel for service to Fishers Island. The goal of the report is to assist FIFD with the selection of a vessel configuration for a new vehicle/passenger ferry. A study of the route profile indicates that a double-ended vessel has a greater margin between transit speed and sprint speed. This margin means a double-ended vessel is more capable of accommodating unexpected delays while maintaining a 45-minute one-way schedule.

Operationally, a single-ended vessel has a single operating station and is most similar to the existing FIFD fleet. However, a double-ended configuration would help simplify the required maneuvering operations at the terminals.

The Trip Data provided by FIFD shows a professionally managed transportation system. The reservation system appears to do an excellent job managing demand to stay within the system limits to minimize frustrated travelers being left at the dock. This also makes it difficult to extrapolate what the actual capacity need is. What is clearly shown is that during the peak summer months a double-ended vessel can represent a 25% capacity increase in vehicle traffic to the island over a comparable single-ended vessel.

7. REFERENCES

[1] Fishers Island Ferry District, Sailing Schedule, Fishers Island, NY, 2018.

[2] Fishers Island Ferry District, RACE POINT Vessel Information, Fishers Island, NY, 2023.

[3] Fishers Island Ferry District, SILVER EEL Vessel Information, Fishers Island, NY, 2023.

[4] Fishers Island Ferry District, MUNNATAWKET Vessel Info, Fishers Island, NY, 2023.

[5] Fishers Island Ferry District, Trip Count Data, Fishers Island, NY, 2017-2022.

ATTACHMENT 3

Alternative Propulsion Study Memo

Elliott Bay Design Group

STATE OF ALASKA
49TH
Sarah Nichols
SARAH E. NICHOLS
ME 146884
REGISTERED PROFESSIONAL ENGINEER

7/6/2023

NEW VEHICLE FERRY

Alternative Propulsion Study

Prepared for: Fishers Island Ferry District | Fishers Island, NY

Ref: 22075-100-050-1 Rev. B July 6, 2023

PREPARED BY

ELLIOTT BAY DESIGN GROUP
P.O BOX 45790
SEATTLE, WA 98145

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
-	Initial Issue	5/12/23	SEN ME 146884
A	Revised Electrical information and rates.	6/26/23	SEN ME 146884
B	Minor wording changes in Sections 2.2, 3.1, 3.3, 3.5, 4.2, 4.3.2, 4.4, 4.4.1, 4.4.3, 4.4.4, 6.2, and 7. Changed second list in Section 2.3 to bullets from numbers. Adjusted percentages in Table 6 and Table 7. Changed BESS to ESS to be consistent. Corrected calculation error in Table 10 and Table 14. Added electrical costs to Table 12 for Option 3. Added maintenance costs to Table 13. Updated calculations in Appendix A. Changed Appendix B to D and added new Appendix B and C. Updated appendix page numbers.	7/6/23	SEN ME 146884

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1. PURPOSE

This study evaluates alternative propulsion options for a new ferry to be operated by Fishers Island Ferry District (FIFD) for their operation between Fishers Island, NY and New London, CT. The new vessel will replace the M/V MUNNATAWKET and will be designed to meet the requirements of USCG Subchapter K and to carry at least 34 vehicles and 250 passengers. The vessel will be a double ended vehicle/passenger ferry and will be 160' in length x 32' in breadth x 10' in depth.

2. PROCEDURE

2.1 STUDY OVERVIEW

Selecting a vessel's propulsion system is a critical step in the early design phases. The hull shape, tankage, and machinery arrangement revolve around this selection. The propulsion system is a primary component in the capital cost, operational cost, and environmental impact of the vessel.

A hybrid propulsion system is one that includes electrical energy storage in addition to the propulsion engine or generator. The energy storage system (ESS), lithium-ion batteries in this instance, stores excess energy produced by a diesel engine or from shore power during times of lower power consumption and releases that energy later to assist or substitute the energy from the propulsion engine. Hybridization often allows the engines to operate at a more efficient power level over more of their operational time and can reduce total operational hours, thus reducing engine maintenance. Hybridization is most beneficial when low cost, clean shore power can be used to charge batteries and reduce the vessel's diesel dependency.

This study evaluates one non-hybrid system, one hybrid system with an ESS, one hybrid system with an ESS and shore power, and one methanol system.

2.2 BATTERY OVERVIEW

It is important to note that vessel hybridization is more complex than adding batteries to a conventional propulsion system. Battery hybrid vessels require different auxiliary systems than conventional systems.

For starters, the batteries must be installed inside of battery rooms, which are steel structures with A-60 insulation. On the surface, this is like fuel tanks located outside of the engine room of a conventional system, but the batteries have more stringent environmental controls than diesel fuel. Battery rooms require active ventilation, heating, and cooling to maintain ideal operating temperatures. Additionally, to address safety concerns, battery rooms much be provided with a thermal run-away vent line and a fire suppression system.

Battery systems are typically comprised many individual cells, and it is critical that these cells operate in unison. To do this the system is provided with a battery management system (BMS), a proprietary software system which monitors and controls each cell and performs complex calculations related to the system status. The BMS plays a crucial role in determining battery life and safety.

Typically, battery banks are sized such that a single discharge cycle is less than 30% of the beginning of life capacity. Batteries lose capacity over time as they cycle through charge and discharge operations;

exposure to adverse temperatures will expedite battery degradation. Generally, as the batteries approach 75-80% of their capacity, it is time to replace them. Past 80% the battery loses its capacity at a much faster rate. A current industry practice is to size batteries for a 10-year lifespan; however, alternative lifespans are possible.

Additional information on maritime battery systems can be found in [1].

2.3 EVALUATION CRITERIA

This study examines several propulsion options in terms of the following criteria:

- Capital Cost – Estimated cost of equipment necessary for propulsion and maneuvering.
- Fuel Costs – Estimated annual fuel cost.
- Emissions – Estimated annual production of particulate matter, nitrous oxides, hydrocarbons, carbon monoxide, and carbon dioxide.

Additionally, this study will conduct a sensitivity analysis of key cost factors such as:

- Fuel price and
- Energy storage system (ESS) cost.

3. GIVEN AND ASSUMED PARAMETERS

3.1 ROUTE PROFILE

The route is an approximately 6.5 nautical mile trip between New London, CT and Fishers Island, NY. Current operations on this route continue year-round. The route is a USCG Lakes, Bays, and Sounds route in partially protected waters.

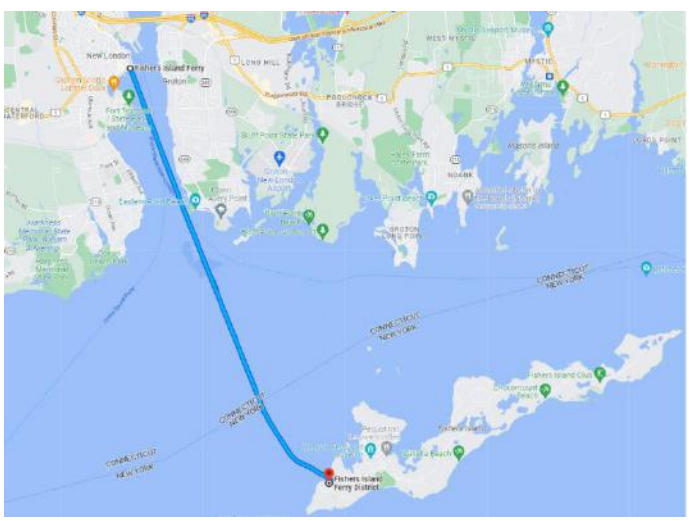

Figure 1: New London – Fisher Island Route

FIFD operates 365 days a year with three different schedules throughout the year, winter, spring, and summer with multiple round trips per day. One-way trips take approximately 85 minutes. Table 1 shows the total number of trips each year from 2018 through 2022 for the M/V RACE POINT. It has been assumed that the new vessel will replace the M/V MUNNATAWKET and that the new vessel will become the primary vessel with the M/V RACE POINT becoming the secondary vessel. For this report the average number of trips for 2018, 2019, and 2022 is used for calculating operating costs. Data from 2020 and 2021is not considered as the COVID-19 pandemic curtailed the number of annual trips.

Table 1: Annual One-Way Trips

YEAR	TRIPS
2018	2,324
2019	2,968
2020	1,961
2021	1,377
2022	2,515
Average	2,602

3.2 HOTEL LOAD ESTIMATION

The hotel load has been estimated to be 38.5 kW based on estimated lighting, ventilation, and mechanical loads.

3.3 POWER PROFILE

Elliott Bay Design Group (EBDG) performed speed and powering calculations to determine the power necessary to achieve cruising speeds between 7 knots and 13 knots. Table 2 shows the speed and power data.

Table 2: Speed and Powering

SPEED (KTS)	POWER REQUIRED HP (KW)
7	82.5 (61.5)
8	121.7 (90.7)
9	174.5 (130.1)
10	247.3 (184.4)
11	345.4 (257.6)
12	479.9 (357.9)
13	674.8 (503.2)

Typically, the transit speed of a ferry vessel is based on a Taylor speed ratio of 0.9 to 1.0. The Taylor speed ratio is the speed in knots divided by the square room of the length of the waterline (LWL) in feet. Based on the Taylor speed ratio, the transit speed for this vessel should be between 11 knots and 12 knots. However, the vessel normally operates between 9.5 – 10 kts thus a cruising speed of 10 knots has been used for this study.

Table 3 shows the expected propulsion and hotel demand and time at each power level for a typical round-trip crossing. The power loads shown include the fixed pitch propulsor efficiency, but they do not account for any other efficiency losses introduced by the system providing power. The resulting power profile is shown in Figure 2. It has been assumed that the propulsion engines run from departure to arrival and shut down at the terminals assuming the vessel is tied up or held in position without pushing against the dock with the propellers engaged.

Table 3: Propulsion and Hotel Demand

SEGMENT	TIME	PROP LOAD (KW)	HOTEL LOAD (KW)	TOTAL LOAD (KW)
Loading New London	15 min	0	38.5	38.5
Accelerating to Cruise Speed	1.5 min	274	38.5	312.5
Transit to Fisher Island	45 min	184	38.5	396.5
Arrival Maneuvering	5 min	220	38.5	258.5
Unloading at Fisher Island	15 min	0	38.5	38.5
Loading at Fisher Island	15 min	0	38.5	38.5
Departure	5 min	274	38.5	312.5
Transit to New London	45 min	184	38.5	396.5
Arrival Maneuvering	5 min	220	38.5	258.5
Unloading New London	15 min	0	38.5	38.5

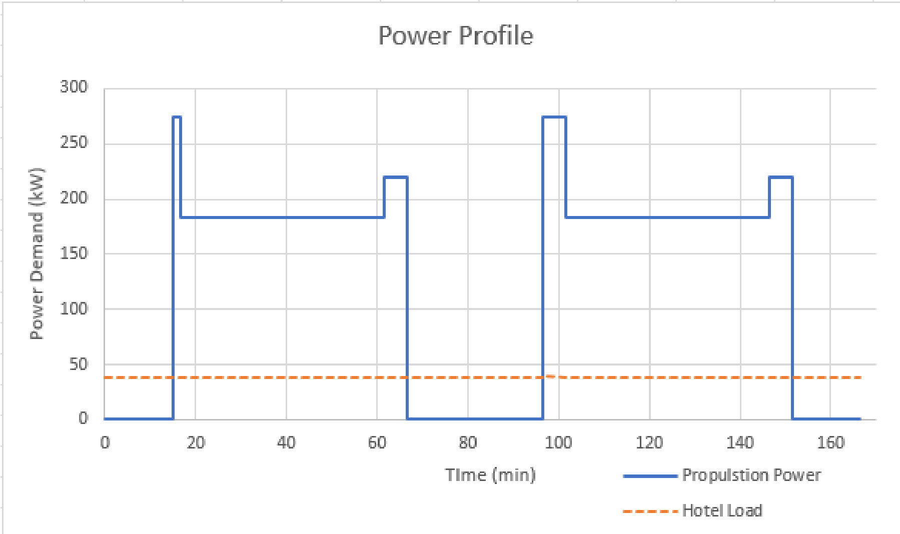

Figure 2: Round Trip Power Profile

3.4 POWERING SYSTEM EFFICIENCIES

Every component in the power path that takes the power from the engines and delivers it to the propellers will contribute to system losses. Reduction gears, shafts, generators, inverters, rectifiers, and battery chargers have efficiencies ranging from 97% to 99%. The more equipment required to get from power generation to shaft power, the greater the system losses will be.

A diesel mechanical system derives energy from diesel combustion in the engine with a high-speed shaft output. The high-speed shaft output must then be reduced to match a desired propeller speed via a reduction gear. This system is the most efficient arrangement.

A hybrid propulsion system, generally, experiences the greatest systemic energy losses. Energy produced by a diesel engine is converted to alternative current (AC) electric energy by a generator. This energy is converted to direct current (DC) electric energy to charge batteries. The batteries discharge DC energy which is then converted a few times to produce mechanical power at the shaft. Note that not all electrical power produced by the generators flows through the batteries, only excess power not immediately required will be subject to the charge and discharge losses of the batteries.

For this study, all motors are assumed to be permanent magnet motors.

3.5 SYSTEM POWER LIMITATIONS

All engine options in this study are rated below 599 kW (803 HP) to keep the engine within the Environmental Protection Agency (EPA) requirements for Tier 3 emissions standards.

As discussed in Section 3.3, this study is focused on a transit speed of 10 knots. Some installations will be capable of higher speeds. EBDG typically selects propulsion engines such that the normal operating power is approximately 85% of the maximum continuous rating (MCR). Powering a double-ended ferry with shafted propulsion and rudder steering is typically split 80/20 with the aft pushing propeller providing the bulk of the power required.

The final operational profile for the vessel will be fine-tuned based upon the propulsion system selected.

3.6 SHORE POWER AVAILABILITY

Currently the terminal in New London has 208/120V AC at 60 amps available. The construction of the new U.S. Coast Guard a museum nearby may allow a high-capacity charging system to be installed.

4. CANDIDATE PROPULSION SYSTEMS

Utilizing the power profile presented in Section 3.3, EBDG evaluated four different propulsion arrangements. System variations considered are fuel type, power generation, energy storage and shore power availability.

As shown in Appendix A, this evaluation includes the determination of the power required for propulsion and hotel loads and the power source utilized for the demand. These calculations are also used to determine the equipment rating necessary for the intended operating scheme. Each system has different efficiency losses as discussed in Section 3.4 and these losses are accounted for in the calculations where each unique power demand is calculated.

All four options are described below with a list of the equipment considered and a discussion of how each system is intended to operate. All arrangements will power two fixed pitch propellers, one per end.

Data supplied by vendors was used to estimate fuel consumption, capital costs and emissions.

The first three system descriptions include simplified system schematics, Figure 3 is a key for all major components included in these diagrams.

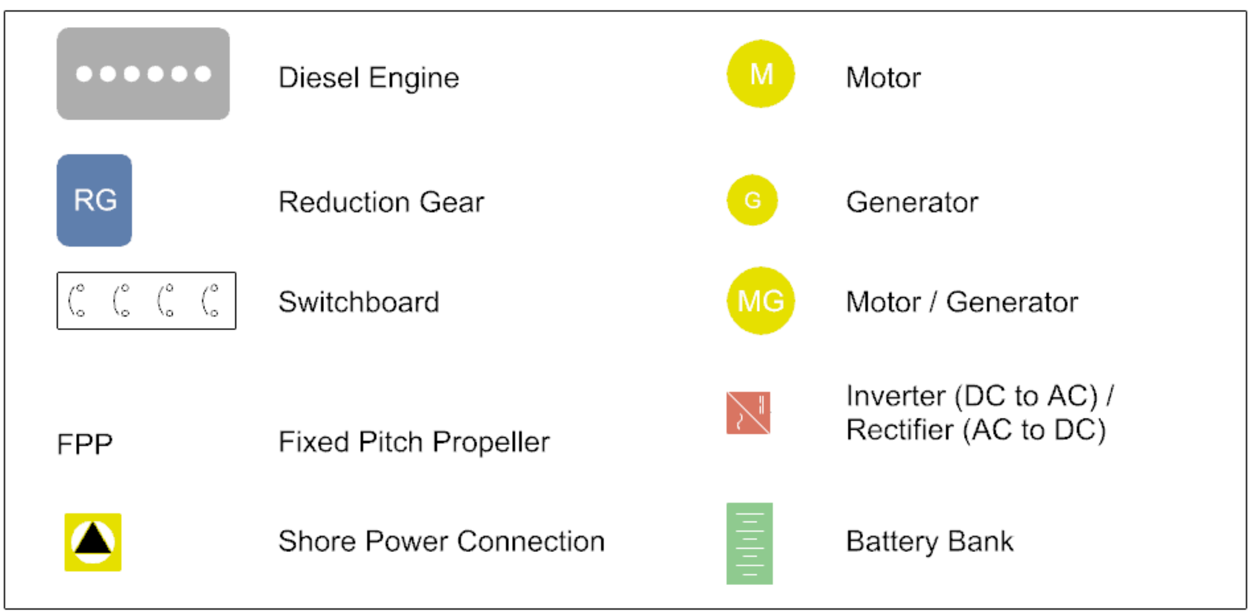

Figure 3: System Schematic Key

4.1 OPTION 1 | DIESEL MECHANICAL

A diesel mechanical propulsion system serves as the baseline for this study as it is the system installed on the M/V MUNNATAWKET. This propulsion system is comprised of two Cummins X-15 diesel powered main engines each rated for 336 kW driving a fixed pitch propeller system. The hotel loads are provided by two Onan Marine MDDCS diesel generators each rated for 55 ekW; one generator is in operation while the second generator is on standby.

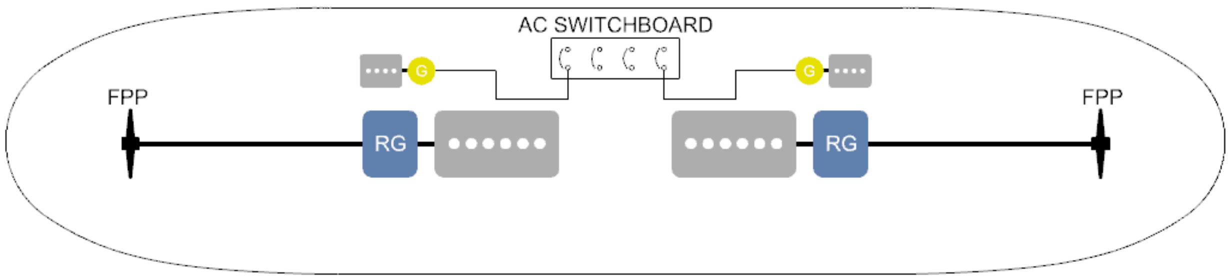

Figure 4: Diesel Mechanical System

4.1.1 EQUIPMENT

This arrangement specifically considers:

- 2 (ea) Cummins X-15 propulsion diesel engines rated for 336 kW
- 2 (ea) TwinDisc reduction gear MGX-5146SC
- 2 (ea) conventional shaft lines
- 2 (ea) Onan Marine QD 55 kW ship service generators
- 1 (ea) AC switchboard for ship services
- 2 (ea) fixed pitch propellers

4.1.2 OPERATING SCHEME

This arrangement assumes a 50/50 power split between the aft and forward propellers during maneuvering and an 80/20 power split between aft and forward propellers during transit. When the vessel is in port at either terminal for loading and unloading the propulsion engines will be shut down, and a single ship service generator will continue to operate to provide necessary hotel loads.

4.2 OPTION 2 | DIESEL MECHANICAL HYBRID WITH ESS

Option 2 is a hybrid propulsion option. The system is considered a parallel hybrid arrangement because there are two sources of power provided to the propulsor, a diesel engine rated for 336 kW and an electric motor/generator rated for 373 ekW. The electric motor is coupled to the drive train by a reduction gear with a power take off / power take in (PTO/PTI). Batteries are charged with excess power from the diesel engines via the PTI/PTO. Batteries can be used as a source of hotel power or propulsion power. The ship service generator is provided as a redundant source for hotel loads. Note that this arrangement is likely subject to more stringent USCG electrical requirements than is typically required for a vessel of this size due to the complexity of the system.

Additionally, this arrangement has auxiliary propulsion loads for the batteries and electrical equipment that option 1 did not require.

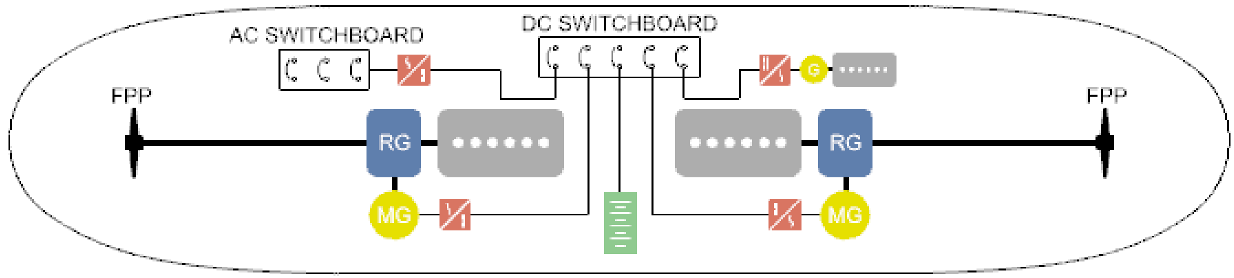

Figure 5: Diesel Mechanical Hybrid

4.2.1 EQUIPMENT

This arrangement specifically considers:

- 2 (ea) Cummins X-15 propulsion diesel engine rated for 336 kW
- 2 (ea) propulsion motor/generator rated at 373 ekW
- 2 (ea) reduction gears with PTI/PTO
- 1 (ea) DC propulsion switchboard with all necessary converters and filters
- 1 (ea) AC switchboard for ship services
- 1 (ea) Onan Marine QD 55 kW ship service generator (backup)
- 2 (ea) conventional shaft lines
- 2 (ea) fixed pitch propellers
- 50 kWh Batteries

4.2.2 OPERATING SCHEME

This arrangement assumes a 50/50 power split between the aft and forward propellers during maneuvering and an 80/20 power split between aft and forward propellers during transit. The aft propeller will be powered by a diesel engine and the forward propeller will be powered by batteries. A main engine will provide propulsion power and charge the batteries during maneuvering and transit periods. At both terminals during load and unload hotel power is provided by batteries and the propulsion engines and ship service generators are shut down. This arrangement allows for a single engine operating under normal conditions with the caveat that it must always be the engine at the "aft" end of the vessel. The propulsion motor is sized for full power to the propellers.

4.3 OPTION 3 | DIESEL ELECTRIC HYBRID WITH ESS AND SHORE POWER

Option 3 is the next hybrid propulsion option. The system is considered a series hybrid arrangement because there is a single source of power provided to the propulsor, an electric motor. The primary source of power is a diesel driven generator rated for 373 kW. Batteries are charged with excess power from the diesel generator or by shore power. Batteries can be used as a source of hotel power or propulsion power. Two variable speed motors, one at each end of the vessel would drive the propellers.

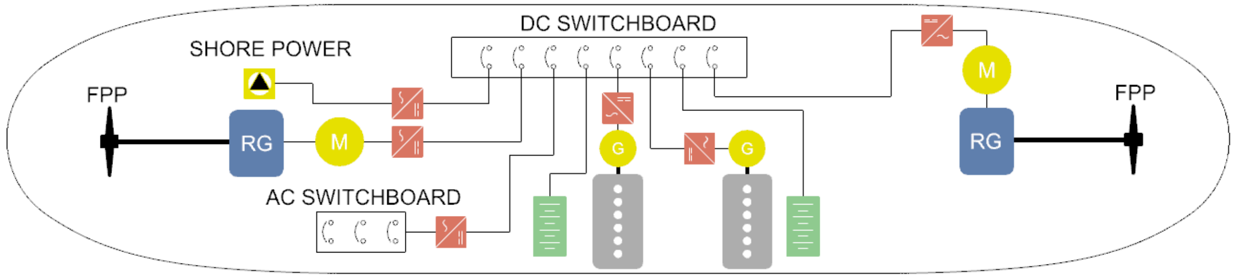

Figure 6: Diesel Electric Hybrid

4.3.1 EQUIPMENT

This arrangement specifically considers:

- 2 (ea) Cummins X-15 propulsion diesel constant speed generators rated for 373 kW
- 2 (ea) Propulsion motors/generator rated for 373 ekW
- 2 (ea) Twin Disc Reduction Gear
- 2 (ea) conventional shaft lines
- 2 (ea) fixed pitch propellers
- 164 kWh Batteries
- 650 kW shore power charging rate for 30 minutes

4.3.2 OPERATING SCHEME

This arrangement assumes that one generator will only run during transit at 80% load to supply the propulsion power and provide some charge to the batteries. The second generator will be on standby. Shore power would then be used to fully charge the batteries during the load and unload at the New London Terminal. This results in an approximate shore power demand 325 kW for thirty minutes which equates to 162 kWh. Operation in diesel-electric mode remains a viable option.

4.4 OPTION 4 | METHANOL FUELED

Methanol is a popular alternative fuel and is a candidate for fueling internal combustion engines. Methanol produces less CO2, NOX, and CO emissions and less particulate matter than diesel. However, methanol is very toxic to human and environmental health. Exposure to methanol can cause skin irritation, long term organ damage, blindness and death. Methanol is extremely flammable and methanol vapor is heavier than air so it can accumulate on the deck and in confined spaces. Storing methanol is challenging due to the hazardous zones and risk-reduction measures that must be considered in case of a methanol leak. As a low-flashpoint fuel, methanol tanks must be secured with an inert gas blanket (e.g. nitrogen).

4.4.1 ARRANGEMENT CONSIDERATIONS

Methanol has a lower energy density (chemical energy per unit volume) and increased fire and explosion risks compared to diesel. Methanol's characteristics yield the following considerations for applications on vessels.

- Increased fuel tank volumes or decreased endurance

- Increased parasitic loads for added ventilation
- Additional alarms and monitoring systems
- More extensive fixed gas firefighting systems
- The addition of a tall mast for safe remote release of any gas leaks
- Requirement for substantial automation
- Extensive crew training requirements
- Double wall piping requirements (increased cost, space, maintenance, active ventilation requirements or pressurized annular space with inert gas)
- Explosion-proof motors, electronics and lighting
- Additional structural fire protection insulation
- Arrangement complications
    - Ventilated cofferdams around all fuel tanks or external fuel tanks
    - Restricted crew access to hazardous spaces
    - Air locks on hull spaces that do not open to an exterior deck
    - Careful consideration of location of compartment openings (ventilation, doors, etc.) with regards to hazardous zones
    - Bunkering station location
    - Balancing the vessel considering the fuel arrangement and hazardous zone issues
    - If using alternative fuels in an internal combustion engine, may need to mitigate NOx (adding a selective catalytic reducer, DEF tanks, etc.)
- Stability issues for external tanks

4.4.2 FUEL PROPERTIES

Table 4 shows a comparison of the properties of diesel and methanol. Methanol has roughly half the energy density and specific energy of diesel, indicating that for the same endurance the vessel will have to carry twice as much fuel weight and volume. The last column shows the inherent CO_2 produced during combustion per unit energy. Methanol has slightly lower CO2 production for the same energy from combustion (not including any additional auxiliary loads required to safely utilize alternative fuels). Battery storage is provided in the last row to illustrate how much heavier and more voluminous battery banks are compared to any fuel.

Table 4: Various Fuel Properties

FUEL	DENSITY	SPECIFIC ENERGY	ENERGY DENSITY	CO2 PRODUCTION
Diesel	846 kg/m^3	42.6 MJ/kg	36 MJ/L	0.27 kgCO_2/kW (LHV)
Methanol	791 kg/m^3	19.9 MJ/kg	15.8 MJ/L	0.25 kgCO_2/kW (LHV)
Batteries	1128 kg/m^3	0.27 MJ/kg	0.28 MJ/L	N/A

4.4.3 FUEL PRICES

Between 2018 and 2022, FIFD has experienced a wide range of diesel prices ranging from $1.37 to $4.12 with an average price of $2.76. The cost of fuel is expected to rise in the future, but for this report a diesel price of $2.76 will be used. Because alternative fuels have varied fuel densities (energy per unit volume) fuel prices shown in Table 5 are in dollars per unit energy. Note that the methanol prices do not include the logistical costs of delivering the methanol to FIFD, so final methanol prices may be higher.

Table 5: Fuel Prices

FUEL	$/kWh*	$/GAL
Diesel	0.073	2.76
Methanol	0.128	2.12
*Heat of combustion (lower heating value)		

4.4.4 ENGINE AVAILABLITY

Methanol can be used to fuel an internal combustion engine, but there are limited methanol engines available in the USA that meet EPA regulations and all of which are too large for this vessel. However, there is one company in Denmark that has a IMO Tier III 505 HP methanol engine available. This engine runs on Methanol (MD97) which is a mix of 96.9% Methanol (IMPCA), 3% Beraid 3555M, 0.1% Armolube 211. For this report, we have used this engine as a representative of what methanol engines will be capable of when they become available in the US and have EPA approval.

It is unknown how long it will be before methanol engines are available in the US and what other methanol equipment will be available at that time. Methanol fuel cells are slowly gaining traction and were assumed to be capable of supplying the necessary power that otherwise would be supplied by a ship service generator.

4.4.5 EQUIPMENT

This arrangement specifically considers:

- 2 (ea) variable speed 375 kW methanol propulsion engines
- 2 (ea) Twin Disc reduction gear
- 2 (ea) conventional shaft lines
- 2 (ea) fixed pitch propellers
- 2 (ea) methanol fuel cells

4.4.6 OPERATING SCHEME

This arrangement is similar to Option 1, it assumes a 50/50 power split between the aft and forward propellers during maneuvering and an 80/20 power split between aft and forward propellers during transit. When the vessel is in port at either terminal for loading and unloading the propulsion engines will be shut down, and fuel cells will continue to operate to provide for the necessary hotel loads.

5. DISCUSSION

Utilizing the power profile presented in Section 3.3, this study examines how each of the different propulsion options will perform. As shown in Appendix A, these powering calculations include the determination of the power required for propulsion and hotel loads and the energy source utilized to meet the total demand. The powering calculations also determine the quantity of batteries required for the hybrid and shore power options.

5.1 CAPITAL COST

EBDG obtained new Rough Order of Magnitude (ROM) equipment quotes to compile total propulsion system costs. The equipment cost does not include any variations in labor and materials, but it can be assumed that any hybrid system will require higher installation costs as such systems are still relatively novel.

The Fleet Replacement report [2] estimated a conventional diesel mechanical double-ended ferry suitable for the needs of the Fisher Island community would cost approximately $12.75 million. Costs shown below are for a single vessel excluding terminal modifications and shore side battery charging station.

Table 6 summarizes the system equipment costs and their impact on the overall vessel cost.

Table 6: Propulsion and Vessel Capital Cost Summary

OPTION	BASE	PROPULSION SYSTEM	TOTAL	% DIFFERENCE FROM OP 1
Option 1 Diesel Mechanical	$12,418,000	$332,000	$12,750,000	-
Option 2 DM Hybrid w/ESS	$12,418,000	$1,515,333	$13,933,333	9%
Option 3 DE Hybrid w/ESS and SP	$12,418,000	$1,611,561*	$14,029,561	10%
Option 4 | Methanol	$12,418,000	$917,937	$13,335,937	5%

* Does not include shore power system

5.2 OPERATING COST

5.2.1 FUEL COST

Fuel consumption is a function of the time at load and the associated fuel consumption rate for that load. Utilizing the power profile and vessel schedule presented in Section 3.3 as well as the average number of yearly trips presented in Section 3.1, the annual fuel consumption and consequently annual fuel cost is calculated. Fuel consumption rates for each engine loading condition are based upon vendor information, [3] [4] [5] [6].

Diesel fuel is assumed to cost $2.76/gallon.

The resulting annual fuel consumption and costs are tabulated in Table 7.

Table 7: Fuel consumption and Cost

ARRANGEMENT OPTION	RT FUEL CONSUMPTION	ANNUAL FUEL CONSUMPTION	ANNUAL FUEL CONSUMPTION COST ($)	% DIFFERENCE FROM OP 1

Option 1 Diesel Mechanical	33.5 gal	43,563 gal	$120,233	-
Option 2 DM Hybrid w/ESS	36.7 gal	48,023 gal	$132,544	10%
Option 3 | DE Hybrid w/ESS and SP	30.7 gal	39,920 gal	$110,180	-8%
Option 4 | Methanol	60.9 gal	79,178 gal	$167,858	40%

The most fuel-efficient system is Option 3, the diesel electric hybrid arrangement with an ESS and shore charging. This arrangement cuts engine operating hours by only running the generator during transit.

While option 3 will consume less fuel there is an additional expense of electricity consumption and cost. Electricity cost is typically a combination of electricity consumption charges ($/kWh), and demand charges ($/kW). The electrical supplier for the New London Terminal is Eversource. Eversource has various rate classes that depend on the type of service and the demand. Currently, FIFD is in Rate 30 which is a "Small General Electric Service" with demand less than 200 kW. Eversource classifies demand as the greatest amount of electricity used in any half-hour period during the billing cycle. If a battery storage system is placed on shore, it may be possible to keep the demand under 200 kW. Costs for a shoreside battery storage system were not included in this study.

If a battery storage system is not placed on shore, then the shore charging system could change FIFD to Rate 56 – "Intermediate Time-of-Day Electrical Service – Non-Manufacturers" which is for demand greater than 350 kW but less than 1000 kW.

Table 8 shows the summary of the electrical utility & generation rates including the yearly cost for only the shore charging, other terminal electrical demands were not included. The yearly cost is based on a charge of 162 kWh per round trip (See Appendix A) which equates to 210,762 kWh per year. For Rate 30 the demand was assumed to be 175 kW. For Rate 56 the demand is 307.8 kVA (See Appendix A), Rate 56 uses kVA for demand instead of kW, a 0.95% power factor has been assumed. Additionally, on-peak charging has been assumed for 60% of the trips. See Appendix C for further breakdown of calculations and Appendix D for the Eversource electrical and generation costs for all Rate classes.

Table 8: Summary of Electrical Charges

	RATE 30	RATE 56
Monthly Charge	$44	$350
Rate per Demand KW	$25.33	
Rate per Demand kVA	-	$19.56
Rate per kWh	$0.11	
Rate per On-Peak kWh		$0.1218
Rate per Off-Peak kWh		$0.1159
Total Yearly Cost	$56,456	$101,621

5.2.2 ENERGY STORAGE SYSTEM COST

Based upon discussions with battery manufacturers, Energy Storage Systems (ESS) cost $650/kWh for replacement. The cost per kWh for ESSs is expected to continue to fall as the production of high-quality lithium-ion batteries increases and marine hybrid technology becomes more widespread. ESSs are assumed to have a 10-year life. If the cost to replace the ESS is considered an operational cost, a simplified annual cost estimate is the replacement cost divided by 10. Table 9 presents the ESS replacement cost for each of the options that include ESSs. For simplicity, this estimate does not account for any salvage value earned for recycling the old ESS or the cost to remove and install new ESS.

Table 9: Battery Replacement Cost

ARRANGEMENT OPTION	BATTERY QTY (KWH)	COST TO REPLACE	ANNUAL COST
Option 2 | DM Hybrid w/ESS	50	$32,500	$3,250
Option 3 | DE Hybrid w/ESS and SP	164	$106,600	$10,660

5.2.3 MAINTENANCE

Systems with more moving parts require more maintenance, so hybrid systems that reduce the quantity of engines or the operating hours of said engines are expected to reduce the maintenance burden of the system.

Option 1, the diesel mechanical system, is considered the baseline as it is most like the M/V MUNNATAWKET. The propulsion engines run from departure to arrival and shut down at the terminals assuming the vessel is tied up or held in position without pushing against the dock with the propellers engaged. A ship service generator must run for the entire day to provide hotel loads.

Option 2, the diesel mechanical hybrid with ESS option reduces the main engine operating hours and eliminates the use of the ship service generator.

Option 3, the diesel electric hybrid with ESS and shore power option would reduce the operating hours by eliminating the use of a generator and the ship service generator.

Option 4, the methanol system, is similar to option 1 with the same engine and fuel cell operating hours.

In a recent study, EBDG estimated the average annual maintenance over a 30-year period for diesel mechanical engine and reduction gear to be approximately $10.25 per engine operating hour, for propulsion diesel electric generator and reduction gear to be approximately $13.75 per propulsion generator operating hour, for ship service generators to be approximately $3.75 per generator operating hour and $6,115 per year for battery system maintenance. It has been assumed that the methanol engine would have similar maintenance costs as a diesel engine. It has also been assumed that the fuel cell would have minimal maintenance cost. Yearly maintenance costs for the four options are given in Table 10. See Appendix B for engine and generator hour calculations.

Table 10: Yearly Maintenance

ARRANGEMENT OPTION	YEARLY MECHANICAL	YEARLY BATTERY	TOTAL YEARLY
Option 1 | Diesel Mechanical	$60,879	-	$60,879
Option 2 | DM Hybrid w/ESS	$22,982	$6,115	$29,097
Option 3 | DE Hybrid w/ESS and SP	$26,833	$6,115	$32,948
Option 4 | Methanol	$60,879	-	$60,879

Options 2 and 3 are hybrid and will incorporate electrical equipment that will be unique to this vessel when compared to the diesel mechanical option. If a hybrid solution is selected, FIFD will require different service providers and the employed staff will require different knowledge and skills than is currently required. The marine hybrid market is constantly growing in the United States and worldwide. System failures have been minimal and selecting a system provider with a proven track record can minimize the operational risks. There are several hybrid system equipment providers with local support in the United States and many offer remote monitoring and support for operators.

5.3 EMISSIONS

Utilizing the power profile and vessel schedule presented in Section 3.3 as well as the average number of yearly trips presented in Section 3.1, the annual emissions generation is calculated. The standard practice is to measure emissions in metric units. CO_2 generation is a function of fuel burned; one metric ton of CO_2 is generated for every 99.4 gallons of diesel burned. All other emissions are based on the emissions data provided by the engine manufacturers, [3] [5] [6].

Table 11 presents the annual emissions generation of Options 1, 2, and 4 as a percentage of Option 1.

Table 11: Annual Emissions

	EMISSIONS GENERATION				
Arrangement Option	CO_2 (% of 1)	NO_X (% of 1)	CO (% of 1)	HC (% of 1)	PM (% of 1)
Option 1 | Diesel Mechanical	100%	100%	100%	100%	100%
Option 2 | DM Hybrid w/ESS	110%	116%	87%	124%	121%
Option 3 | DE Hybrid w/ESS and SP	92%	97%	63%	104%	89%
Option 4 | Methanol	62%	30%	71%	316%	0%

Note that hydrocarbon and particulate matter data was not available for the Onan 55 kW generator used in Option 1 and 4, so the EPA Tier 3 limits for hydrocarbon and particulate matter are used to estimate the emissions for this generator.

For Option 3, it is critical to note that unless the shore power is from a renewable source, reducing the locally generated emissions simply shifts the emissions to a location upstream. Per a 2018 report [7] the energy Eversource purchases for Connecticut is at minimum 27.5% renewable.

6. SENSITIVITY ANALYSIS

6.1 FUEL PRICE

Table 12 shows the estimated yearly fuel costs at various prices per gallon.

Table 12: Fuel consumption and Cost

ARRANGEMENT OPTION	CONSUMPTION	$2.76/GAL	$4.00/GAL	$6.00/GAL
Option 1 | Diesel Mechanical	43,563 gal	$120,233	$174,252	$261,378
Option 2 | DM Hybrid w/ESS	48,023 gal	$132,544	$192,092	$288,138
Option 3 | DE Hybrid w/ESS and SP*	39,920 gal	$166,636 - $211,801	$216,136 - $261,301	$295,976 - $341,141

*Includes electrical costs.

Even at a diesel cost of $6.00 per gallon, Options 1 and 2 still have a cheaper overall fuel cost than Option 3.

6.2 ESS COST

Table 13 shows the estimated yearly ESS replacement cost for various prices per kWh.

Table 13: Annual ESS Replacement and Overall Maintenance Costs

ARRANGEMENT OPTION	$650/KWH	$500/KWH	$400/KWH	$300/KWH
Option 2 | DM Hybrid w/ESS	$32,347	$31,597	$31,097	$30,597
Option 3 | DE Hybrid w/ESS and SP	$43,608	$41,148	$39,508	$37,868

From Table 10, Option 1 had a yearly maintenance cost of $60,879. Therefore, at $650/kWh the overall maintenance cost for Options 2 and 3 are lower than Option 1. As prices fall, Options 2 and 3 become even more attractive in regard to maintenance costs.

7. CONCLUSIONS

This study evaluated 4 different propulsion systems for the next ferry for FIFD, one non-hybrid system, two hybrid systems, and one alternative fuel system. Each of these options has merits and drawbacks as summarized in the following paragraphs. Additionally, Table 14 is provided for a succinct summary. Once selected, the propulsion system should be optimized for a route and power profile unique to the system.

Option 1 is considered to best match the equipment installed on the M/V RACE POINT. This system is a simple system and thus cheapest to purchase and install. It is the tried-and-true method of vessel propulsion, prevalent in all marine markets. While the maintenance costs may be higher than Options 2 and 3, the maintenance of the vessel will be simple in that it is no different than the M/V RACE POINT and will not require any additional specialized training or vendor interaction. Furthermore, a diesel mechanical system is often one of the highest efficiency options as the energy transformations are minimized; combustion energy is transferred to mechanical energy to propel the vessel. Hence this arrangement has one of the better fuel consumption values. That said, this option limits FIFD's ability to update the propulsion system over time without a whole vessel repower. This system does not readily allow the addition of batteries and the reduction of the vessel's dependency on non-renewable fuel.

Option 2 improves on Option 1 with the addition of a PTI/PTO which could more easily increase maneuvering power. This system is really designed for the owner that is uncertain about the electric propulsion future and wishes to have the fallback option of diesel mechanical. It is the cheaper of the two hybrid options as it requires fewer batteries than Option 3. From a performance perspective this option has higher fuel consumption than Option 1 and other than carbon monoxide it produces more emissions. The maintenance burden is lower than Option 1. The installation would be complex and does not appear to offer much benefit for all the installed equipment. Since this is a hybrid system there may be grants available to assist with the cost to build the vessel.

Option 3 reduces the maintenance cost and offers environmental improvements over Option 1. However, Option 3 requires installing a shore charging system, upgrading the existing electrical infrastructure to get more power availability, and increases the fuel cost when the cost of the electricity is included. Similar to Option 2, the installation would be complex and does not appear to offer much benefit for all the installed equipment.

Option 4 represents a future option as it is not currently available in the USA, and it is unknown when small methanol engines will be available for marine use. This system is not a simple system and requires additional design considerations regarding vessel arrangement and the storage of methanol.

8. ABBREVIATIONS

DM	Diesel Mechanical
DE	Diesel Electric
ESS	Energy Storage System
ekW	Electrical Power in Kilowatts
FPP	Fixed Pitch Propeller
kW	Kilowatt
kWh	Kilowatt-hour
SP	Shore Power

Table 14: Summary of Results

ARRANGEMENT OPTION	CAPITAL COST	ANNUAL OPERATING COST ($)			EMISSIONS (% OF OP 1)				
		Fuel/Elec Cost @ $2.79/Gal for Fuel	Maintenance	Battery Replacement	CO_2	NO_X	CO	HC	PM
Option 1 | Diesel Mechanical	$12.75M	$120,233	$60,879	-	100	100	100	100	100
Option 2 | DM Hybrid w/ESS	$13.93M	$132,544	$29,097	$3,250	110	116	87	124	121
Option 3 | DM Hybrid w/ESS and SP*	$14.03M	$166.6k - $211.8k	$32,948	$10,660	92	97	63	104	89
Option 4 | Methanol	$13.13M	$167,858	$60,879	-	62	30	71	316	0

* Does not include shoreside shore power charging system infrastructure and installation

9. REFERENCES

[1] DNV-GL, "DNV GL Handbook for Maritime and Offshore Battery Systems," Report No. 2016-1056 Revision V1.0, Document No. 15DJV2L-2, 12/19/2016.

[2] Elliott Bay Design Group, "New Vehicle Ferry: Fleet Replacement," 2023.

[3] Cummins Inc, "Propulsion Marine Engine Performance Data", "Curve No. M-11676: X15-M," 04/29/22.

[4] Cummins Inc, "Marine Generators", "40-65 KW," 09/2021.

[5] Cummins Inc, "Auxiliary Marine Engine Performance Data", "Curve No. FR11677: X15-D(M)," 04/29/22.

[6] Nordhavn Power Solutions, "Variable Speed 375 kW (505 HP) at 1800 RPM".

[7] Eversource Energy, "2018 Sustainability Report," 2018.

APPENDIX A

Powering Calculations

OPTION 1: DIESEL MECHANICAL PROPULSION CALCULATIONS

Operational Profile		Power Demand					Power Supply						Battery Sizing	
Loading Condition	Duration min	Prop. Load 1 kW	Prop. Load 2 kW	Hotel Load kW	Propulsion kW	Total kW	Engine 1 Power kW	Engine 2 kW	Generator 1 kW	Generator 2 kW	Shore Power kW	Battery Power kW	Battery Energy kWh	Battery SoC kWh
Included Efficiency		DM	DM	Hotel			none	none	none	none	Chg/Disch	none	Eff_Chg	
Value		0.965	0.965	0.98			1	1	1	1	0.9506	1	Eff_Disc	
Loading New London	15	0.0	0.0	39.3		39.3	0.0	0.0	39.3	0.0			0.00	0.0
Accelerating	1.5	142.2	142.2	39.3		323.7	142.2	142.2	39.3	0.0			0.00	0.0
Transit to Fisher Islan	45	152.9	38.2	39.3		230.4	152.9	38.2	39.3	0.0			0.00	0.0
Arrival Maneuvering	5	113.8	113.8	39.3		266.8	113.8	113.8	39.3	0.0			0.00	0.0
Unloading Fisher Islan	15	0.0	0.0	39.3		39.3	0.0	0.0	39.3	0.0			0.00	0.0
Loading at Fisher Islar	15	0.0	0.0	39.3		39.3	0.0	0.0	39.3	0.0			0.00	0.0
Departure Manouverir	5	142.2	142.2	39.3		323.7	142.2	142.2	39.3	0.0			0.00	0.0
Transit to New Londo	45	38.2	152.9	39.3		230.4	38.2	152.9	39.3	0.0			0.00	0.0
Arrival Maneuvering	5	113.8	113.8	39.3		266.8	113.8	113.8	39.3	0.0			0.00	0.0
Unloading New Londo	15	0.0	0.0	39.3		39.3	0.0	0.0	39.3	0.0			0.00	0.0
	Trip Time min					Energy kWh	Energy kWh	Energy kWh	Energy kWh	Energy kWh	Power kWh	Losses kWh		Battery Net SoC kWh
	166.5					464	178	178	109	0	0	0		0.00

Operational Profile	Engine Usage								Fuel Consumption			
Loading Condition	Eng 1 Pwr %	Eng 1Time min	Eng 2 Pwr %	Eng 2 Time min	Gen1 Pwr %	Gen 1 Time min	Gen2 Pwr %	Gen 2 Time min	Eng.1 BSFC lb/hp-hr	Eng.2 BSFC lb/hp-hr	Gen.1 BSFC lb/hp-hr	Gen.2 BSFC lb/hp-hr
Loading New London	0%	0.0	0%	0.0	71%	15.0	0%	0.0	0.468	0.468	0.440	0
Accelerating	42%	1.5	42%	1.5	71%	1.5	0%	0.0	0.359	0.359	0.440	0
Transit to Fisher Islan	46%	45.0	11%	45.0	71%	45.0	0%	0.0	0.357	0.388	0.440	0
Arrival Maneuvering	34%	5.0	34%	5.0	71%	5.0	0%	0.0	0.368	0.368	0.440	0
Unloading Fisher Islan	0%	0.0	0%	0.0	71%	15.0	0%	0.0	0.468	0.468	0.440	0
Loading at Fisher Islar	0%	0.0	0%	0.0	71%	15.0	0%	0.0	0.468	0.468	0.440	0
Departure Manouverir	42%	5.0	42%	5.0	71%	5.0	0%	0.0	0.359	0.359	0.440	0
Transit to New Londo	11%	45.0	46%	45.0	71%	45.0	0%	0.0	0.388	0.357	0.440	0
Arrival Maneuvering	34%	5.0	34%	5.0	71%	5.0	0%	0.0	0.368	0.368	0.440	0
Unloading New Londo	0%	0.0	0%	0.0	71%	15.0	0%	0.0	0.468	0.468	0.440	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
	0%		0%	0.0	0%		0%	0.0	0	0	0	0
		Op. Time/Eng min		Op. Time/Eng min		Op. Time/Gen min		Op. Time/Gen min	Eng Fuel gal	Eng Fuel gal	Gen Fuel gal	Gen Fuel gal
		106.5		106.5		166.5		0.0	12.2	12.2	9.1	0

Operational Profile	Engine 1 Emissions				Engine 2 Emissions				Generator Emissions			
Loading Condition	NOX g/hp-hr	CO g/hp-hr	HC g/hp-hr	PM g/hp-hr	NOX g/hp-hr	CO g/hp-hr	HC g/hp-hr	PM g/hp-hr	NOX g/hp-hr	CO g/hp-hr	HC g/hp-hr	PM g/hp-hr
	g/hr-hp				g/hr-hp				g/hr-hp			
Loading New London	0	0	0	0	0	0	0	0	3.497	0.82027	0.07457	0.045488
Accelerating	3.65	0.35	0.11	0.06	3.65	0.35	0.11	0.06	3.497	0.82027	0.07457	0.045488
Transit to Fisher Islan	3.65	0.35	0.11	0.06	3.65	0.35	0.11	0.06	3.497	0.82027	0.07457	0.045488
Arrival Maneuvering	3.65	0.35	0.11	0.06	3.65	0.35	0.11	0.06	3.497	0.82027	0.07457	0.045488
Unloading Fisher Islan	0	0	0	0	0	0	0	0	3.497	0.82027	0.07457	0.045488
Loading at Fisher Islar	0	0	0	0	0	0	0	0	3.497	0.82027	0.07457	0.045488
Departure Manouverir	3.65	0.35	0.11	0.06	3.65	0.35	0.11	0.06	3.497	0.82027	0.07457	0.045488
Transit to New Londo	3.65	0.35	0.11	0.06	3.65	0.35	0.11	0.06	3.497	0.82027	0.07457	0.045488
Arrival Maneuvering	3.65	0.35	0.11	0.06	3.65	0.35	0.11	0.06	3.497	0.82027	0.07457	0.045488
Unloading New Londo	0	0	0	0	0	0	0	0	3.497	0.82027	0.07457	0.045488
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	NOX g	CO g	HC g	PM g	NOX g	CO g	HC g	PM g	NOX g	CO g	HC g	PM g
	870	83	26	14	870	83	26	14	512	120	11	7

OPTION 2: DIESEL MECHANICAL HYBRID WITH ESS PROPULSION CALCULATIONS

Operational Profile		Power Demand							Power Supply				Battery Sizing		Engine Usage				Fuel Consumption		Engine 1 Emissions				Engine 2 Emissions			
Loading Condition	Duration	Prop. Load 1		Prop. Load 2		Hotel Load	Propulsion Auxiliary	Total	Engine 1 Power	Engine 2 Power	Shore Power	Battery Power	Battery Energy	Battery SoC	Eng 1 Pwr	Eng 1 Time	Eng 2 Pwr	Eng 2 Time	Eng.1 BSFC	Eng.2 BSFC	NOX	CO	HC	PM	NOX	CO	HC	PM
	min	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kWh	kWh	%	min	%	min	lb/hp-hr	lb/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr
Included Efficiency		DM	DMH	DM	DMH	Hotel	Hotel		none	none	none	none	Eff_Chg								g/hr-hp				g/hr-hp			
Value		0.9653	0.938364	0.9653	0.938364	0.98	0.98		1	1	1	1	Eff_Disch															
Loading New London	15	0.0	0.0	0.0	0.0	39.3	20.4	59.7	0.0	0.0		59.71	16.46	-16.5	0%	0.0	0%	0.0	0.468	0.468	0	0	0	0	0	0	0	0
Accelerating	1.5	142.2	0.0	0.0	146.3	39.3	20.4	348.2	299.6	0.0		48.52	1.34	-17.8	89%	1.5	0%	1.5	0.367	0.468	3.65	0.35	0.11	0.06	0	0	0	0
Transit to Fisher Islar	45	152.9	0.0	0.0	39.3	39.3	20.4	251.9	299.6	0.0		-47.73	-35.08	17.3	89%	45.0	0%	45.0	0.367	0.468	3.65	0.35	0.11	0.06	0	0	0	0
Arrival Maneuvering	5	113.8	0.0	0.0	117.0	39.3	20.4	290.5	299.6	0.0		-9.16	-0.75	18.0	89%	5.0	0%	5.0	0.367	0.468	3.65	0.35	0.11	0.06	0	0	0	0
Unloading Fisher Isla	15	0.0	0.0	0.0	0.0	39.3	20.4	59.7	0.0	0.0		59.71	16.46	1.6	0%	0.0	0%	0.0	0.468	0.468	0	0	0	0	0	0	0	0
Loading at Fisher Isla	15	0.0	0.0	0.0	0.0	39.3	20.4	59.7	0.0	0.0		59.71	16.46	-14.9	0%	0.0	0%	0.0	0.468	0.468	0	0	0	0	0	0	0	0
Departure Maneuverii	5	0.0	146.3	142.2	0.0	39.3	20.4	348.2	0.0	299.6		48.52	4.46	-19.4	0%	0.0	89%	0.0	0.468	0.367	0	0	0	0	3.65	0.35	0.11	0.06
Transit to New Londor	45	0.0	39.3	152.9	0.0	39.3	20.4	251.9	0.0	299.6		-47.73	-35.08	15.7	0%	0.0	89%	0.0	0.468	0.367	0	0	0	0	3.65	0.35	0.11	0.06
Arrival Maneuvering	5	0.0	117.0	113.8	0.0	39.3	20.4	290.5	0.0	299.6		-9.16	-0.75	16.5	0%	0.0	89%	0.0	0.468	0.367	0	0	0	0	3.65	0.35	0.11	0.06
Unloading New Londc	15	0.0	0.0	0.0	0.0	39.3	20.4	59.7	0.0	0.0		59.71	16.46	0.0	0%	0.0	0%	0.0	0.468	0.468	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
															0%		0%		0	0	0	0	0	0	0	0	0	0
	Trip Time							Energy	Energy	Energy	Power	Losses		Battery Net SoC		Op. Time/Eng		Op. Time/Eng	Eng Fuel	Eng Fuel	NOX	CO	HC	PM	NOX	CO	HC	PM
	min							*kWh*	*kWh*	*kWh*	*kWh*	*kWh*		*kWh*		*min*		*min*	*gal*	*gal*	*g*	*g*	*g*	*g*	*g*	*g*	*g*	*g*
	166.5							524	257		0	-8		0.00		51.5		51.5	17.8	19.1	1259	121	38	21	1344	129	41	22

OPTION 3: DIESEL ELECTRIC WITH ESS AND SP PROPULSION CALCULATIONS

Operational Profile		Power Demand					Power Supply			Battery Sizing		Generator Usage		Fuel Cons.	Engine Emissions			
Loading Condition	**Duration**	**Prop. Load 1**	**Prop. Load 2**	**Hotel Load**	**Propulsion Auxiliary**	**Total**	**Gen Power**	**Shore Power**	**Battery Power**	**Battery Energy**	**Battery SoC**	**Gen Pwr**	**Gen Time**	**Gen BSFC**	**NOX**	**CO**	**HC**	**PM**
	min	kW	kW	kW	kW	kW	kW	kW	kW	kWh	kWh	%	min	lb/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr	g/hp-hr
Included Efficiency		DE	DE	Hotel	Hotel		none	none	none	Eff_Chg					g/hr-hp			
Value		0.925227	0.925227	0.98	0.98		1	1	1	Eff_Disch								
Loading New London	15	0.0	0.0	39.3	40.8	80.1	0.0	324.6	-244.44	-59.89	59.9	0%	0.0	0	0	0	0	0
Accelerating	1.5	148.3	148.3	39.3	40.8	376.8	0.0		376.80	10.39	49.5	0%	0.0	0	0	0	0	0
Transit to Fisher Island	45	159.5	39.9	39.3	40.8	279.5	298.4		-18.90	-13.89	63.4	80%	45.0	0.363	3.65	0.3	0.11	0.052
Arrival Maneuvering	5	118.7	118.7	39.3	40.8	317.5	0.0		317.48	29.18	34.2	0%	0.0	0	0	0	0	0
Unloading Fisher Island	15	0.0	0.0	39.3	40.8	80.1	0.0		80.12	22.09	12.1	0%	0.0	0	0	0	0	0
Loading at Fisher Island	15	0.0	0.0	39.3	40.8	80.1	0.0		80.12	22.09	-10.0	0%	0.0	0	0	0	0	0
Departure Maneuvering	5	148.3	148.3	39.3	40.8	376.8	0.0		376.80	34.63	-44.6	0%	0.0	0	0	0	0	0
Transit to New London	45	39.9	159.5	39.3	40.8	279.5	298.4		-18.90	-13.89	-30.7	80%	45.0	0.363	3.65	0.3	0.11	0.052
Arrival Maneuvering	5	118.7	118.7	39.3	40.8	317.5	0.0		317.48	29.18	-59.9	0%	0.0	0	0	0	0	0
Unloading New London	15	0.0	0.0	39.3	40.8	80.1	0.0	324.6	-244.44	-59.89	0.0	0%	0.0	0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
												0%		0	0	0	0	0
	Trip Time					Trip Energy	Gen Energy	Shore Power	Batt. Losses		Battery Net SoC		Op. Time/Gen	Gen Fuel	NOX	CO	HC	PM
	min					*kWh*	*kWh*	*kWh*	*kWh*		*kWh*		*min*	*gal*	*g*	*g*	*g*	*g*
	166.5					593	448	162	-17		0.00		90.0	30.7	2191	180	66	31

APPENDIX B

Maintenance Calculations

OPERATING HOUR CALCULATIONS

Table 15: Engine/Generator Operating Hours

	DIESEL MECHANICAL	DM HYBRID W/ESS	DE HYBRID W/ESS & SP
Total Round Trips per Year	1,301	1,301	1,301
Qty Engines	2	2	-
Each Engine Operating Hours per Round Trip	1.78	0.86	-
Total Yearly Engine Operating Hours	4,618.55	2,233.38	-
Qty Generators	2	1	1
Total Generator Operating Hours per Round Trip	1.39	-	1.5
Total Yearly Generator Operating Hours	3,610.28	24	1,951.5

APPENDIX C

Electrical Cost Calculations

ELECTRICAL USAGE CALCULATIONS

	kW	kWh	kVA (pf=0.95)
Electricity Per Round Trip	324	162	307.8
Yearly Round Trips	1,301	1,301	
Yearly Electricity	421,524	210,762	-
On-Peak Electricity (60% of trips)	-	126,457.2	-
Off-Peak Electricity (40% of trips)	-	84,304.8	-

RATE 56 – "INTERMEDIATE TIME OF DAY ELECTRICAL SERVICE – NON-MANUFACTURERS"

	Cost	kWh	kVA	Frequency	Yearly Total
Distribution Customer Charge (per month)	$350.00	-	-	12	$4,200
Distribution Charge – Demand Charge (per kVA)	$7.91	-	307.8	12	$29,216.38
Electric System Improvements Charge – Demand Charge (per kVA)	$0.91	-	307.8	12	$3,361.18
Revenue Adjustment Mechanism (per kWh)	$0.0019	210,762	-	-	$404.66
Transmission Charge – Demand Charge (per kVA)	$10.88	-	307.8	12	$40,186.37
Combined Public Benefits Charge (per kWh)	$0.0073	210,762	-	-	$1,532.24
Competitive Transition Assessment Charge – Demand Charge (per kVA)	$(0.14)	-	307.8	12	$(517.10)
FMCC Delivery Charge – On-Peak (per kWh)	$(0.0309)	126,457.2	-	-	$(3,906.26)
FMCC Delivery Charge – Off-Peak (per kWh)	$(0.0068)	84,304.8	-	-	$(575.80)
Generation Service Charge – On-Peak (per kWh)*	$0.1435	126,457.2	-	-	$18,149.14
Generation Service Charge – Off-Peak (per kWh)*	$0.1135	84,304.8	-	-	$9,570.28

*July-December (2022) rates were used because January-June (2023) rates were higher than normal due to storm damage.

RATE 30 - "SMALL GENERAL ELECTRIC SERVICE"

	Cost	kWh	kW	Frequency	Yearly Total
Distribution Customer Charge (per month)	$44.00	-	-	12	$528.00
Distribution Charge – Demand Charge (per kW over 2kW)	$14.22	-	175	12	$29,862.00
Electric System Improvements Charge – Demand Charge (per kW)	$1.86	-	175	12	$325.50
Revenue Adjustment Mechanism (per kWh)	$0.0019	210,762	-	-	$404.66
Transmission Charge – Demand Charge (per kWh)	$9.36	-	175	12	$1,638.00
Combined Public Benefits Charge (per kWh)	$0.0075	210,762	-	-	$1,587.04
Competitive Transition Assessment Charge – Demand Charge (per kW over 2kW)	$(0.11)	-	175	12	$(19.25)
FMCC Delivery Charge (per kWh)	$(0.015)	210,762	-	-	$(3,161.43)
Generation Service Charge (per kWh)*	$0.12	210,762	-	-	$25,291.44

*July-December (2022) rates were used because January-June (2023) rates were higher than normal due to storm damage.

APPENDIX D

Eversource Electrical Rates & Generation Rates

Summary of Connecticut Electric Rates

Last Updated: March 1, 2023

The following rates are available to customers and have been approved by the State of Connecticut Public Utilities Regulatory Authority. In order to calculate a total bill, the Generation Service Charge (Standard Service or a competitive third-party supplier) would need to be included in addition to the Delivery Service Charges listed below.

001 – (Rate 1 – "Residential Electric Service")
Available for the entire electrical requirements of single-family residences, residential outbuildings, individual apartments and general service use (i.e. common areas) in apartment buildings, where residential use constitutes over 50% of the metered energy. This rate is also available for agricultural/farm customers.

- Distribution Customer Service Charge (per month): $9.62
- Distribution Charge (per kWh): $0.05844
- Electric System Improvements Charge (per kWh): $0.00997
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge (per kWh): $0.03681
- Combined Public Benefits Charge (per kWh): $0.01291
- Competitive Transition Assessment Charge (per kWh): -$0.00036
- FMCC Delivery Charge (per kWh): -$0.01702

005 – (Rate 5 – "Residential Electric Heating Service")
Available for the entire electrical requirements of single-family residences, residential outbuildings, individual apartments, and general service use (i.e. common areas) in apartment buildings, where residential use constitutes over 50% of the metered energy. This rate is also available for agricultural/farm customers.

This rate is not available to new applicants after December 21, 2006. However, this rate is available for requests for electric service at a service location assigned to Rate 5 on or before December 21, 2006.

Available only to customers who use electric energy as the primary space heating source and who enter into an agreement with the Company for a period of not less than twelve (12) months.

- Distribution Customer Service Charge (per month): $23.75
- Distribution Charge (per kWh): $0.03847
- Electric System Improvements Charge (per kWh): $0.00843
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge (per kWh): $0.03573
- Combined Public Benefits Charge (per kWh): $0.01291
- Competitive Transition Assessment Charge (per kWh): -$0.00036
- FMCC Delivery Charge (per kWh): -$0.01639

007 – (Rate 7 – "Residential Time-of-Day Electric Service")
Available for the entire electrical requirements of single-family residences, residential outbuildings, individual apartments, and general service use (i.e. common areas) in apartment buildings, where residential use constitutes over 50% of the metered energy. This rate is also available to agricultural/farm customers, recreational campgrounds/marinas (residential use only), and customers who have a solar heating system that is used as a source of space heating and for which electricity provides backup.

On-Peak: (Weekdays Noon – 8 p.m., Eastern Prevailing Time)
Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month): $9.62
- Distribution Charge
  - On-Peak (per kWh): $0.05513
  - Off-Peak (per kWh): $0.05513
- Electric System Improvements Charge (per kWh): $0.00997

- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
  - On-Peak (per kWh): $0.08558
  - Off-Peak (per kWh): $0.01841
- Combined Public Benefits Charge (per kWh): $0.01291
- Competitive Transition Assessment Charge (per kWh): -$0.00036
- FMCC Delivery Charge
  - On-Peak (per kWh): -$0.03957
  - Off-Peak (per kWh): -$0.00851

018 – (Rate 18 – "Controlled Water Heating Electric Service")
Available for controlled water heating electric service only. This rate is available to all customers, except residential customers whose sole source of domestic hot water is supplied by electricity. This rate is not available for any space heating or for commercial or industrial processes.

- Distribution Customer Service Charge (per month): $11.00
- Distribution Charge (per kWh): $0.02351
- Electric System Improvements Charge (per kWh): $0.00751
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge (per kWh): $0.03221
- Combined Public Benefits Charge (per kWh): $0.00753
- Competitive Transition Assessment Charge (per kWh): -$0.00037
- FMCC Delivery Charge (per kWh): -$0.01500

027 – (Rate 27 – "Small Time-Of-Day General Electric Service")
Available for the entire electrical requirements at a single service location measured through one metering installation where the customer's maximum demand is less than 350 kW.

On-Peak: (Weekdays Noon – 8 p.m. during Eastern Standard Time)
(Weekdays 1 p.m. – 9 p.m. during Daylight Saving Time)

Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month): $44.00
- Distribution Charge
  - Demand Charge (Over 2 kW): $14.22 per kW
- Electric System Improvements Charge
  - Demand Charge (Over 2 kW): $1.86 per kW
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
  - Demand Charge (Over 2 kW): $4.68 per kW
  - On-Peak (per kWh): $0.03608
  - Off-Peak (per kWh): $0.00805
- Combined Public Benefits Charge (per kWh): $0.00753
- Competitive Transition Assessment Charge
  - Demand Charge (Over 2 kW): -$0.11 per kW
- FMCC Delivery Charge
  - On-Peak (per kWh): -$0.03360
  - Off-Peak (per kWh): -$0.00750

029 – (Rate 29 – "Outdoor Recreational Lighting Electric Service")
Available for outdoor recreational lighting loads which are energized only between 7 p.m. and 7 a.m.

- Distribution Customer Service Charge (per month): $30.00
- Distribution Charge (per kWh): $0.12715
- Electric System Improvements Charge (per kWh): $0.02120

- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge (per kWh): $0.03221
- Combined Public Benefits Charge (per kWh): $0.00760
- Competitive Transition Assessment Charge (per kWh): -$0.00037
- FMCC Delivery Charge (per kWh): -$0.01500

030 – (Rate 30 – "Small General Electric Service")
Available for the entire electrical requirements at a single service location measured through one metering installation where the customer's maximum demand is less than 200 kW.

- Distribution Customer Service Charge (per month): $44.00
- Distribution Charge
    - Demand Charge (Over 2 kW): $14.22 per kW
- Electric System Improvements Charge
    - Demand Charge (Over 2 kW): $1.86 per kW
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
    - Demand Charge (Over 2 kW): $9.36 per kW
- Combined Public Benefits Charge (per kWh): $0.00753
- Competitive Transition Assessment Charge
    - Demand Charge (Over 2 kW): -$0.11 per kW
- FMCC Delivery Charge (per kWh): -$0.01500

035 – (Rate 35 – "Intermediate General Electric Service")
Available for the entire electrical requirements at a single service location measured through one metering installation where the customer's maximum demand is less than 200 kW.

- Distribution Customer Service Charge (per month): $270.00
- Distribution Charge
    - Demand Charge (per kW): $8.69
- Electric System Improvements Charge
    - Demand Charge (per kW): $1.09
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
    - Demand Charge (per kW): $10.63
- Combined Public Benefits Charge (per kWh): $0.00727
- Competitive Transition Assessment Charge
    - Demand Charge (per kW): -$0.13
- FMCC Delivery Charge (per kWh): -$0.01388

037 – (Rate 37 – "Intermediate Time-Of-Day General Electric Service")
Available for the entire electrical requirements at a single service location measured through one metering installation where the customer's maximum demand is less than 350 kW.

On-Peak: (Weekdays Noon – 8 p.m. during Eastern Standard Time)
(Weekdays 1 p.m. – 9 p.m. during Daylight Saving Time)

Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month): $270.00
- Distribution Charge
    - Demand Charge (per kW): $8.69
- Electric System Improvements Charge
    - Demand Charge (per kW): $1.09
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge

  - Demand Charge (per kW): $5.32
  - On-Peak (per kWh): $0.03359
  - Off-Peak (per kWh): $0.00754
- Combined Public Benefits Charge (per kWh): $0.00727
- Competitive Transition Assessment Charge
  - Demand Charge (per kW): -$0.13
- FMCC Delivery Charge
  - On-Peak (per kWh): -$0.03094
  - Off-Peak (per kWh): -$0.00727

040 – (Rate 40 – "Small Church and School Electric Service")
Available for the electrical requirements of churches and tax exempt schools where the customer's maximum demand is less than 350 kW.

- Distribution Customer Service Charge (per month): $65.00
- Distribution Charge (per kWh): $0.04701
- Electric System Improvements Charge (per kWh): $0.00803
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge (per kWh): $0.03125
- Combined Public Benefits Charge (per kWh): $0.00753
- Competitive Transition Assessment Charge (per kWh): -$0.00037
- FMCC Delivery Charge (per kWh): -$0.01413

041 – (Rate 41 – "Large Church and School Electric Service")
Available for the electrical requirements of churches and tax exempt schools where the customer's maximum demand is greater than or equal to 350 kW.

On-Peak: (Weekdays Noon – 8 p.m. during Eastern Standard Time)
(Weekdays 1 p.m. – 9 p.m. during Daylight Saving Time)

Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month): $350.00
- Distribution Charge
  - Demand Charge (per kW): $8.10
  - On-Peak (per kWh): $0.04717
  - Off-Peak (per kWh): $0.04717
- Electric System Improvements Charge (per kWh): $0.00559
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
  - Demand Charge (per kW): $16.36
  - On-Peak (per kWh): $0.04664
  - Off-Peak (per kWh): $0.01035
- Combined Public Benefits Charge (per kWh): $0.00727
- Competitive Transition Assessment Charge (per kWh): -$0.00037
- FMCC Delivery Charge
  - On-Peak (per kWh): -$0.02892
  - Off-Peak (per kWh): -$0.00642

055 – (Rate 55 – "Intermediate Time-Of-Day Electric Service - Manufacturers")
Available for the entire electrical requirements at a single service location measured through one metering installation. This rate is only applicable to customers that are manufacturers. Customers must also have an annual maximum demand greater than or equal to 350 kW, but less than 1000 kW.

On-Peak: (Weekdays Noon – 8 p.m. during Eastern Standard Time)
(Weekdays 1 p.m. – 9 p.m. during Daylight Saving Time)

Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month): $350.00
- Distribution Charge
  - Demand Charge (per kVA): $6.65
- Electric System Improvements Charge
  - Demand Charge (per kVA): $0.81
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
  - Demand Charge (per kVA): $8.75
- Combined Public Benefits Charge (per kWh): $0.00727
- Competitive Transition Assessment Charge
  - Demand Charge (per kVA): -$0.11
- FMCC Delivery Charge
  - On-Peak (per kWh): -$0.03036
  - Off-Peak (per kWh): -$0.00688

056 – (Rate 56 – "Intermediate Time-Of-Day Electric Service – Non-Manufacturers")
Available for the entire electrical requirements at a single service location measured through one metering installation. This rate is only applicable to customers that are not manufacturers. Customers must also have an annual maximum demand greater than or equal to 350 kW, but less than 1000 kW.

On-Peak: (Weekdays Noon – 8 p.m. during Eastern Standard Time)
(Weekdays 1 p.m. – 9 p.m. during Daylight Saving Time)

Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month): $350.00
- Distribution Charge
  - Demand Charge (per kVA): $7.91
- Electric System Improvements Charge
  - Demand Charge (per kVA): $0.91
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
  - Demand Charge (per kVA): $10.88
- Combined Public Benefits Charge (per kWh): $0.00727
- Competitive Transition Assessment Charge
  - Demand Charge (per kVA): -$0.14
- FMCC Delivery Charge
  - On-Peak (per kWh): -$0.03089
  - Off-Peak (per kWh): -$0.00683

057 – (Rate 57 – "Large Time-Of-Day Electric Service – Manufacturers")
Available for the entire electrical requirements at a single service location measured through one metering installation. This rate is only applicable to customers that are manufacturers. Customers must also have an annual maximum demand greater than or equal to 1000 kW.

On-Peak: (Weekdays Noon – 8 p.m. during Eastern Standard Time)
(Weekdays 1 p.m. – 9 p.m. during Daylight Saving Time)

Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month)
  - Less than 2000 kW: $1,100.00
  - 2000 kW, but less than 5,000 kW: $2,200.00
  - 5,000 kW and above: $4,200.00

- Distribution Charge
    - Demand Charge (per kVA): $5.45
- Electric System Improvements Charge
    - Demand Charge (per kVA): $0.74
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
    - Demand Charge (per kVA): $9.57
- Combined Public Benefits Charge (per kWh): $0.00727
- Competitive Transition Assessment Charge
    - Demand Charge (per kVA): -$0.12
- FMCC Delivery Charge
    - On-Peak (per kWh): -$0.03137
    - Off-Peak (per kWh): -$0.00676

058 – (Rate 58 – "Large Time-Of-Day Electric Service – Non-Manufacturers")
Available for the entire electrical requirements at a single service location measured through one metering installation. This rate is only applicable to customers that are not manufacturers. Customers must also have an annual maximum demand greater than or equal to 1000 kW.

On-Peak: (Weekdays Noon – 8 p.m. during Eastern Standard Time)
(Weekdays 1 p.m. – 9 p.m. during Daylight Saving Time)

Off-Peak: (All other hours)

- Distribution Customer Service Charge (per month)
    - Less than 2000 kW: $1,100.00
    - 2000 kW, but less than 5,000 kW: $2,200.00
    - 5,000 kW and above: $4,200.00
- Distribution Charge
    - Demand Charge (per kVA): $7.53
- Electric System Improvements Charge
    - Demand Charge (per kVA): $0.94
- Revenue Adjustment Mechanism (per kWh): $0.00192
- Transmission Charge
    - Demand Charge (per kVA): $12.42
- Combined Public Benefits Charge (per kWh): $0.00727
- Competitive Transition Assessment Charge
    - Demand Charge (per kVA): -$0.16
- FMCC Delivery Charge
    - On-Peak (per kWh): -$0.03075
    - Off-Peak (per kWh): -$0.00659

CL&P dba Eversource Energy
Standard Service Total Generation
(July 2022 through June 2023)

Rate/Description	GSC Rate (A)	FMCC-Generation Rate (B)	Total Generation Supply Rate C = A + B
	Standard Service (¢/kWh)		
Rate 1 & 5			
July - December (2022)	12.190	-0.140	**12.050**
January - June (2023)	24.322	-0.150	**24.172**
Rate 7			
On-Peak			
July - December (2022)	14.757	-0.140	**14.617**
January - June (2023)	26.949	-0.150	**26.799**
Off-Peak			
July - December (2022)	11.257	-0.140	**11.117**
January - June (2023)	23.449	-0.150	**23.299**
Rate 18, 29, 30, 35, 40 & 115			
July - December (2022)	12.390	-0.140	**12.250**
January - June (2023)	23.181	-0.150	**23.031**
Rate 27 & 37			
On-Peak			
July - December (2022)	14.395	-0.140	**14.255**
January - June (2023)	25.228	-0.150	**25.078**
Off-Peak			
July - December (2022)	11.395	-0.140	**11.255**
January - June (2023)	22.228	-0.150	**22.078**
Rate 41, 55 & 56 (less than 500 kW)			
On-Peak			
July - December (2022)	14.492	-0.140	**14.352**
January - June (2023)	25.325	-0.150	**25.175**
Off-Peak			
July - December (2022)	11.492	-0.140	**11.352**
January - June (2023)	22.325	-0.150	**22.175**
Rate 116 & 117			
July - December (2022)	12.635	-0.140	**12.495**
January - June (2023)	25.603	-0.150	**25.453**
Rate 119			
July - December (2022)	12.340	-0.140	**12.200**
January - June (2023)	23.152	-0.150	**23.002**

CL&P dba Eversource Energy
Last Resort Service Total Generation
(February 2023 through June 2023)

Rate/Description	Last Resort Service (¢/kWh) GSC Rate (A)	FMCC-Generation Rate (B)	Total Generation Supply Rate C = A + B
Rate 39			
February 2023	35.946	-0.150	**35.796**
March 2023	23.722	-0.150	**23.572**
April 2023	12.348	-0.150	**12.198**
May 2023	10.667	-0.150	**10.517**
June 2023	11.269	-0.150	**11.119**
Rate 41, 55 & 56 (greater than or equal to 500 kW)			
On-peak			
February 2023	37.077	-0.150	**36.927**
March 2023	23.035	-0.150	**22.885**
April 2023	12.348	-0.150	**12.198**
May 2023	10.667	-0.150	**10.517**
June 2023	11.269	-0.150	**11.119**
Off-peak			
February 2023	35.529	-0.150	**35.379**
March 2023	23.997	-0.150	**23.847**
April 2023	12.348	-0.150	**12.198**
May 2023	10.667	-0.150	**10.517**
June 2023	11.269	-0.150	**11.119**
Rate 57 & 58			
On-peak			
February 2023	37.077	-0.150	**36.927**
March 2023	23.035	-0.150	**22.885**
April 2023	12.348	-0.150	**12.198**
May 2023	10.667	-0.150	**10.517**
June 2023	11.269	-0.150	**11.119**
Off-peak			
February 2023	35.529	-0.150	**35.379**
March 2023	23.997	-0.150	**23.847**
April 2023	12.348	-0.150	**12.198**
May 2023	10.667	-0.150	**10.517**
June 2023	11.269	-0.150	**11.119**

ATTACHMENT 4

Fleet Replacement Assessment Memo

Elliott Bay Design Group

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5/12/2023

NEW VEHICLE FERRY

Fleet Replacement

Prepared for: Fishers Island Ferry District | Fishers Island, NY

Ref: 22075-100-068-1 Rev. - May 12, 2023

PREPARED BY

ELLIOTT BAY DESIGN GROUP
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SEATTLE, WA 98145

GENERAL NOTES

1. The fleet replacement models are based on the historical operational data provided by Fishers Island Ferry District. The results are intended to provide a high-level forecast of how the ferry system can meet the forecasted needs of the Fishers Island community.

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
-	Initial issue	5/12/23	JEJ

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

The intent of this report is to compare the fleet logistics of potential fleet composition for service between New London, CT and Silver Eel Cove, NY. The report provides a summary of the key financial considerations for Fishers Island Ferry District (FIFD) to contemplate as they select a fleet configuration best suited for the community's needs.

This document will look at the operational and capital costs over a 30-year horizon. These costs will consider ongoing operational costs of the existing fleet, capital costs of constructing new vessels, and the anticipated operational costs of those vessels.

Based on the following analysis it is our recommendation that the SILVER EEL be repowered and the MUNNATAWKET be replaced by a double-ended vessel of similar size and capacity as the RACE POINT. This fleet composition would provide the greatest flexibility and resilience to the Fishers Island community. The increased operational cadence with the double-ended ferry will be more capable during single-vessel operations than the RACE POINT. Until the double-ended ferry has proven itself during a winter season, the RACE POINT will provide the robust service it is known for.

2. INTRODUCTION

Fishers Island Ferry District is considering changing the composition of their fleet for the operation between Fishers Island, NY, and New London, CT. Currently, FIFD operates two single-ended vehicle ferries and a passenger-only fast ferry on this route. The vehicle ferries carry 24 and 34 cars and up to 210 and 245 passengers, respectively. The fast ferry carries up to 18 passengers.

The purpose of this document is to offer a summary of the key financial considerations pertinent to different fleet compositions on this route, and to highlight advantages and disadvantages offered.

3. HISTORICAL OPERATIONAL COSTS

The FIFD supplied detailed operational information regarding vessel sailings, passenger and vehicle counts, fuel usage, maintenance costs, and crewing. These were used to develop a reasonable model for the annual costs associated with operating a fleet of vessels to serve the Fishers Island community.

3.1 FUEL

Five years of fuel data was supplied spanning from 2018 through 2022. It is important to note the disruptions to travel that occurred in 2020 and the subsequent economic impacts to fuel and material prices.

Since 1993 the average rate of change for West Texas Intermediate Crude has been 4.3% [1]. This is the assumed inflation value for fuel costs. However, the actual rate of change for fuel costs has swung dramatically and will vary significantly from year to year.

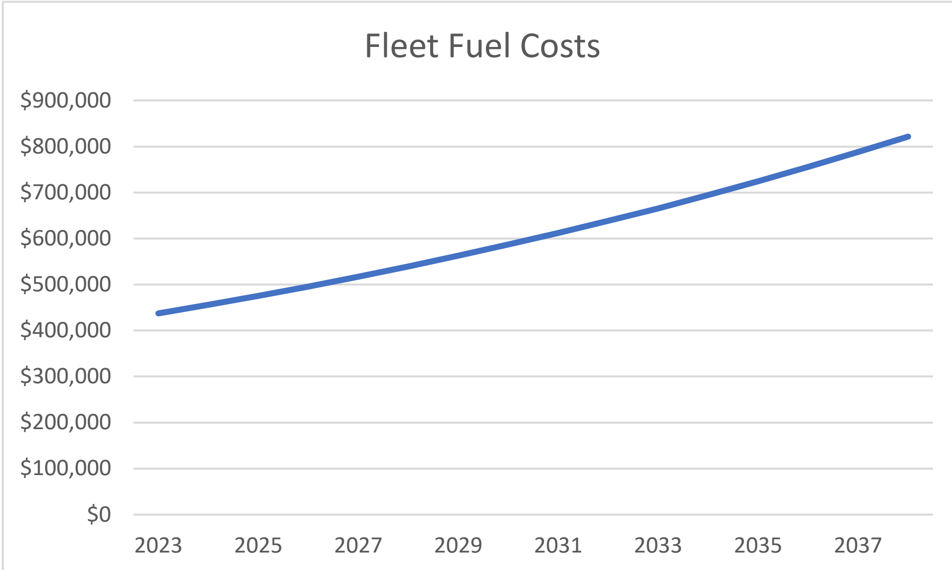


Figure 1: FIFD Fuel cost projection through 2038 based on 4.3% inflation and reported 2022 fuel costs

3.2 CREW

Only one year of crewing data was supplied by FIFD. This data was used to create generic cost rates for the various crew positions. These costs were assumed to be tied to a historical inflation rate of 2.25%, which has been the average over the last 30 years [1].

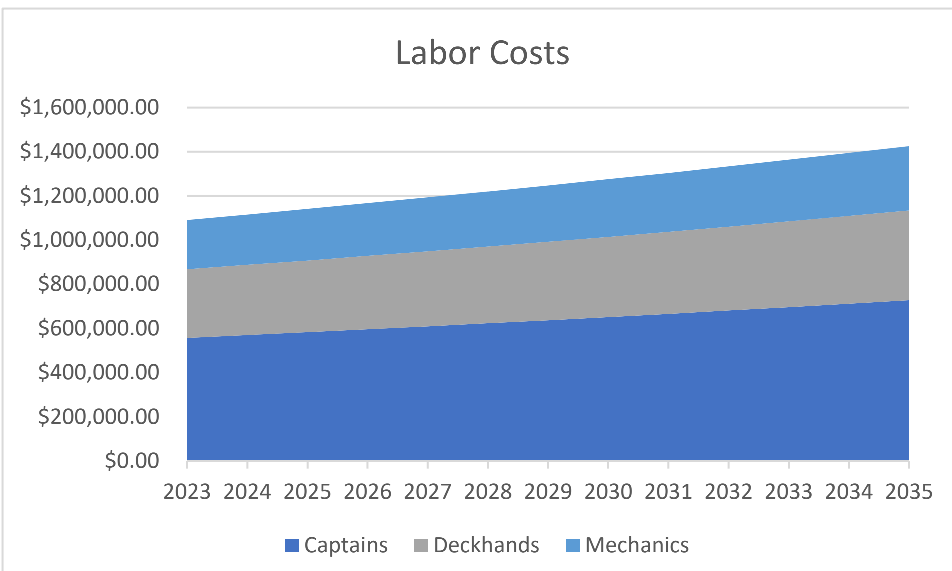


Figure 2: Labor costs based on FIFD reported 2022 data.

3.3 VESSEL MAINTENANCE

Three years of vessel maintenance activities were provided by FIFD. These costs are for the two vehicle ferries. Assumed values were generated for the passenger-only ferry. All maintenance costs assume an annual 4.25% rate of inflation. This accounts for inflation and the increased maintenance needs as the vessel ages.

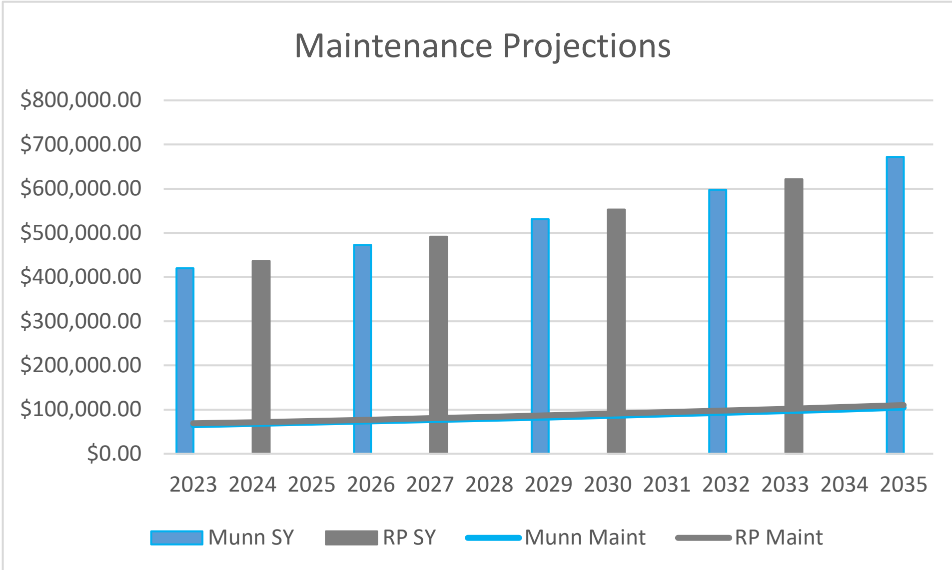


Figure 3: Annual maintenance and intermittent shipyard repair cost model

4. NEW VESSEL CAPITAL COSTS

For this exercise, all vehicle ferry replacement vessels are assumed to have conventional diesel-mechanical propulsion packages with fixed pitch propellers and foil-shaped spade rudders.

Currently there is significant volatility in pricing new vessel construction due to the general economic uncertainty in the wake of the global supply chain disruptions in 2020. As such, the following estimates are Rough Order of Magnitude (ROM) only for planning purposes.

4.1 DOUBLE ENDED FERRY

Vessel construction costs for a conventional propulsion double-ended ferry suitable for the needs of the Fishers Island community is approximately $16.75 million. A double-ended vessel is slightly more expensive to build as it has two control consoles, running lights, and other considerations.

4.2 SINGLE ENDED FERRY

Based on the current arrangements of the RACE POINT, a vessel of comparable size and passenger space was estimated to be $16 million.

4.3 PASSENGER ONLY FERRY

Based on current prices for similar sized small passenger only ferries, it is recommended that FIFD repower the SILVER EEL to continue the existing level of passenger-only service.

5. NEW VESSEL OPERATIONAL COSTS

5.1 FUEL

For this analysis it was assumed that a new double ended ferry will burn 2.5% more fuel annually than the RACE POINT. This is due to the slightly higher total horsepower installed (assumed 1,600 hp, 800 hp per end) and the assumed additional trips the vessels will perform due to the faster operational cadence. Fuel consumption was increased for years the other vehicle ferry was scheduled for shipyard repairs and reduced in years it was scheduled to visit the shipyard.

5.2 MAINTENANCE

In reviewing the recent maintenance data from FIFD there may be modest cost savings in regular maintenance activities as well as lowered shipyard costs. For the cost modeling it was assumed that the regular maintenance costs for a new vessel would start at approximately $45,000 per year in 2022 and increase at 4.25% annually. Similarly, the shipyard costs are anticipated to start in 2022 at approximately $300,000 every third year.

5.3 CREW

Crewing costs are likely to remain consistent across vessels and will depend on the operational hours of FIFD. For this forecast the crew costs assume:

- 14,800 Captain hours
- 15,750 Deckhand hours
- 5,100 Mechanic hours

This data is based on the 2022 information provided by FIFD. Crewing costs were assumed to increase by 2.5% annually. The individual vessel crewing costs were decreased in years the vessel was scheduled for shipyard repairs and increased in years the other vessel visits the shipyard.

6. FLEET REPLACEMENT

To best serve Fishers Island it is critical that FIFD make informed decisions regarding the timing of vessel replacements and their impact on the transportation services provided to the community. This analysis has reviewed vessel replacement scenarios:

1. Replacement of the MUNNATAWKET and re-powering of the SILVER EEL
2. Replacement of the MUNNATAWKET AND RACE POINT

In all cases the accessibility to the island improves. For replacement of the vehicle ferries it is assumed they will be replaced with a double-ended vehicle ferry with similar passenger and vehicle capacities to the RACE POINT.

6.1 VEHICLE FERRY REPLACEMENT AND PASSENGER REPOWER

The first plan under consideration replaces the MUNNATAWKET with a double-ended ferry at the end of the MUNNATAWKET's useful service life of 50-years, which is 2028. Also, the SILVER EEL would be repowered to continue its current level of service.

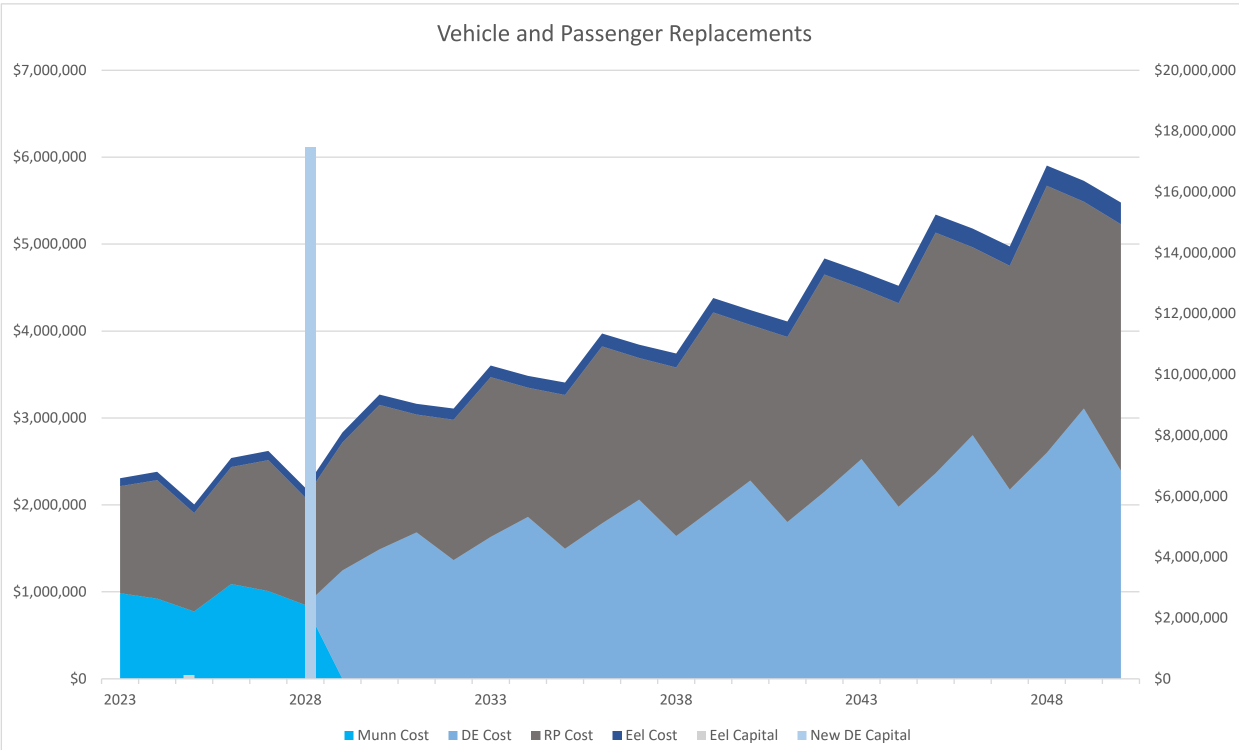


Figure 4: Operational and Capital forecast for replacing the MUNNATAWKET in 2028 and repowering the SILVER EEL in 2025. Operational costs utilize the left axis. Capital costs are shown on the right axis.

The MUNNATAWKET currently carries up to 211-passengers and 24-cars and is limited to carrying trucks and over-height vehicles near the transom. It would be replaced by a double-ended ferry carrying 250-passengers and 34-cars. Even with the existing sailing schedule this is an additional 18% passenger capacity and 42% car capacity added to the system. In ideal conditions this change will save approximately 10-minutes per trip that could provide additional sailings, and lessened passenger wait times, during the busy seasons.

By keeping the RACE POINT in service, FIFD would retain a known asset with proven rough weather performance.

6.2 VEHICLE REPLACEMENTS

The second and final scenario looks at replacing both the MUNNATAWKET and RACE POINT with double-ended ferries of comparable size. By replacing both ferries simultaneously there can be cost efficiencies realized when soliciting shipyard bids. In many cases the second vessel of a class can be discounted as much as 5%. There is an added benefit of having common parts and systems between vessels reducing the complexity of stocking spares and uniform crew training.

For this model it was assumed that the vessels will be built back-to-back as sister vessels at the shipyard. As such, the MUNNATAWKET was assumed to be retired slightly after its 50-year service life in 2030. This schedule allows for ample time for design and construction of the vessels and allows years of service of the RACE POINT after its recent re-power.

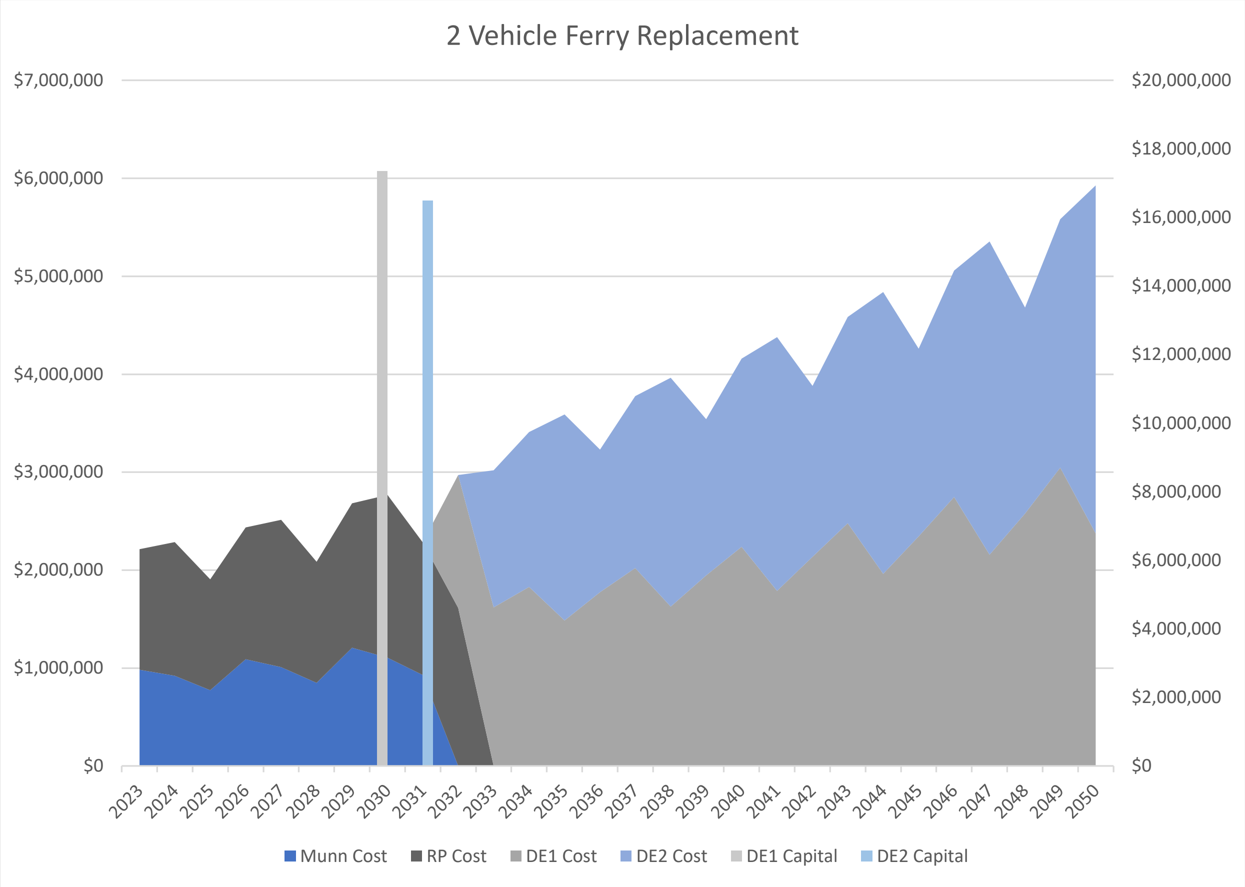


Figure 5: Operational and Capital forecast for replacing both vehicle ferries. Operational costs are shown on the left axis, capital costs on the right.

7. CONCLUSION

Replacement of the MUNNATAWKET with a vessel of comparable size and capability to the RACE POINT provides increased service capability to the fleet and additional resilience during unscheduled repairs.

Replacing both the MUNNATAWKET and RACE POINT would provide optimal scheduling and operational efficiency. By having similar vessels with identical turn-around times there are no wasted moments when operating both vessels, unlike the potential of the double-ended ferry on a slightly faster schedule having to slow its cadence to accommodate the loading times of the single-ended ferry.

However, concerns about rough weather performance were noted by FIFD during the winter months. While water on deck is not a common occurrence with double-ended ferries it is not unheard of. As such, and considering the recent repower of the RACE POINT, our recommendation is to re-power the SILVER EEL and replace the MUNNATAWKET with a double-ended ferry while retaining the RACE POINT.

This will increase the overall service to the community as well as provide vessels that can provide unique experiences and characteristics to the fleet.

8. REFERENCES

[1] Fishers Island Ferry District, Sailing Schedule, Fishers Island, NY, 2018.

[2] Fishers Island Ferry District, RACE POINT Vessel Information, Fishers Island, NY, 2023.

[3] Fishers Island Ferry District, SILVER EEL Vessel Information, Fishers Island, NY, 2023.

[4] Fishers Island Ferry District, MUNNATAWKET Vessel Info, Fishers Island, NY, 2023.

[5] Fishers Island Ferry District, Trip Count Data, Fishers Island, NY, 2017-2022.

ATTACHMENT 5

Comparison to Peer Ferry Operators

Fishers Island Ferry District – Comparison to Peer Ferry Operators

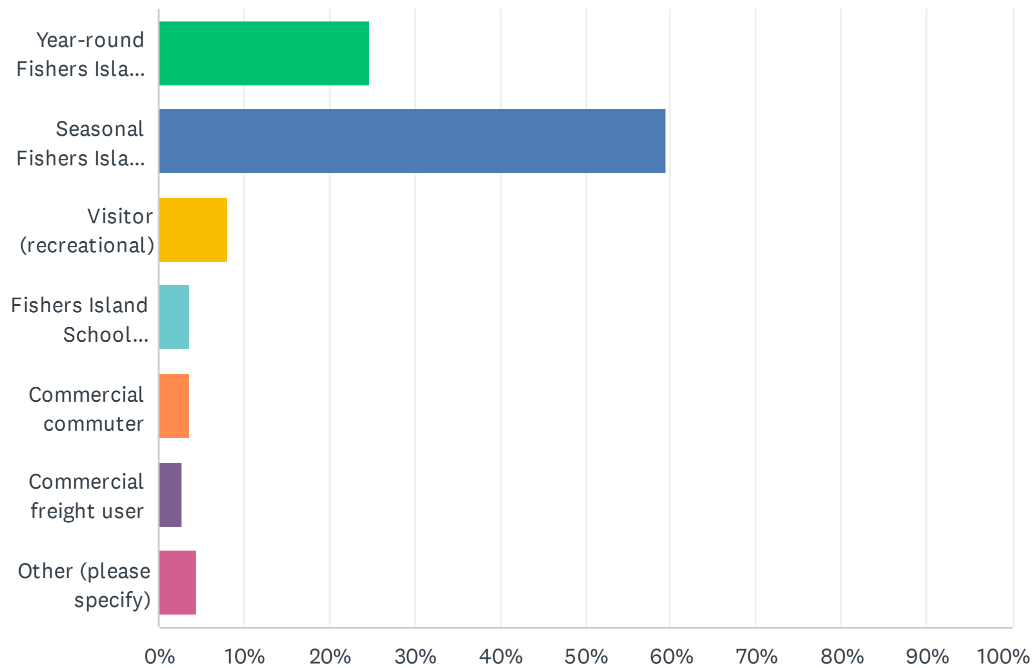
Ferry Operator / Service	Fleet Size / Vessel Characteristics	Terminals / Route Segments	Ridership / Vehicles by Season (one-way)	Governance	Annual Expense Budget by Category	Annual Revenue by Source	Recent Capital Project Grant Funding Awards
Fishers Island Ferry District / Fishers Island Ferry	3 vessels • 2 auto ferries • 1 passenger-only ferry	• Terminals: 2 • Routes: 1 route to 1 island	**2019** 117,000 passengers 36,600 vehicles	Agency owned & operated	**2022 Actual:** • Personnel: $2.4M • Vessel Maint.: $0.8M • Fuel: $0.5M • Ops/Admin: $0.8M • Airport: $0.2M *Total: $4.8M*	**2022 Actual:** • Farebox & ferry operations: $3.2M • Property: $1.6M • Other: $61,000 *Total: $4.8M*	Vessel Repower: • VW Mitigation Trust: $0.8M (2019)
Casco Bay Island Transit District (ME) / Casco Bay Lines	5 vessels (3 passenger, 2 passenger + vehicle) • 2 auto ferries • 3 passenger-only ferry	• Terminals: 8 • Routes: 2 routes to 7 islands	**2019** 940,000 passengers 41,589 vehicles	Agency owned & operated *(transit district)*	**Projected FY23**: • Personnel: $5.2M • Vessel Maint.: $1.8M • Fuel: $1.1M • Ops/Admin: $1.4M *Total: $10.0M*	**Projected FY23:** • Farebox: $5.8M • Federal: $4.1M • State subsidy: $68,000 *Total: $10.0M*	Vessel Construction: • FTA Passenger Ferry Grant Program: $3.6M (2021), $3.2M (2020), $6M (2018) Terminal Improvements: • FTAPassenger Ferry Grant Program: $3.4M (2019)
Maine Department of Transportation / Maine State Ferry Service	7 vessels • 7 auto ferries	• Terminals: 9 • Routes: 6 routes to 6 islands	**2021** 447,237 passengers 190,945 vehicles	Agency owned & operated *(state DOT)*	**Projected 2023** • Personnel: $7.9M • Fuel: $4.0M • Vessel Maint.: $1.2M • Ops/Admin: $1.3M *Total: $14.4M*	**Projected 2023** • Farebox: $6.2M • State/local: $6.2M *Total: $12.3M*	Vessel Construction: • FTA Electric/Low-Emitting: $28M (2022)
Pierce County (WA) / Anderson Island	3 vessels • 3 auto ferries	• Terminals: 3 • Routes: 1 route to 2 islands	**2022 (approx.)** 450,000 passengers 250,000 vehicles	Agency owned *(county public works department)*, operations contracted to private operator	**Projected FY23:** • Op. Contract: $3.5M • Vessel Maint.: $4.1M • Fuel: $0.65M • Ops/Admin: $1.6M *Total: $9.8M*	**Projected 2023** • Farebox: $3.1M • Federal: $1.2M • State/local: $5.5M *Total: $9.8M*	Terminal Improvements: • FHWA Ferry Boat Program (formula distribution): $1.2M (2017-2021)
Skagit County (WA) Guemes Island Ferry	1 vessel • 1 auto ferry *(planned replacement with diesel-electric hybrid in 2025)*	• Terminals: 2 • Routes: 1 route to 1 island	**2022 (approx.)** 400,000 passengers 150,000 vehicles	Agency owned & operated *(county public works department)*	**2022 Actual:** • Personnel: $1.4M • Vessel Maint.: $0.3M • Fuel: $0.3M • Ops/Admin: $0.9M *Total: $2.9M*	**2022 Actual:** • Farebox: $1.2M • State/local: $1.7M *Total: $2.9M*	Terminal Improvements: • FTA Transportation Improvement Funding: $2.5M Vessel Construction: • WA County Ferry Capital Improvement Program (CFCIP) Grant: $10M

ATTACHMENT 6

Public Online Survey Results

Q1 Which category of ferry user best describes you? [choose multiple]

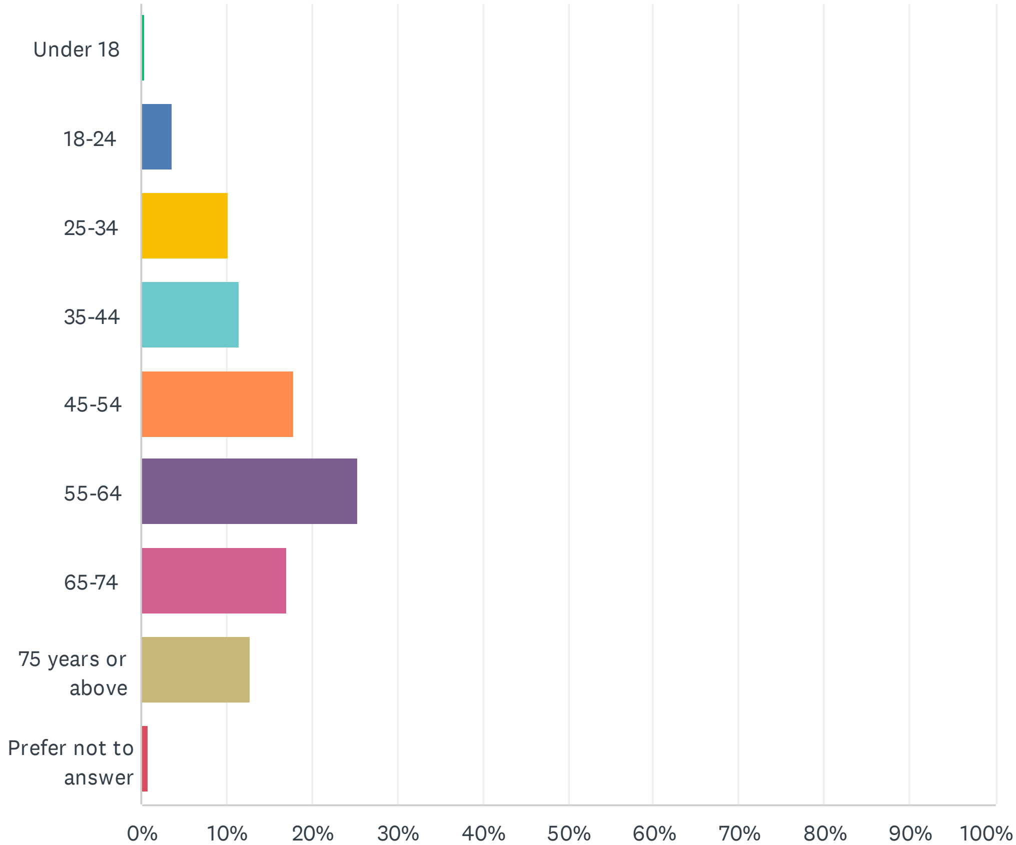
Answered: 524   Skipped: 5



ANSWER CHOICES	RESPONSES	
Year-round Fishers Island resident	24.81%	130
Seasonal Fishers Island resident	59.54%	312
Visitor (recreational)	8.02%	42
Fishers Island School (student, family, or staff)	3.63%	19
Commercial commuter	3.63%	19
Commercial freight user	2.86%	15
Other (please specify)	4.39%	23
Total Respondents: 524		

Q2 What is your age? [Choose one]

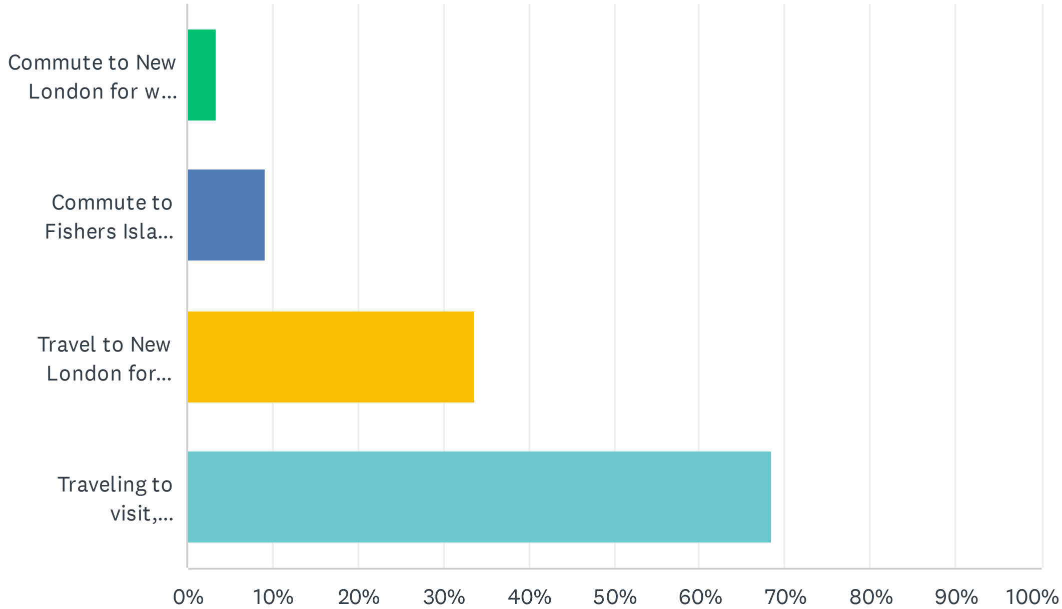
Answered: 525 Skipped: 4



ANSWER CHOICES	RESPONSES	
Under 18	0.38%	2
18-24	3.62%	19
25-34	10.29%	54
35-44	11.62%	61
45-54	17.90%	94
55-64	25.33%	133
65-74	17.14%	90
75 years or above	12.76%	67
Prefer not to answer	0.95%	5
TOTAL		525

Q3 What is the purpose of your typical trip? [choose multiple]

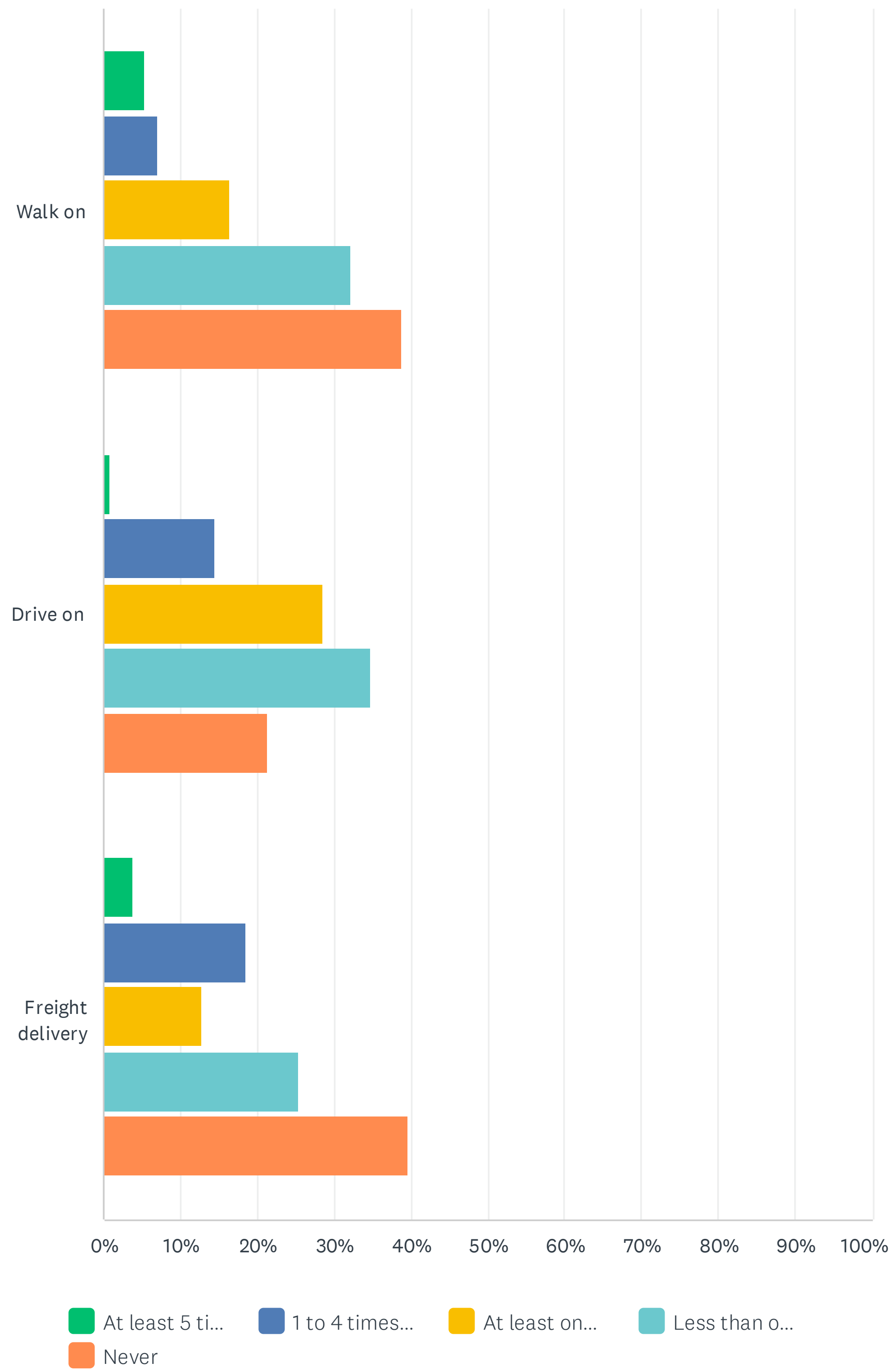
Answered: 515 Skipped: 14



ANSWER CHOICES	RESPONSES	
Commute to New London for work or school	3.50%	18
Commute to Fishers Island for work or school	9.13%	47
Travel to New London for shopping, errands, or appointments	33.59%	173
Traveling to visit, vacation, or stay on the island	68.35%	352
Total Respondents: 515		

Q4 In a typical off-season month (November – April), what best describes how often you travel on or use the Fishers Island Ferry in the following ways? [fill in for each row]

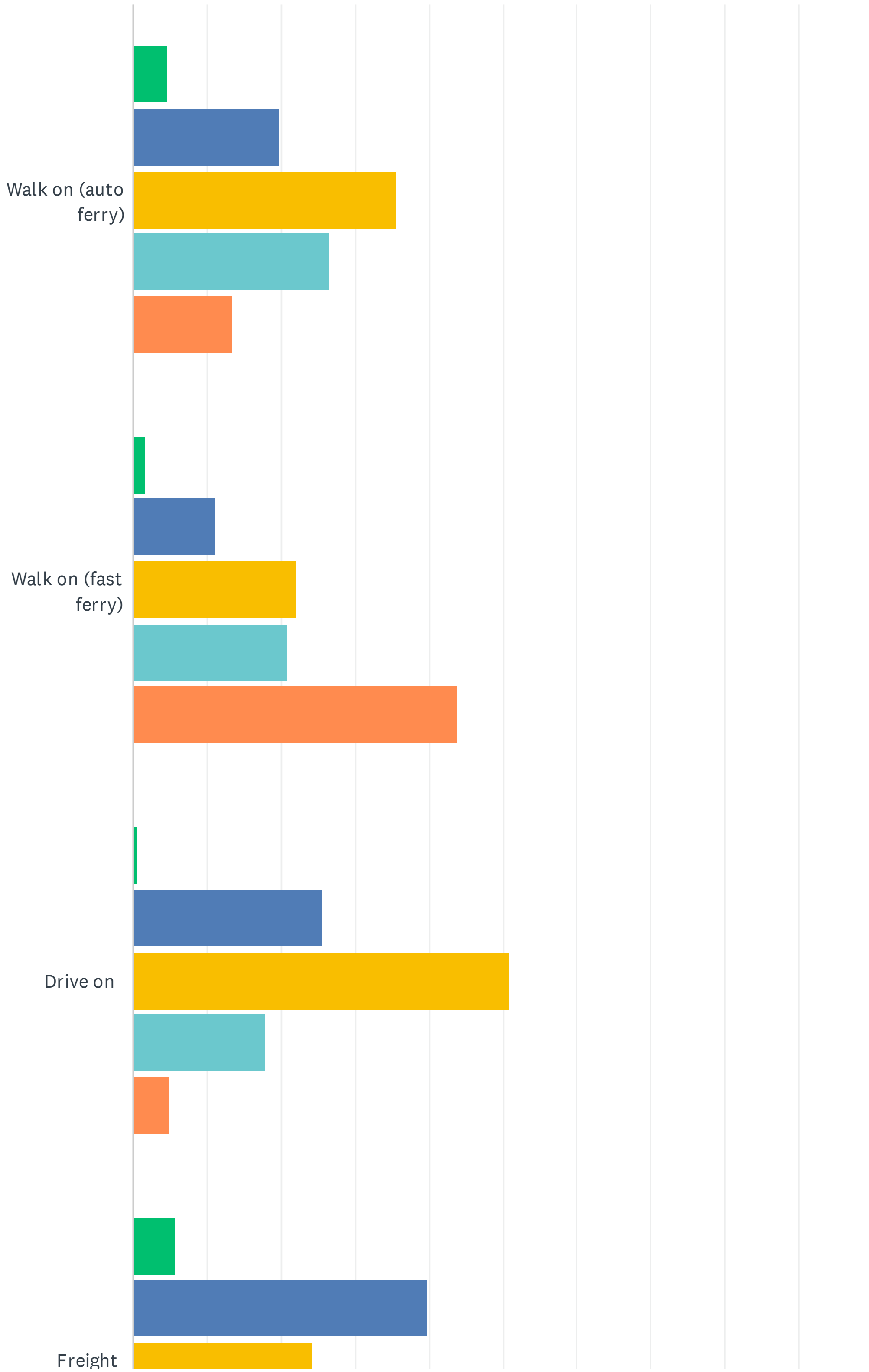
Answered: 524 Skipped: 5

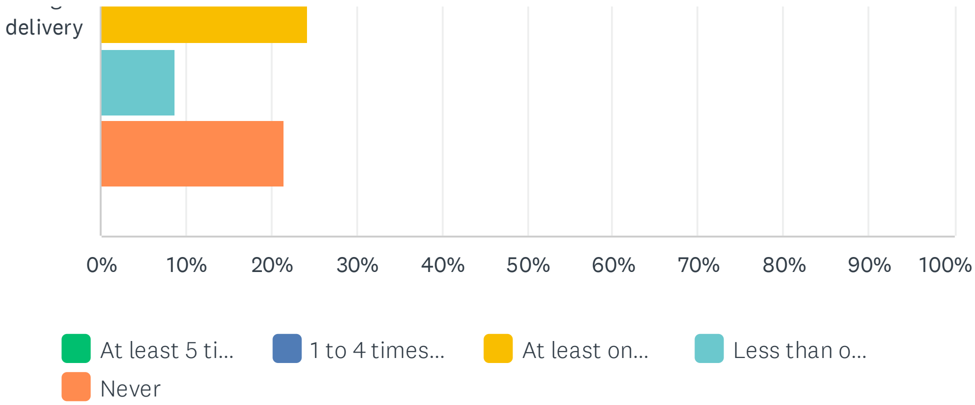


	AT LEAST 5 TIMES PER WEEK	1 TO 4 TIMES PER WEEK	AT LEAST ONCE PER MONTH	LESS THAN ONCE A MONTH	NEVER	TOTAL
Walk on	5.26% 23	7.09% 31	16.48% 72	32.27% 141	38.90% 170	437
Drive on	0.78% 4	14.51% 74	28.63% 146	34.71% 177	21.37% 109	510
Freight delivery	3.74% 17	18.50% 84	12.78% 58	25.33% 115	39.65% 180	454

Q5 In a typical peak-season month (May – October), what best describes how often you travel on or use the Fishers Island Ferry in the following ways? [fill in for each row]

Answered: 525 Skipped: 4

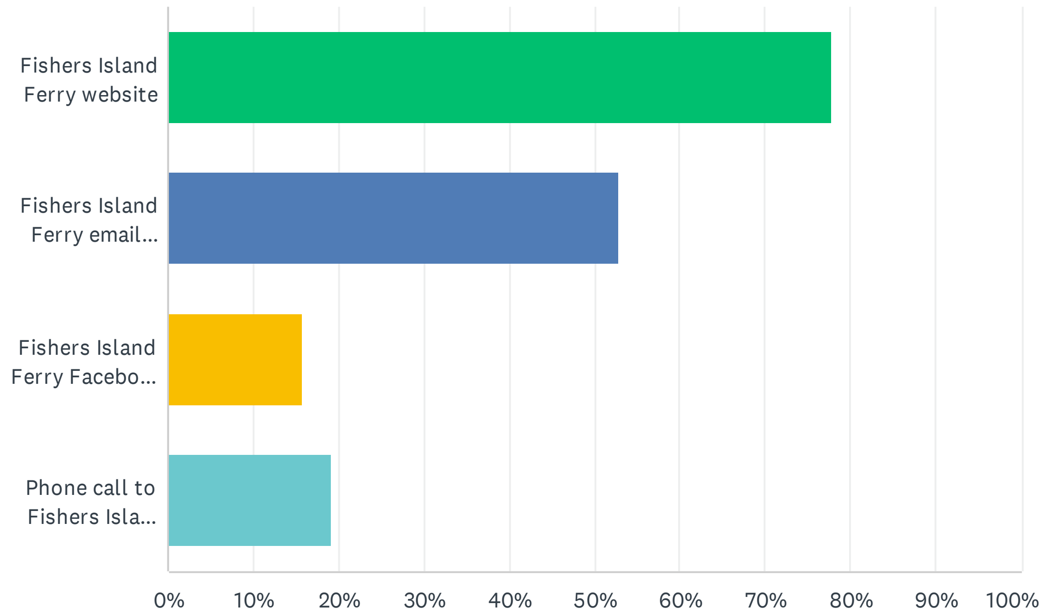




	AT LEAST 5 TIMES PER WEEK	1 TO 4 TIMES PER WEEK	AT LEAST ONCE PER MONTH	LESS THAN ONCE A MONTH	NEVER	TOTAL
Walk on (auto ferry)	4.62% 20	19.86% 86	35.57% 154	26.56% 115	13.39% 58	433
Walk on (fast ferry)	1.75% 7	11.00% 44	22.25% 89	21.00% 84	44.00% 176	400
Drive on	0.60% 3	25.50% 128	51.00% 256	17.93% 90	4.98% 25	502
Freight delivery	5.66% 25	39.82% 176	24.21% 107	8.82% 39	21.49% 95	442

Q6 Which methods do you rely on most to receive information about the Fishers Island Ferry? [choose multiple]

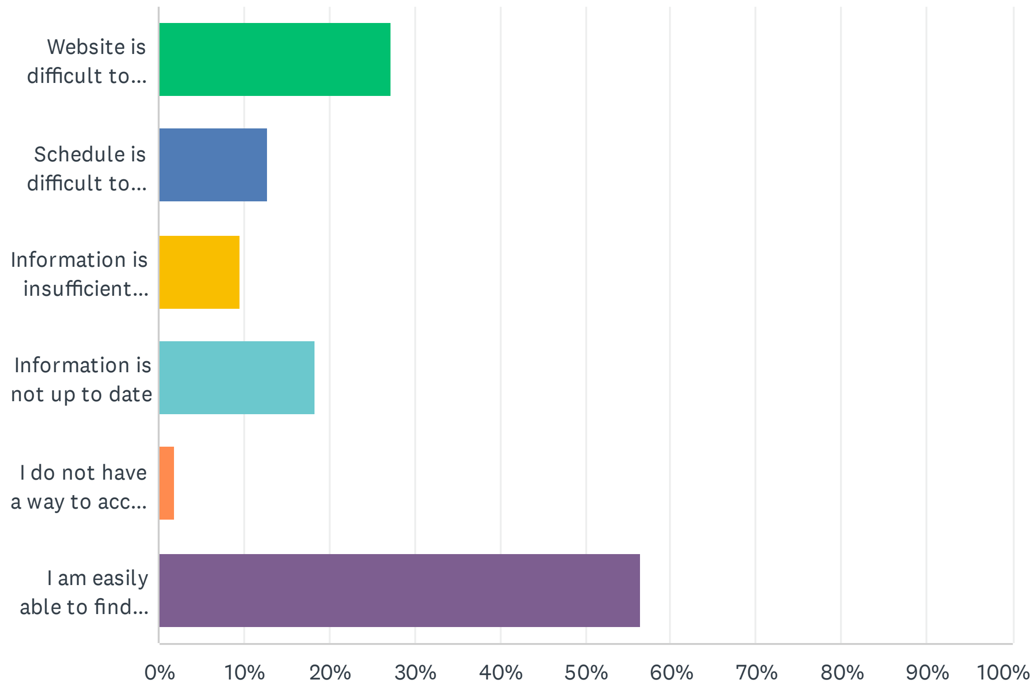
Answered: 499 Skipped: 30



ANSWER CHOICES	RESPONSES	
Fishers Island Ferry website	77.76%	388
Fishers Island Ferry email alert	52.91%	264
Fishers Island Ferry Facebook or Instagram	15.83%	79
Phone call to Fishers Island Ferry personnel	19.24%	96
Total Respondents: 499		

Q7 Which challenges do you face when seeking information about your trip? [select all that apply]

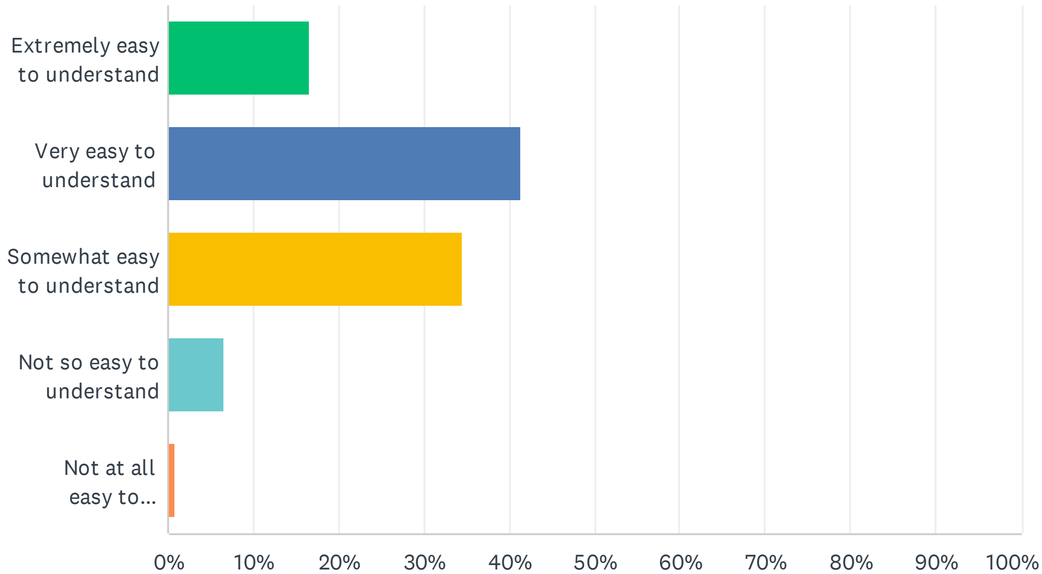
Answered: 488 Skipped: 41



ANSWER CHOICES	RESPONSES	
Website is difficult to navigate	27.25%	133
Schedule is difficult to understand	12.70%	62
Information is insufficient when available	9.63%	47
Information is not up to date	18.24%	89
I do not have a way to access the information	1.84%	9
I am easily able to find all of the information that I need	56.56%	276
Total Respondents: 488		

Q8 How easy is it to understand the Sailing Schedule as currently presented? Consider how quickly you can find the information you are looking for. [choose one]

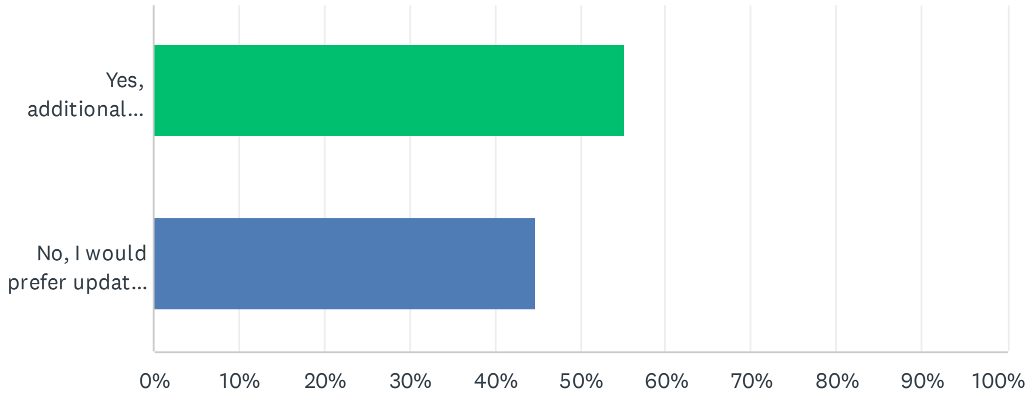
Answered: 500 Skipped: 29



ANSWER CHOICES	RESPONSES	
Extremely easy to understand	16.60%	83
Very easy to understand	41.40%	207
Somewhat easy to understand	34.60%	173
Not so easy to understand	6.60%	33
Not at all easy to understand	0.80%	4
TOTAL		500

Q9 Would you be interested in receiving more information from Fishers Island Ferry District, aside from essential schedule updates (i.e. Ferry District updates, newsletters, etc.)? [choose one]

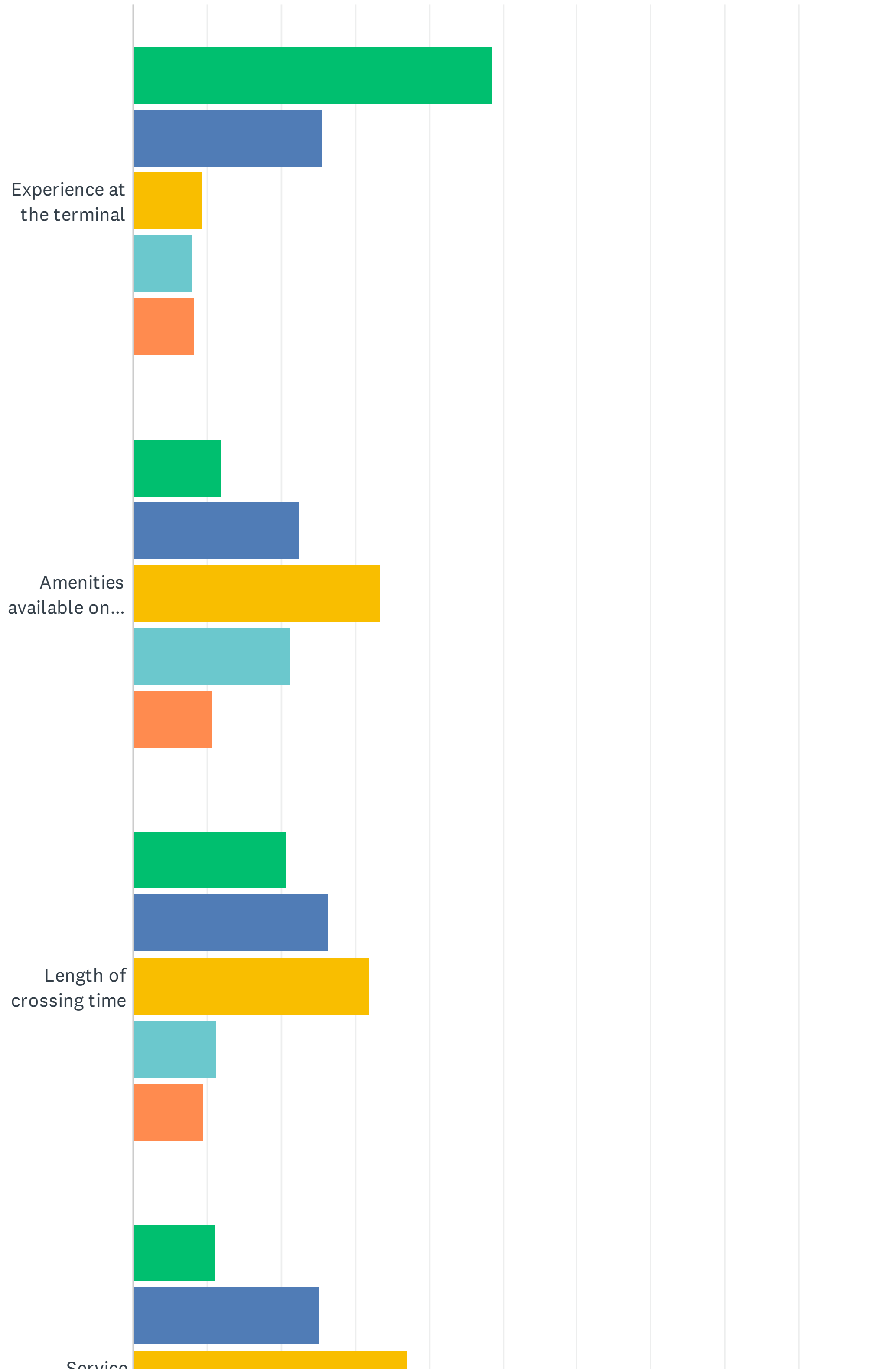
Answered: 503 Skipped: 26

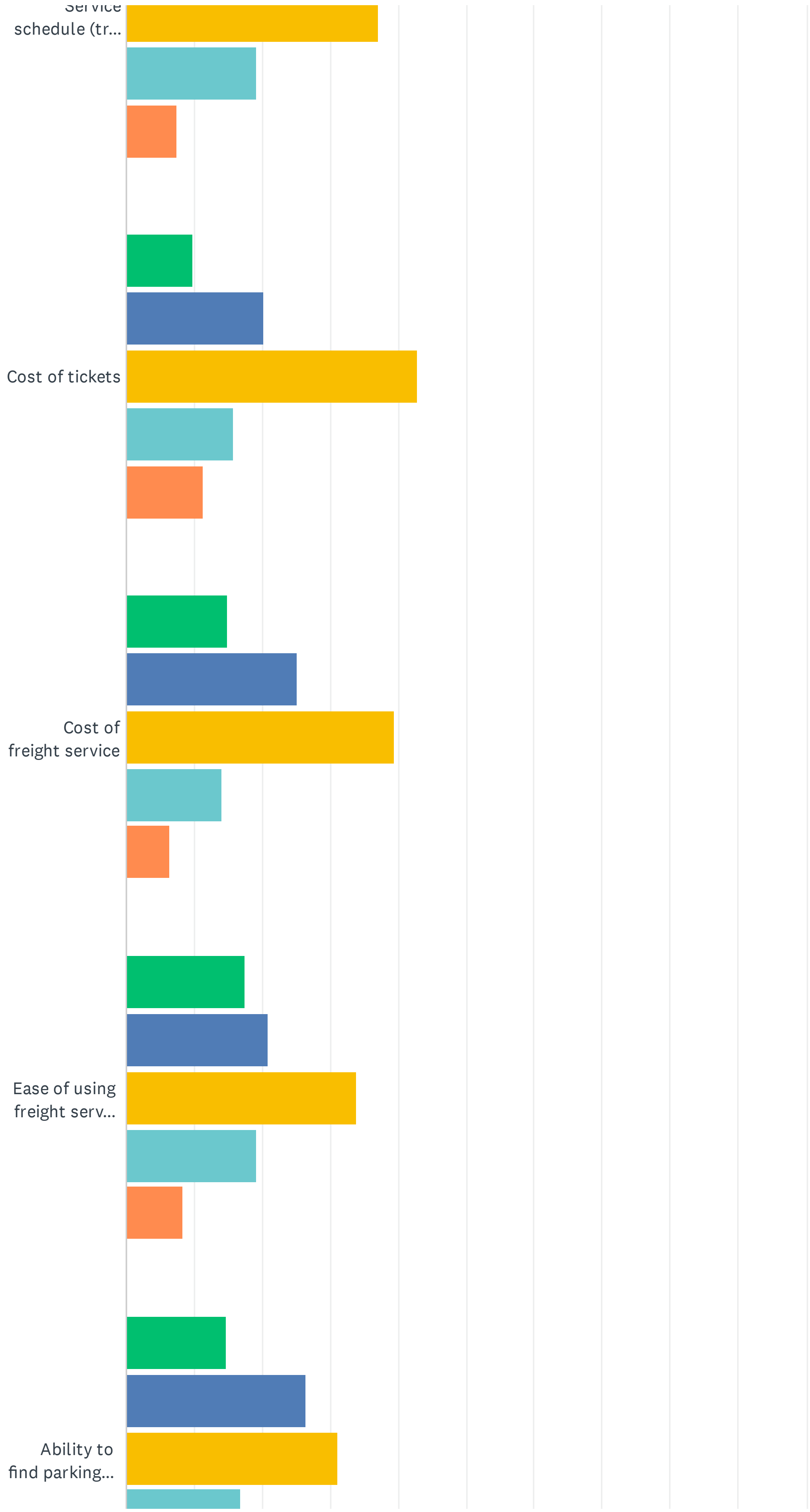


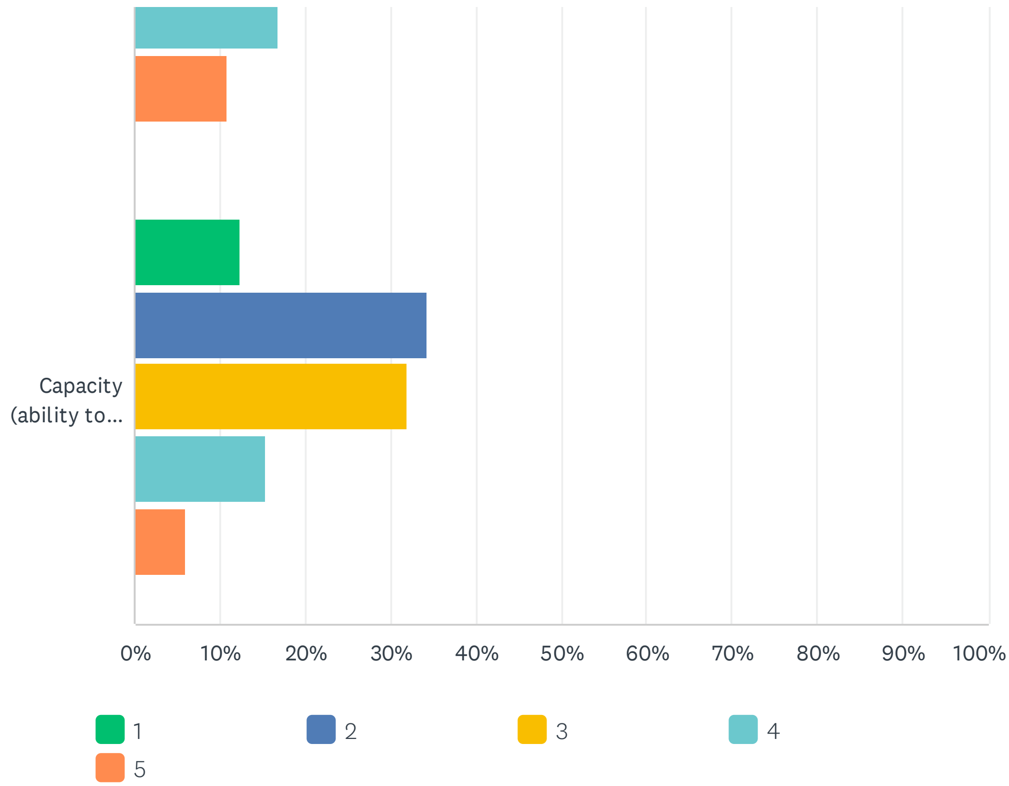
ANSWER CHOICES	RESPONSES	
Yes, additional information would be welcome and appreciated	55.27%	278
No, I would prefer updates being limited to essential service-related information only	44.73%	225
TOTAL		503

Q10 On a scale of 1-5, how would you rate your experience with the following: [choose one option for each item, 1 being the best and 5 being the worst]

Answered: 448 Skipped: 81



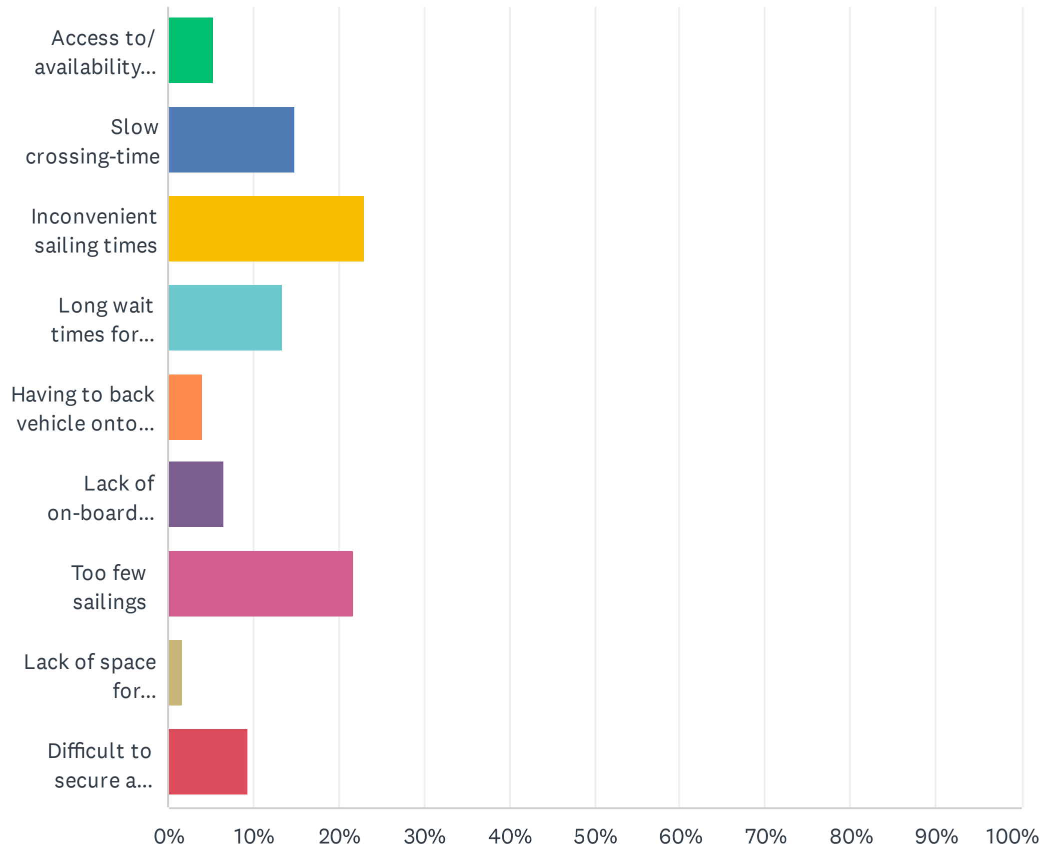

Service schedule (tr...
Cost of tickets
Cost of freight service
Ease of using freight serv...
Ability to find parking...



	1	2	3	4	5	TOTAL
Experience at the terminal	48.65% 217	25.56% 114	9.42% 42	8.07% 36	8.30% 37	446
Amenities available on the vessel	11.91% 53	22.70% 101	33.48% 149	21.35% 95	10.56% 47	445
Length of crossing time	20.72% 92	26.35% 117	31.98% 142	11.26% 50	9.68% 43	444
Service schedule (trip times and length of service day)	11.04% 49	25.23% 112	37.16% 165	19.14% 85	7.43% 33	444
Cost of tickets	9.71% 43	20.32% 90	42.89% 190	15.80% 70	11.29% 50	443
Cost of freight service	14.89% 60	25.06% 101	39.45% 159	14.14% 57	6.45% 26	403
Ease of using freight service (efficiency and communication)	17.49% 71	20.94% 85	33.99% 138	19.21% 78	8.37% 34	406
Ability to find parking in New London	14.81% 61	26.46% 109	31.07% 128	16.75% 69	10.92% 45	412
Capacity (ability to travel on the sailing of my choice)	12.36% 55	34.38% 153	31.91% 142	15.28% 68	6.07% 27	445

Q11 Of the following, what is the biggest challenge you face when using Fishers Island Ferry services? [choose one]

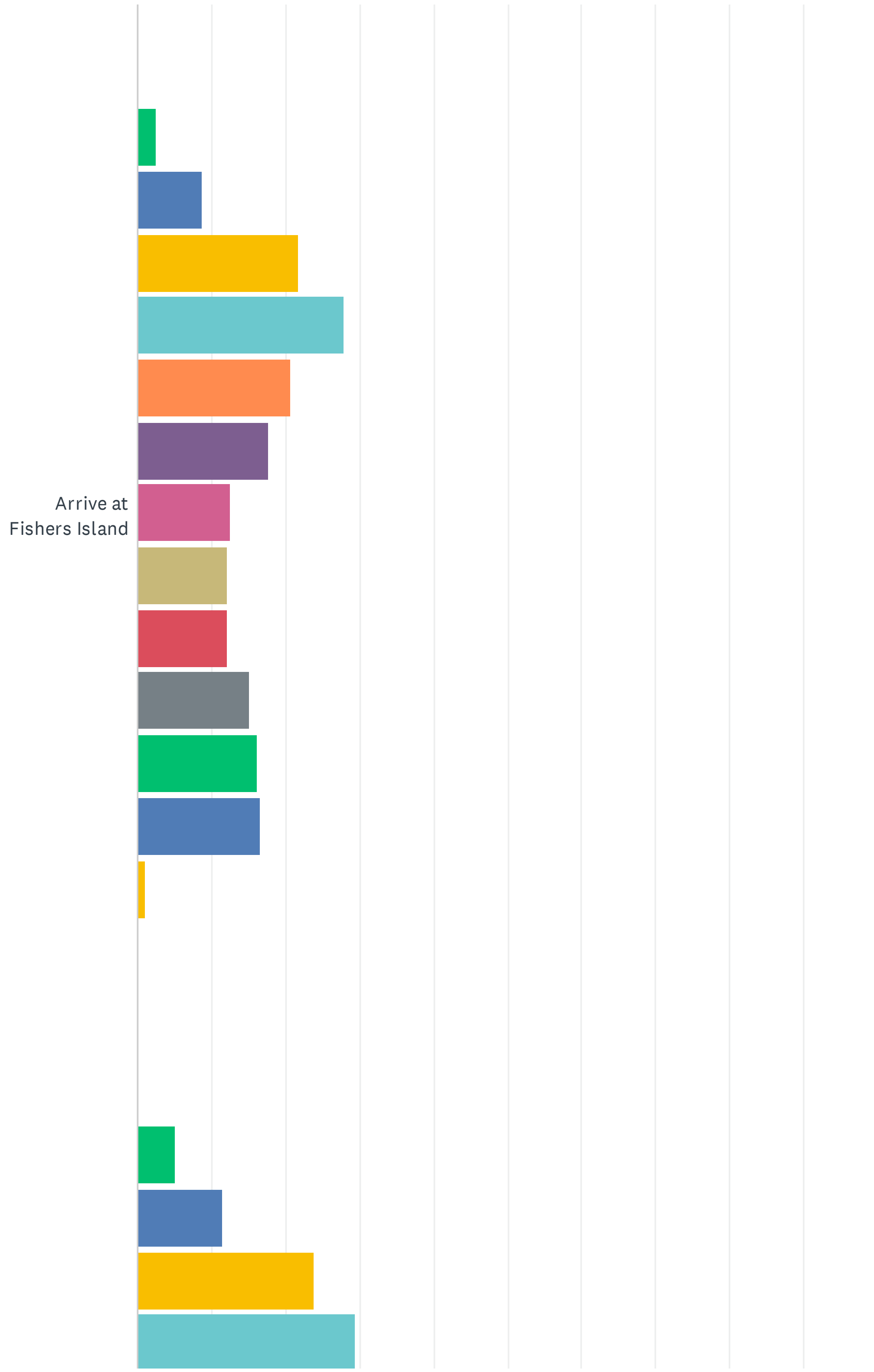
Answered: 427 Skipped: 102

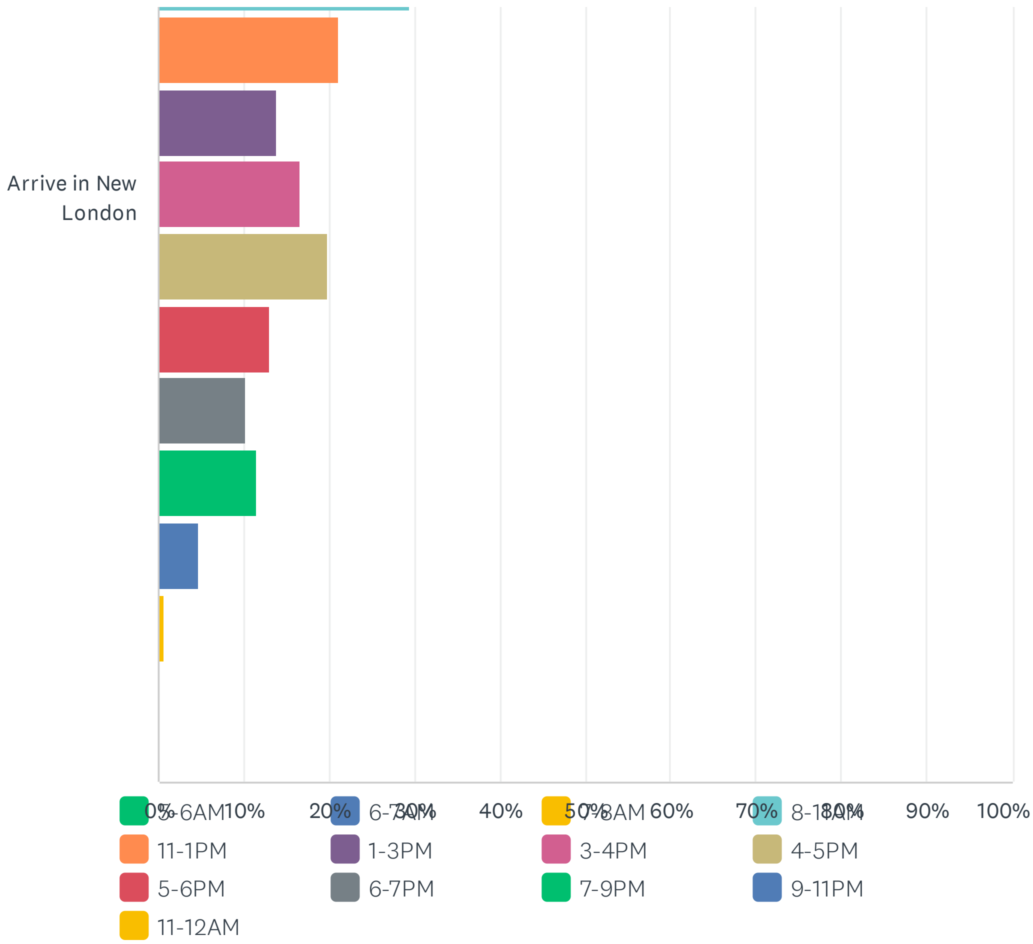


ANSWER CHOICES	RESPONSES	
Access to/ availability of parking at New London	5.39%	23
Slow crossing-time	14.99%	64
Inconvenient sailing times	22.95%	98
Long wait times for boarding / loading	13.35%	57
Having to back vehicle onto ferry	3.98%	17
Lack of on-board amenities	6.56%	28
Too few sailings	21.78%	93
Lack of space for freight/baggage	1.64%	7
Difficult to secure a reservation	9.37%	40
TOTAL		427

Q12 What would be your most preferred times for the following off season (November– April) arrivals? Skip if not applicable. (Please select up to two choices for each scenario.)

Answered: 283 Skipped: 246

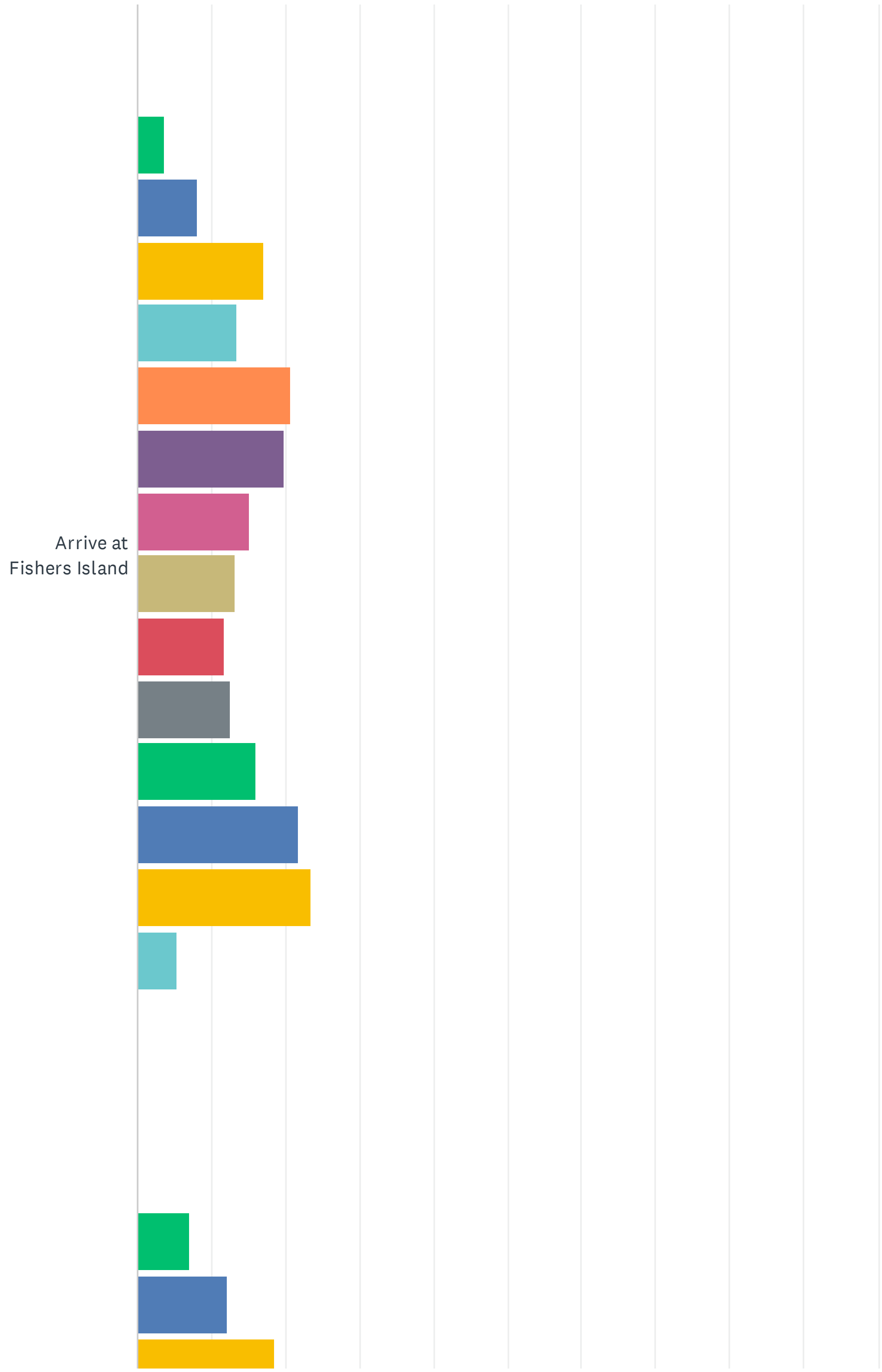


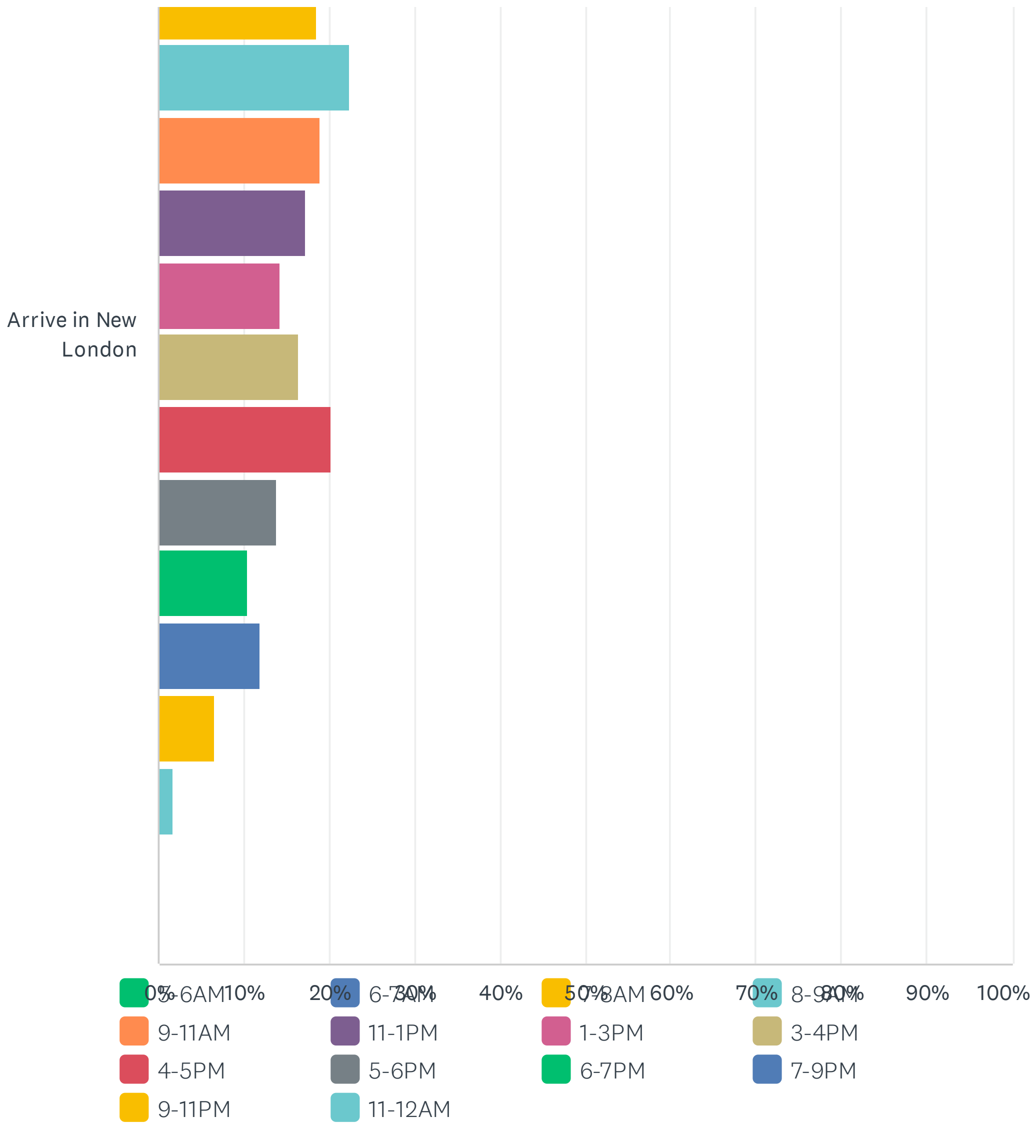


	5-6AM	6-7AM	7-8AM	8-11AM	11-1PM	1-3PM	3-4PM	4-5PM	5-6PM	6-7PM	7-9PM	9-11PM
Arrive at Fishers Island	2.57% 7	8.82% 24	21.69% 59	27.94% 76	20.59% 56	17.65% 48	12.50% 34	12.13% 33	12.13% 33	15.07% 41	16.18% 44	16.54
Arrive in New London	5.07% 14	11.59% 32	23.91% 66	29.35% 81	21.01% 58	13.77% 38	16.67% 46	19.93% 55	13.04% 36	10.14% 28	11.59% 32	4.71 1

Q13 What would be your most preferred times for the following peak season (May – October) arrivals? Skip if not applicable. (Please select up to two choices for each scenario.)

Answered: 367 Skipped: 162

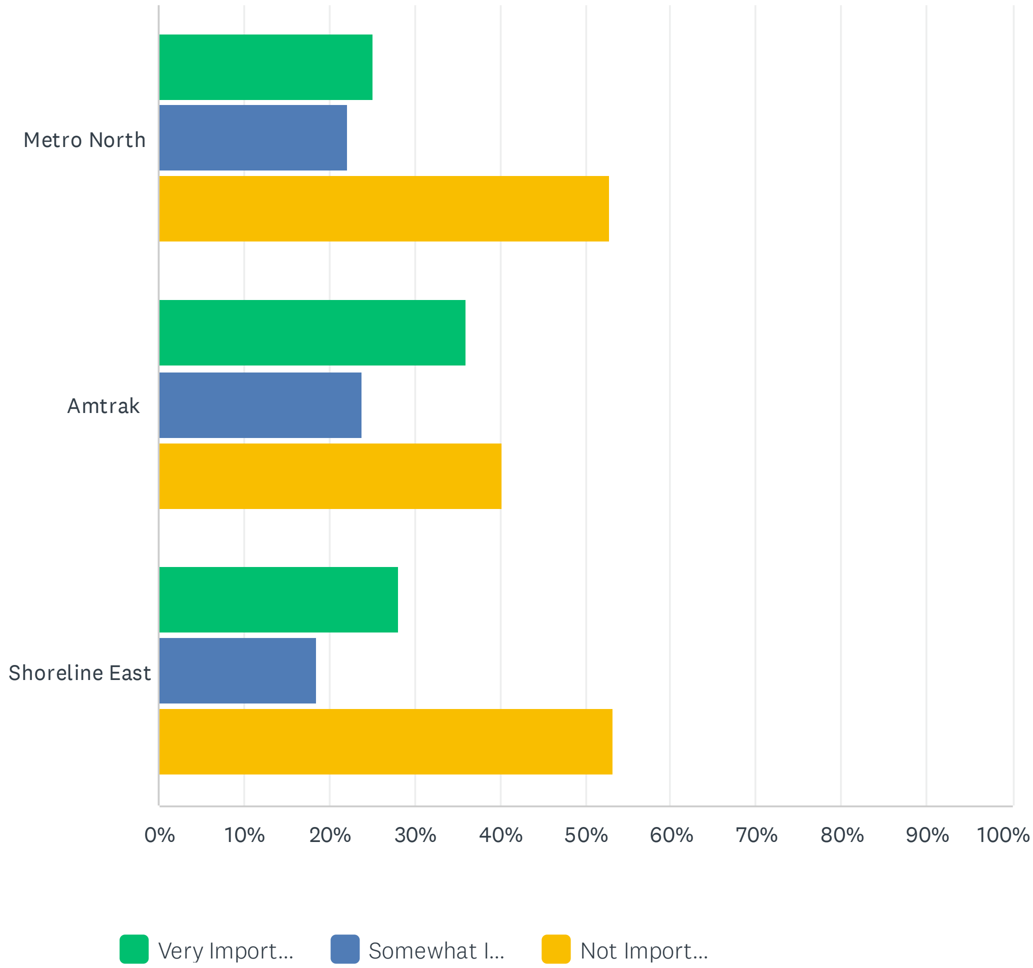




	5-6AM	6-7AM	7-8AM	8-9AM	9-11AM	11-1PM	1-3PM	3-4PM	4-5PM	5-6PM	6-7PM	7-9PM
Arrive at Fishers Island	3.63% 13	8.10% 29	17.04% 61	13.41% 48	20.67% 74	19.83% 71	15.08% 54	13.13% 47	11.73% 42	12.57% 45	15.92% 57	21.79 7
Arrive in New London	7.10% 25	12.22% 43	18.47% 65	22.44% 79	19.03% 67	17.33% 61	14.20% 50	16.48% 58	20.17% 71	13.92% 49	10.51% 37	11.93 4

Q14 How important is it for you to be able to connect with the following train schedule(s)? [choose one option, Very/Somewhat/Not Important, for each item]

Answered: 431 Skipped: 98



	VERY IMPORTANT	SOMEWHAT IMPORTANT	NOT IMPORTANT	TOTAL
Metro North	25.06% 101	22.08% 89	52.85% 213	403
Amtrak	35.95% 151	23.81% 100	40.24% 169	420
Shoreline East	28.04% 113	18.61% 75	53.35% 215	403

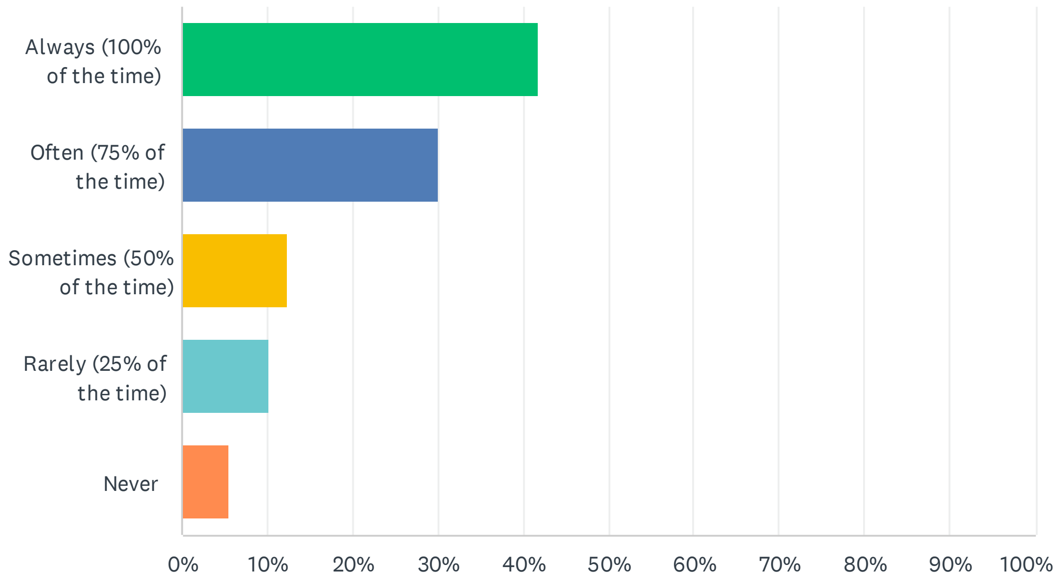
Q15 What connecting train time is most important to you if a new ferry schedule was drafted? Skip if not applicable.

Answered: 75 Skipped: 454

ANSWER CHOICES	RESPONSES	
For AM trips:	84.00%	63
For PM trips:	80.00%	60

Q16 Do you generally make a vehicle reservation when planning a ferry trip? [choose one]

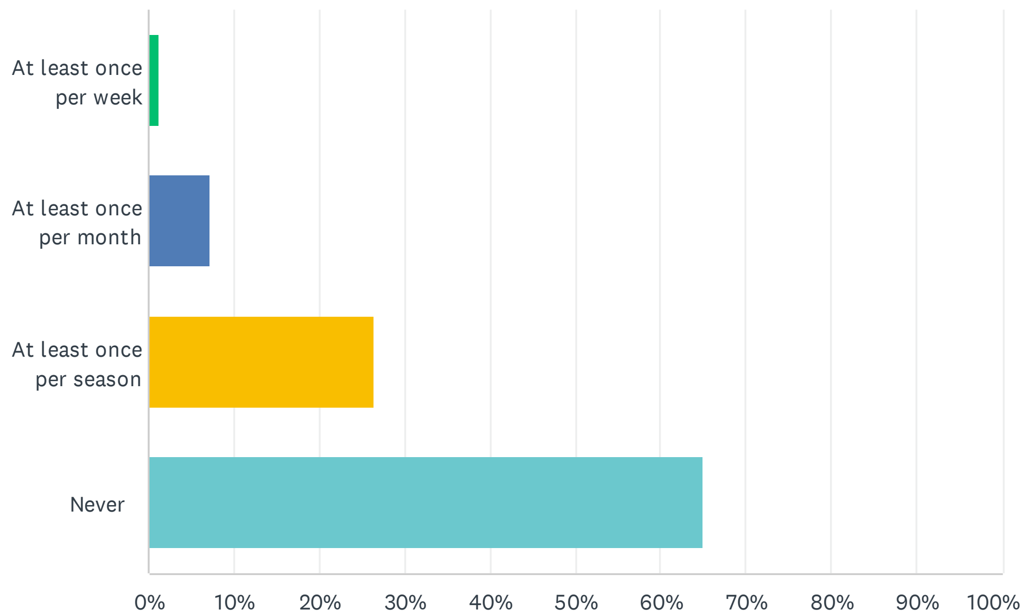
Answered: 441 Skipped: 88



ANSWER CHOICES	RESPONSES	
Always (100% of the time)	41.72%	184
Often (75% of the time)	30.16%	133
Sometimes (50% of the time)	12.47%	55
Rarely (25% of the time)	10.20%	45
Never	5.44%	24
TOTAL		441

Q17 In a typical off-season (November– April), how often are you unable to travel on the sailing of your choice because reservations are full? [choose one]

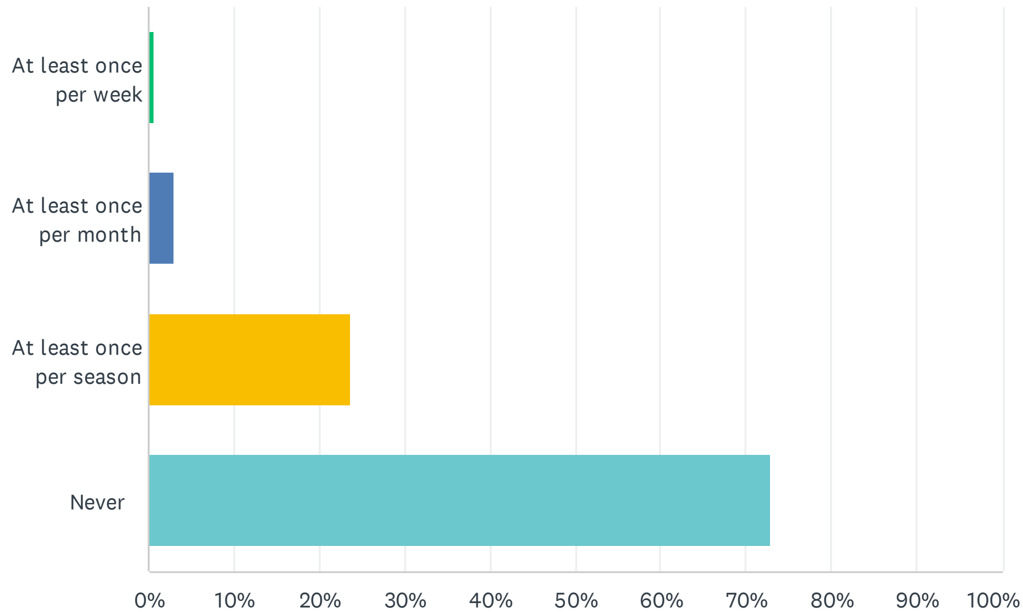
Answered: 385   Skipped: 144



ANSWER CHOICES	RESPONSES	
At least once per week	1.30%	5
At least once per month	7.27%	28
At least once per season	26.49%	102
Never	64.94%	250
TOTAL		385

Q18 In a typical off-season (November– April), how often do you miss a boat while waiting in standby? [choose one]

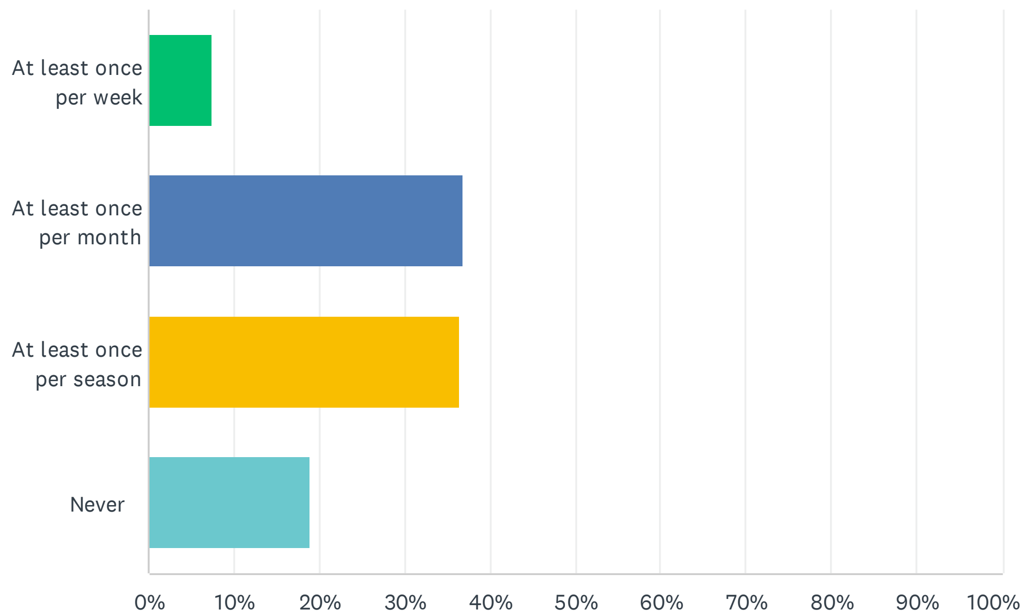
Answered: 372 Skipped: 157



ANSWER CHOICES	RESPONSES	
At least once per week	0.54%	2
At least once per month	2.96%	11
At least once per season	23.66%	88
Never	72.85%	271
TOTAL		372

Q19 In a typical peak-season (May-October), how often are you unable to travel on the sailing of your choice because reservations are full? [choose one]

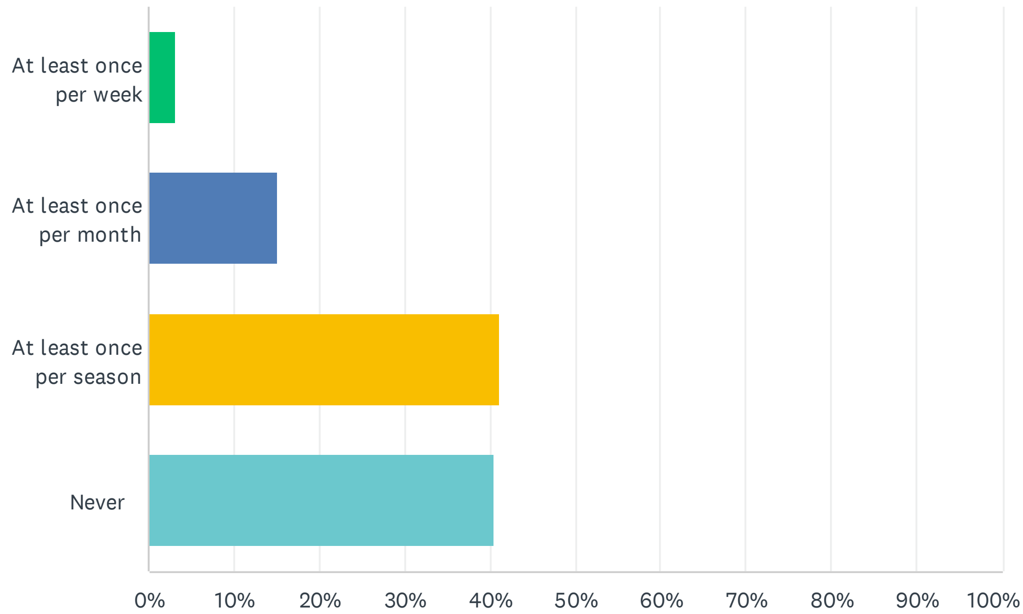
Answered: 430 Skipped: 99



ANSWER CHOICES	RESPONSES	
At least once per week	7.44%	32
At least once per month	36.98%	159
At least once per season	36.51%	157
Never	19.07%	82
TOTAL		430

Q20 In a typical peak-season (May – October), how often do you miss a boat while waiting in standby? [choose one]

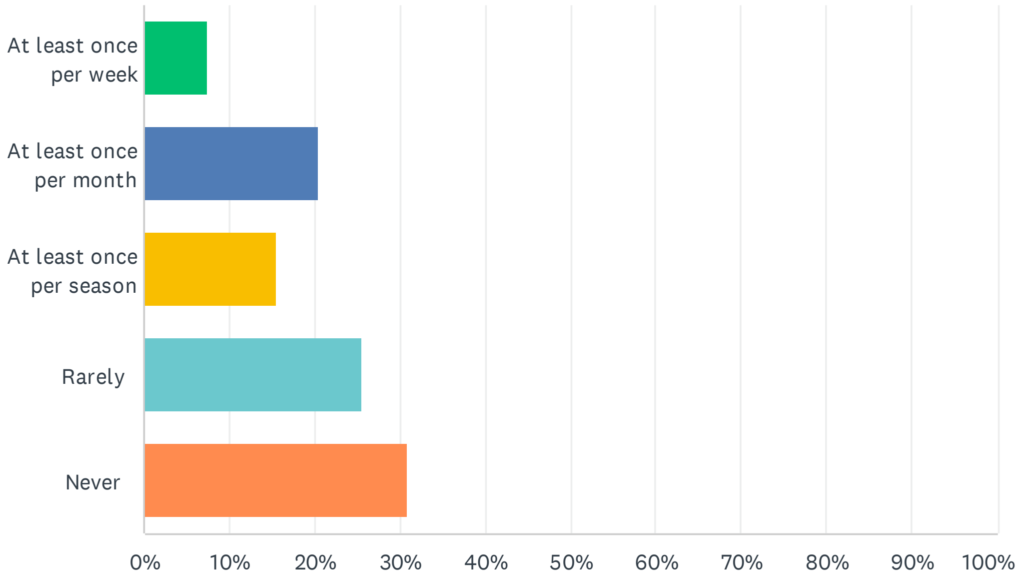
Answered: 405 Skipped: 124



ANSWER CHOICES	RESPONSES	
At least once per week	3.21%	13
At least once per month	15.06%	61
At least once per season	41.23%	167
Never	40.49%	164
TOTAL		405

Q21 How often do you use private water taxi service (including but not limited to Popeye or West Cove II Charters) to travel between Fishers Island and the mainland? [choose one]

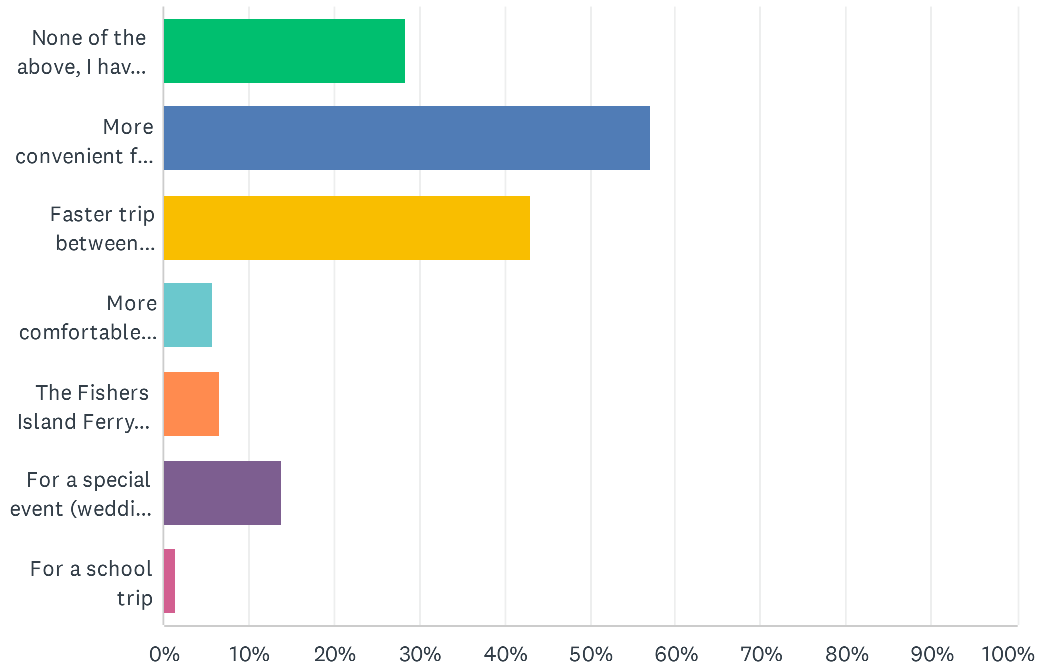
Answered: 437 Skipped: 92



ANSWER CHOICES	RESPONSES	
At least once per week	7.55%	33
At least once per month	20.37%	89
At least once per season	15.56%	68
Rarely	25.63%	112
Never	30.89%	135
TOTAL		437

Q22 For what reasons have you opted to take private water taxi instead of the Fishers Island Ferry? [choose multiple]

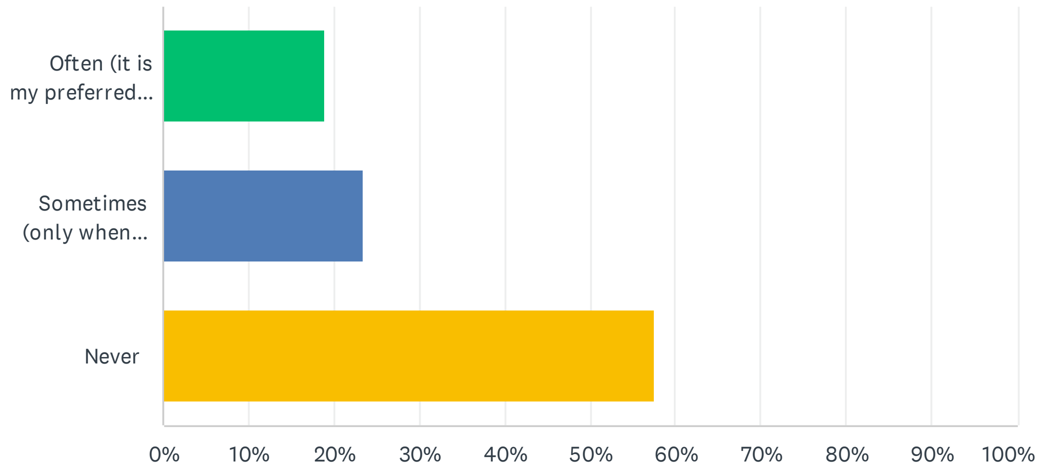
Answered: 413   Skipped: 116



ANSWER CHOICES	RESPONSES	
None of the above, I have never used a private water taxi service	28.33%	117
More convenient for my schedule needs	57.14%	236
Faster trip between mainland and Fishers Island	43.10%	178
More comfortable than the ferry	5.81%	24
The Fishers Island Ferry trip I was planning to take was full	6.54%	27
For a special event (wedding, golf tournament, etc.)	13.80%	57
For a school trip	1.45%	6
Total Respondents: 413		

Q23 Do you often use your own private vessel to travel between New London and Fishers Island? [choose one]

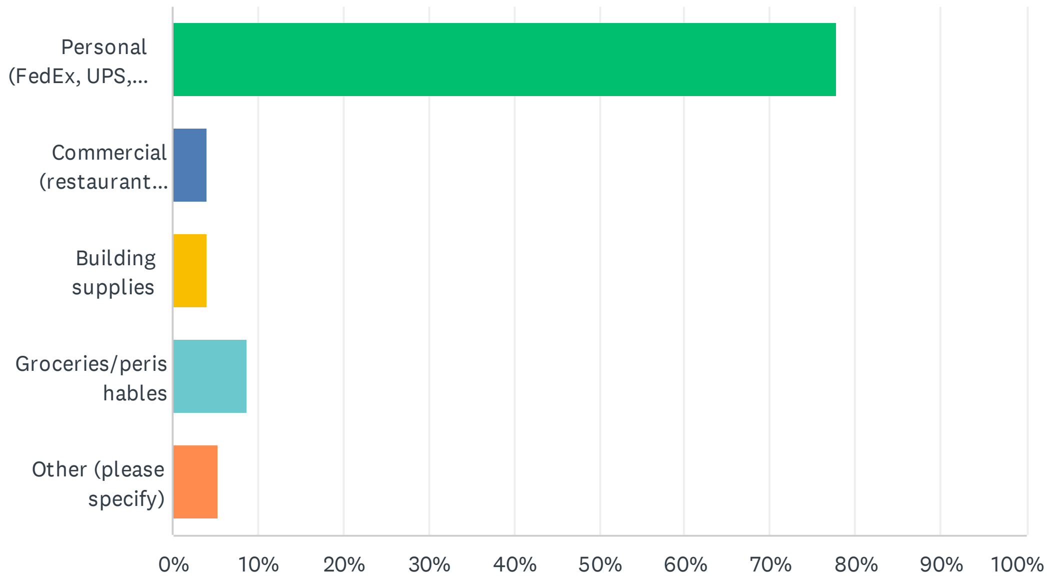
Answered: 431 Skipped: 98



ANSWER CHOICES	RESPONSES	
Often (it is my preferred method)	19.03%	82
Sometimes (only when necessary)	23.43%	101
Never	57.54%	248
TOTAL		431

Q24 What types of deliveries do you most often rely on ferry service to receive? [choose one]

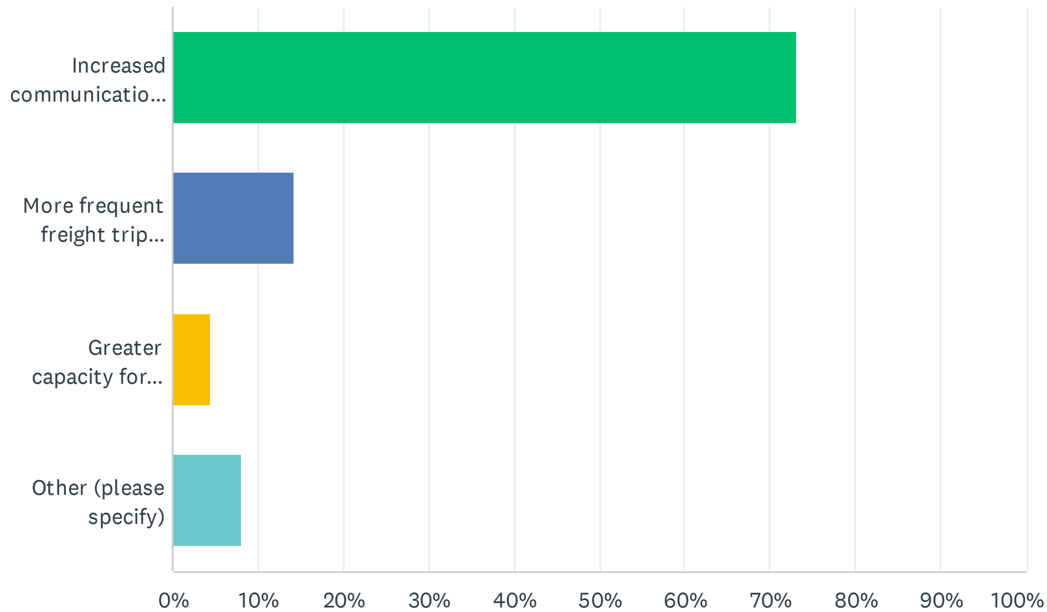
Answered: 416   Skipped: 113



ANSWER CHOICES	RESPONSES	
Personal (FedEx, UPS, etc.)	77.88%	324
Commercial (restaurant supply, bulk orders, etc.)	4.09%	17
Building supplies	4.09%	17
Groceries/perishables	8.65%	36
Other (please specify)	5.29%	22
TOTAL		416

Q25 Of the potential improvements to the current freight service, which would you most like to see? [choose one]

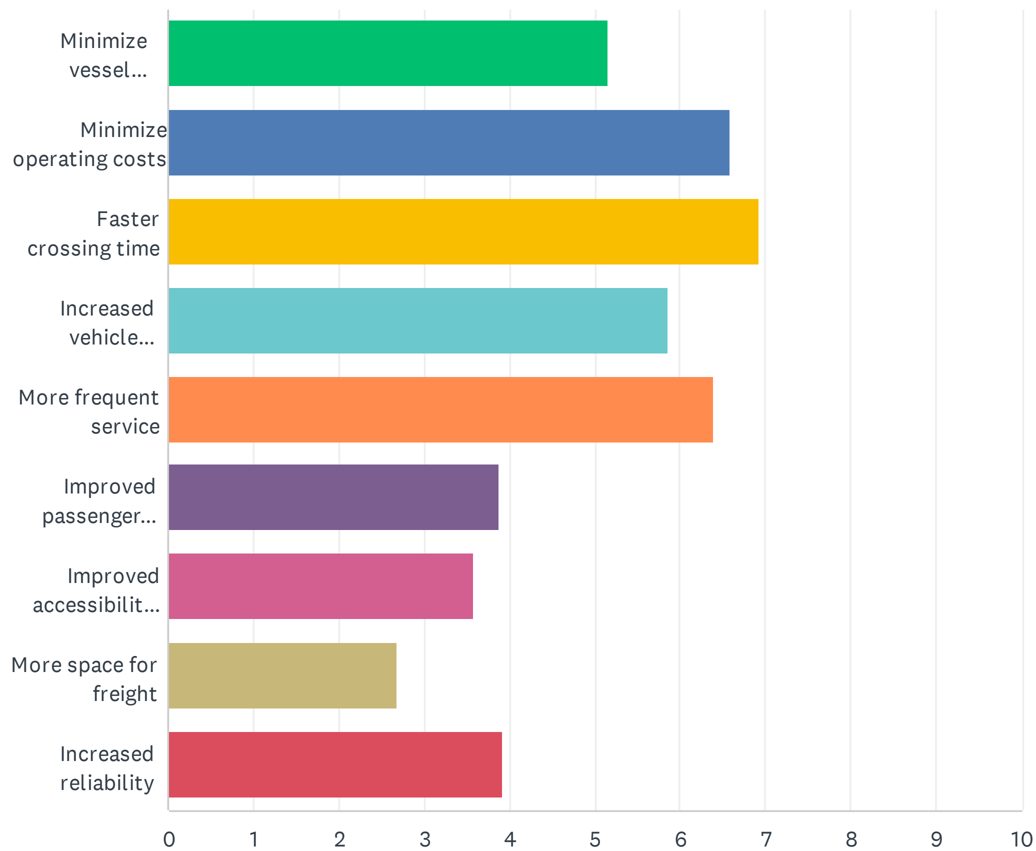
Answered: 372 Skipped: 157



ANSWER CHOICES	RESPONSES	
Increased communication when deliveries arrive (tracking)	73.12%	272
More frequent freight trips for increased reliability	14.25%	53
Greater capacity for freight on vessel	4.57%	17
Other (please specify)	8.06%	30
TOTAL		372

Q26 When considering a future auto ferry service, please rank the following vessel characteristics in order from your highest priority (1) to lowest priority (9). [use the arrows or drag to move options up and down]

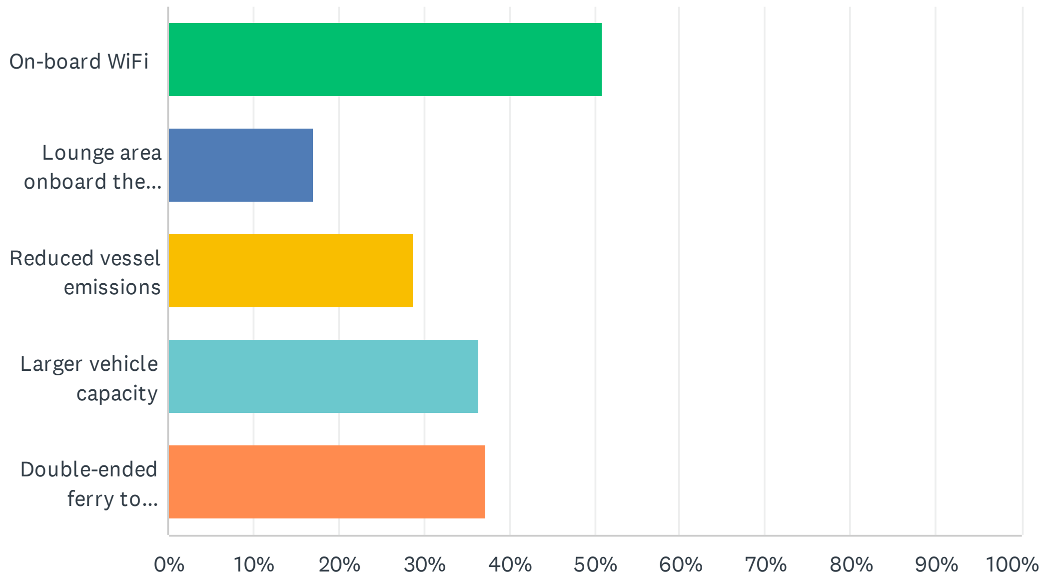
Answered: 406 Skipped: 123



	1	2	3	4	5	6	7	8	9	TOTAL	SCORE
Minimize vessel emissions	17.00% 69	11.58% 47	11.33% 46	9.61% 39	8.87% 36	7.39% 30	8.87% 36	6.65% 27	18.72% 76	406	5.15
Minimize operating costs	19.70% 80	20.94% 85	17.24% 70	14.53% 59	10.84% 44	7.88% 32	3.45% 14	3.69% 15	1.72% 7	406	6.58
Faster crossing time	25.37% 103	22.41% 91	20.44% 83	9.85% 40	7.88% 32	5.91% 24	4.19% 17	2.22% 9	1.72% 7	406	6.92
Increased vehicle capacity	8.62% 35	15.76% 64	13.79% 56	21.18% 86	17.00% 69	11.82% 48	4.93% 20	4.68% 19	2.22% 9	406	5.86
More frequent service	18.23% 74	18.23% 74	14.78% 60	12.56% 51	18.47% 75	10.10% 41	3.69% 15	2.96% 12	0.99% 4	406	6.39
Improved passenger amenities on board	1.48% 6	2.71% 11	6.65% 27	9.85% 40	11.33% 46	26.85% 109	15.52% 63	12.07% 49	13.55% 55	406	3.89
Improved accessibility for passengers on board	1.97% 8	3.20% 13	5.17% 21	5.91% 24	9.36% 38	11.82% 48	32.02% 130	23.40% 95	7.14% 29	406	3.59
More space for freight	0.49% 2	0.25% 1	4.43% 18	4.43% 18	4.93% 20	8.37% 34	17.24% 70	34.98% 142	24.88% 101	406	2.69
Increased reliability	7.14% 29	4.93% 20	6.16% 25	12.07% 49	11.33% 46	9.85% 40	10.10% 41	9.36% 38	29.06% 118	406	3.93

Q27 Of the vessel amenities below, which would you be most interested in when considering a replacement auto ferry? [select two]

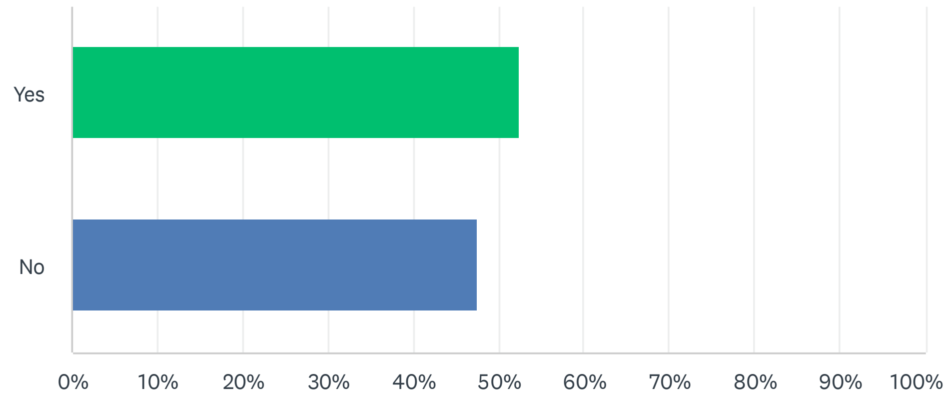
Answered: 400 Skipped: 129



ANSWER CHOICES	RESPONSES	
On-board WiFi	51.00%	204
Lounge area onboard the vessel	17.00%	68
Reduced vessel emissions	28.75%	115
Larger vehicle capacity	36.50%	146
Double-ended ferry to eliminate the need for vehicles to back onto the ferry	37.25%	149
Total Respondents: 400		

Q28 Does the Silver Eel meet the needs for seasonal fast ferry service? [choose one]

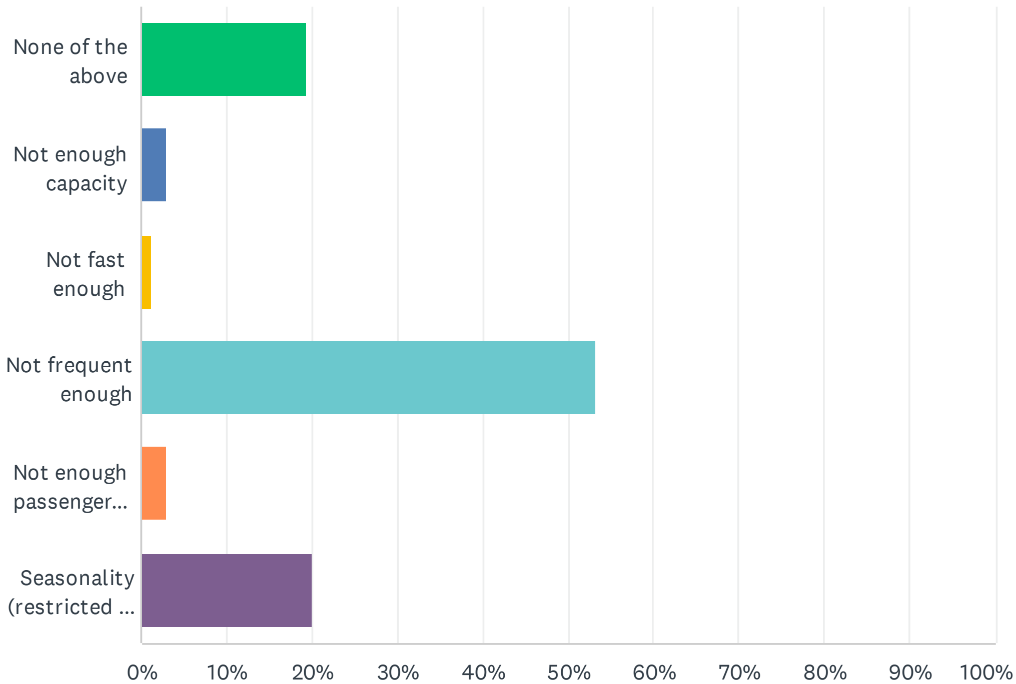
Answered: 366 Skipped: 163



ANSWER CHOICES	RESPONSES	
Yes	52.46%	192
No	47.54%	174
TOTAL		366

Q29 If you answered No to Question 28, why not? [choose one or skip if N/A]

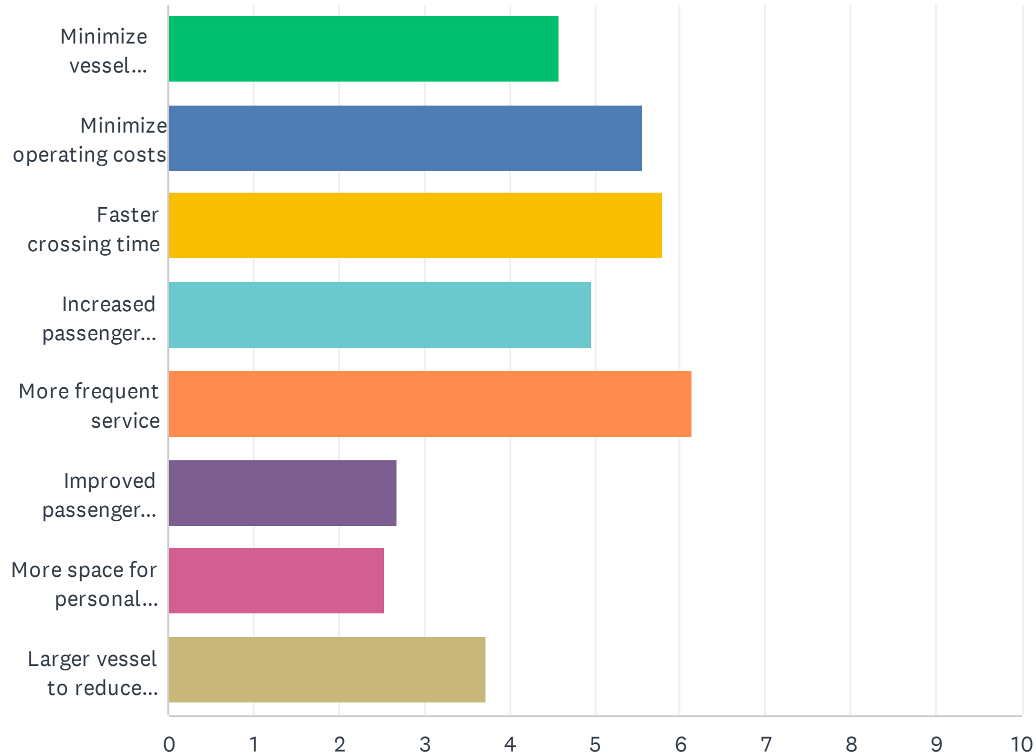
Answered: 165   Skipped: 364



ANSWER CHOICES	RESPONSES	
None of the above	19.39%	32
Not enough capacity	3.03%	5
Not fast enough	1.21%	2
Not frequent enough	53.33%	88
Not enough passenger amenities/comfort	3.03%	5
Seasonality (restricted by weather)	20.00%	33
TOTAL		165

Q30 Thinking about potential future fast ferry service, please rank the following vessel characteristics in order from your highest priority (1) to lowest priority (8). [use the arrows or drag to move options up and down]

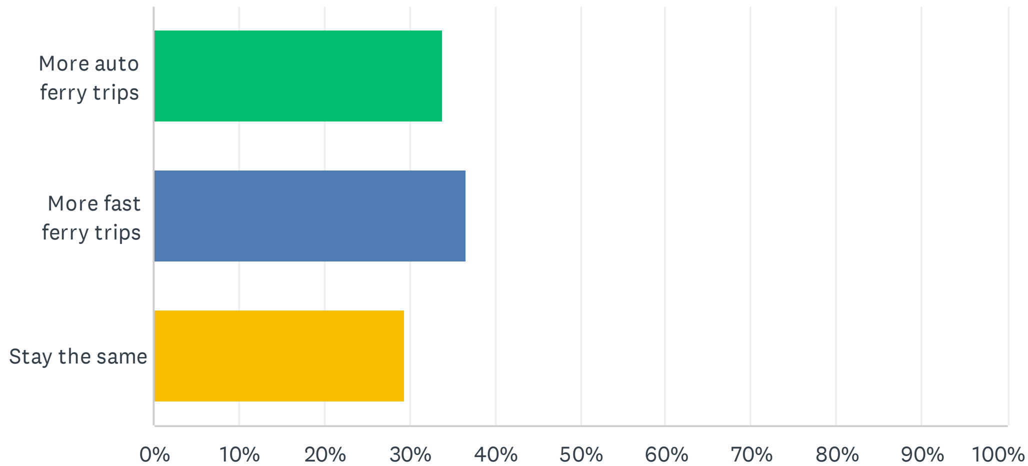
Answered: 364 Skipped: 165



	1	2	3	4	5	6	7	8	TOTAL	SCORE
Minimize vessel emissions	18.41% 67	10.71% 39	11.81% 43	11.81% 43	11.54% 42	8.52% 31	7.97% 29	19.23% 70	364	4.59
Minimize operating costs	14.84% 54	22.25% 81	18.68% 68	15.93% 58	12.64% 46	9.62% 35	4.40% 16	1.65% 6	364	5.56
Faster crossing time	22.80% 83	21.15% 77	18.41% 67	14.56% 53	7.42% 27	7.42% 27	4.67% 17	3.57% 13	364	5.79
Increased passenger capacity	4.40% 16	13.19% 48	16.21% 59	26.92% 98	24.73% 90	10.16% 37	3.30% 12	1.10% 4	364	4.96
More frequent service	30.77% 112	19.78% 72	17.31% 63	7.69% 28	18.41% 67	3.30% 12	2.20% 8	0.55% 2	364	6.15
Improved passenger amenities on board	0.55% 2	0.27% 1	2.75% 10	4.67% 17	8.24% 30	40.38% 147	25.00% 91	18.13% 66	364	2.68
More space for personal items/luggage	0.55% 2	2.47% 9	3.30% 12	7.42% 27	6.59% 24	12.36% 45	44.23% 161	23.08% 84	364	2.54
Larger vessel to reduce cancellations due to weather conditions	7.69% 28	10.16% 37	11.54% 42	10.99% 40	10.44% 38	8.24% 30	8.24% 30	32.69% 119	364	3.73

Q31 Are you satisfied with the mix of service between auto ferry trips and fast ferry trips, or do you think it should be adjusted? [choose one]

Answered: 378   Skipped: 151



ANSWER CHOICES	RESPONSES	
More auto ferry trips	33.86%	128
More fast ferry trips	36.77%	139
Stay the same	29.37%	111
TOTAL		378

Q32 What other ideas would you like to share, related to service enhancements or improvements to terminals or vessels, that would improve your experience with Fishers Island Ferries? [Write in]

Answered: 173 Skipped: 356