
Date: Thursday, 16 March 1978

Place: Near Portsal, north coast of France

Voyage: From Kharg Island, Iran, to Rotterdam via Lyme Bay, English Channel

The *Amoco Cadiz* was fully laden with crude oil, part of which was for discharge at Lyme Bay. On the morning of 16 March she passed through the traffic separation scheme off Ushant, though her exact path is uncertain. At 09:46 her steering gear system failed in a rough sea with a strong south-westerly wind, about 8 nm north of Ushant.

The ship, with rudder stuck initially in the hard-a-port position, started to veer north. The master, concerned about obstructing the approach to the west-going traffic lane, stopped the engine and transmitted radio warnings that the ship was not under command. He requested other vessels to keep clear of her but did not request outside assistance; the engineers were attempting to repair the steering gear.

By about 10:05 the vessel's original momentum was lost, and she began to drift under the influence of wind and tidal stream only. The latter, with rates up to 1 knot (neaps), was setting easterly from the time of breakdown until about noon; south-westerly until about 17:00; then north-easterly until grounding.

By 11:00 the vessel's heading had changed to 160°T, and she had drifted about 1 1/2 nm in a south-easterly direction.

At 11:20 the engineers reported failure in repairing the steering gear; in the heavy seas the rudder swung about and could not be locked for them to carry out the work. The master, realizing that he needed outside help, radioed for tugs.

The tug *Pacific*, then 15 nm away, responded promptly and arrived at the ship at 12:20. Making fast proved difficult in the heavy seas; a towing hawser was finally made fast on the starboard bow. Shortly after 14:00 the *Pacific* began towing off to starboard to try to turn the *Amoco Cadiz* onto a westerly heading. By then she had drifted about 6 1/2 nm SSE from her 10:05 position and was less than 6 nm off Ushant Island. The tug stopped the *Amoco Cadiz* drifting south, but could not stop her drifting 2 nm further east. Her heading changed only 20° to starboard, from about 160°T to 180°T.

At 16:15 the towing hawser parted and the engine of the *Amoco Cadiz* was at once put to run astern with all possible power. As a result the heading changed to 130°T (i.e. the stern turned towards the wind, which was veering from SW to NW and continued to blow with gale force). For the next 2 1/2 hours, with the engine running astern, the vessel's motion was towards the northeast.

By 19:00 the *Pacific* had prepared a new hawser and was ready to try again. This time, the stern of the *Amoco Cadiz* was made fast. Her engine was stopped to enable the difficult operation to be carried out. But she swung round to head 260°T and drifted eastwards; at 20:04 the port anchor was dropped (1.3 nm west of Roche de Portsal buoy) but dragged, even though a large scope of cable was paid out. Seas were being shipped over the starboard bow and it was considered unsafe for the crew to try to drop the starboard anchor. (The French authorities later recovered the port anchor and found that both flukes had broken off.)

At 20:33 the crew got the towing hawser on board but it was not made fast until 20:55. The *Pacific* moved off to begin towing but minutes later, at 21:04, the *Amoco Cadiz* struck the ground aft. The pump room was damaged and started to flood. Oil leaked and because of fire risk all power was switched off. At about 21:30 the vessel struck ground again and the engine-room flooded. The *Amoco Cadiz* was firmly aground. The *Pacific* continued to tow without effect until the towing hawser parted at 22:12. A second tug, the *Simson*, arrived about an hour later but could only stand by. The ship was doomed.

It was impossible to launch the lifeboats in the heavy seas. French naval helicopters were alerted and performed a daring rescue during darkness in the early hours of Friday, 17 March. No lives were lost.

Cause: The obvious cause of the disaster was the failure of the steering gear. However, the dangers of a lee-shore in the circumstances of breakdown are well known. The *Amoco Cadiz* on her passage to Lyme Bay could

have passed much further offshore without increasing her passage distance or time significantly, but thus increasing her safety margin. Vessels are not compelled to enter the traffic separation zone off Ushant, but if they do they must comply with it.

After the breakdown, the hazardous position of the *Amoco Cadiz* was not fully appreciated by those on board. Even without steering, engine power could have been used more effectively; more urgent steps could have been taken to summon assistance from tugs and to prepare both anchors.

Consequences: The entire oil cargo was lost and the resulting pollution was far in excess of the previous worst case (the *Torrey Canyon*). Following the *Amoco Cadiz* disaster the French Government introduced stricter regulations concerning laden tankers approaching the coasts of France. Radio reports have now to be made to the French marine authorities, and the areas in which laden tankers could operate are restricted. The French Government also insisted that IMO redesign and move further seaward some of the traffic separation schemes in the vicinity of the coast of France, to ensure that laden tankers pass further offshore.

Exxon Valdez

1989

(from "Out of the Channel" and personal observation)

Vessel Description: U.S. oil tanker, 300 m in length. At the time of grounding, she had 1,286,738 barrels of crude oil.

Time of Stranding: 00.04 AST

Date: Friday, 24 March 1989 ("Good Friday")

Place: Bligh Reef, Valdez Arm, Prince William Sound, Alaska USA

Voyage: From Valdez, Alaska to Long Beach, California

On Thursday, 23 March, 9:12 p.m., the *Exxon Valdez* cleared the dock after loading almost 1.3 million barrels of Alaska North Slope crude oil from the Valdez Marine Terminal of the Trans-Alaska Pipeline. The mates and captain, having been involved in either cargo-loading operations or drinking across the bay in Valdez, were fatigued and of questionable performance capability. At 10:20, she turned south at Entrance Island on Port Valdez into the established inbound/outbound Traffic Separation Scheme (TSS) out through Valdez Narrows and Arm. The harbor pilot was disembarked at 11:24 at Rocky Point, and shortly afterwards the Captain radioed the Valdez Traffic Center to request permission to divert from the outbound (westward) traffic lane to the inbound (eastward) lane to avoid glacial icebergs in the Arm.

The radar relied on by the Valdez Traffic Center had been downgraded in the early 1980s and now focused primarily on the Narrows – it didn't always reach as far as Bligh Reef.

The Valdez Traffic Center watchstanders later tested positive for alcohol and marijuana use.

As the vessel returned to a speed of 11 knots after disembarking the pilot, the captain noticed that the ice in the lanes was heavy and ordered a course change to 180°T, in order to try to slip around the eastern edge of the ice outside the TSS. This is not an unusual procedure for tankers avoiding ice in this area, when they want to maintain their speed.

The captain ordered the ship put on autopilot, that the ship's computers load up or accelerate the engines to sea speed of 14 knots, and to turn the ship back into the TSS when it was abeam of the Busby Island light. He then left the bridge under command of the Third Mate who did not have pilot credentials for Prince William Sound.

Thus, the vessel was at this point loading up to full sea speed, outside the TSS, headed directly toward Bligh Reef, on autopilot, piloted by a mate without pilotage credentials for this seaway. The Third Mate later testified that he then ordered the vessel taken off autopilot. It is suspected that this command was either never given or never executed by the helmsman. At 11:52, the wing watch and helmsman were changed; the helmsman who

would later testify that "I get so confused." When the Busby light was abeam, the Third Mate ordered a simple 10 degree right rudder to return to the TSS. The vessel did not respond.

The Bligh Reef (red light) buoy could now be seen off the starboard bow, indicating the vessel was headed for the reef.

The voyage data recorder aboard the vessel later indicated a turn did not commence until 12:01 a.m., despite the Third Mate's testimony that he had ordered the hard over five minutes earlier. It is strongly suspected that the vessel had unknowingly been left on autopilot, and until the mistake was noticed, did not respond to helm commands. By then, it was too late.

At about 12:04 a.m., March 24, the vessel grounded into Bligh Reef and at 12:26, the captain radioed the VTC in Valdez to report the grounding and, in a rather extraordinary understatement, report that "evidently, we're leaking some oil!"

The captain radioed Valdez Coast Guard that he was attempting to wiggle the vessel off the reef; his commands suggest he was actually maneuvering the vessel harder on the reef to protect her from sinking. Although the official estimate of the amount of oil released was about 250,000 barrels, or 1/5 of the load, other estimates suggest that perhaps 2-3 times that amount was spilled. The remainder was transferred to lightering vessels and the ship was refloated, taken to Long Beach, reconstructed, and returned to service in foreign trade under the name "S/R *Mediterranean*."

Consequences: Though not the largest oil spill in terms of volume of oil spilled, the *Exxon Valdez* spill became the most damaging — biologically, socially, and economically — in history. Coastal currents spread the oil eventually over 10,000 square miles, and 1,500 miles of shoreline were oiled. More marine mammals and seabirds were killed than any other spill on record. Coastal communities dependent on coastal fisheries were in turmoil for years.

Although Exxon spent over \$2 billion on a massive clean-up effort, only about 20,000 barrels, less than 7%, was eventually recovered. Today, it is estimated that several million gallons of *Exxon Valdez* crude remain trapped in beach sediments of Prince William Sound.

Braer

1993

(from "Innocent Passage," J. Wills)

Vessel Description: U.S. managed tanker, built in Japan, flagged in Liberia, owned in Bermuda by Americans, crewed by Greeks, Poles, and Filipinos, carrying Norwegian oil to Canada. At the time of grounding, she had 84,413 tons of Gulfax crude on board and 1,700 tons of heavy fuel oil.

Time of Stranding: 11:13 GMT

Date: 5 January 1993

Place: Garth's Ness, southern tip of Shetland, U.K.

Voyage: From Mongstad, Norway to Quebec, Canada

On the morning of Sunday, 3 January 1993, the T/V *Braer* set sail from the Mongstad oil terminal, north of Bergen. In Mongstad, there had been trouble with the steam boiler, which was needed to heat the ship's fuel oil for her main engine. They had to use the auxiliary burner to inert the cargo tanks during loading.

Weather upon sailing was poor — 30 foot seas, 50 knot south winds. Green water was taken on deck. Progress was very slow — after 24 hours, the vessel was only 60 miles out, an average speed of 25 knots.

The U.S. Coast Guard had given the *Braer* a complete inspection on November 11, 1992 (7 weeks earlier), and passed her with a clean certificate. Although she was 17 years old, she wasn't particularly old by international

standards. Several sixteen foot-long steel pipes were lashed to steel racks on the deck outside the Inert Gas Room. Heavy seas were running the full length of the deck. Large waves slammed the vessel.

The rack holding the pipes was constructed at order of the Chief Engineer on a cold, wet, open deck in the mid-Atlantic in mid-winter on her journey to Norway. Welding is better done in warm, dry conditions. The wind rose and seas increased to 50 feet.

The rack and pipes broke loose in the heavy weather south of Shetland. They rolled around on the port aft deck, and it was judged too dangerous to send anyone out to secure the pipes. The rolling pipes on deck soon smashed the fuel tank vent pipe, allowing seawater to enter the fuel tanks. The spiral of mechanical failure had begun.

They had been running slow because of the heavy seas and the main engine, a 7-cylinder, two-stroke Sulzer, slowed and clogged. They could have switched to running on diesel, but did not. Because of fuel contaminated with seawater, the auxiliary engines, generators, and steam boiler failed at the same time as the main engine, and the ship was in serious trouble. The ship's electrical power stopped — the *Braer* was dead-in-the-water, broadside to a force 9 gale, with a fast approaching lee-shore — South Shetland.

At 05:00, the Captain radioed not the Coast Guard, but his home office in Stamford, Connecticut for instructions. No mayday was sent immediately. This turned out to be a grave mistake.

At 05:19, when the captain spoke with the Coast Guard, he reported engine failure, but “no immediate danger.”

At 6:26 a.m., the captain realizing the vessel's northward drift toward Sumburgh Head, issued the “Pan” message that the Coast Guard had urged him to issue at 6:11 a.m. which allowed rescue vessels to be dispatched. The delay in calling for assistance is deemed a significant contributing cause for the grounding.

The *Braer* had broken down in the “Sumburgh Roost,” the Fair Isle Channel, in some of the messiest tidal currents known, in the midst of a North Sea hurricane. Lowering the anchors, which required sending men forward on decks awash, was simply impossible. No one could reach the bow towing cables to deploy. And there was no stern anchor.

As the vessel drifted within 2.5 miles of Sumburgh Head, her crew was lifted off by the RAF Coast Guard helicopter. At 8:50 a.m., only the captain and one crewman were left on board. Two fishing boats now standing by — the *Philorth* and the *Sette Mari* — were helpless to assist. The salvage tug *Star Sirius* was still 44 minutes away.

Shetlanders had spoken for generations of a witch named Norma whose lair was high on Fitful Head, luring ships to their doom for centuries off the Roost. The *Braer* was to be her prize catch.

The salvage tug *Star Sirius* arrived at the vessel around 9:30 a.m. and stood by with no one aboard to fix a tow to the vessel. Later, the Shetland Fishermen's Association would say they were “astonished” at the decision to abandon ship so early.

At 11:07, the first line fixed by the *Star Sirius* missed. They then fixed a second line; it was received, but it was too heavy to hold. The men were lifted off. Four minutes later, at 11:13, the *Braer* struck the rocks at Garth's Ness. She and her cargo became a total loss.

Consequences: The intense hurricane-force winds that drove the vessel onto S. Shetland continued for two to three more weeks and the huge seas and turbulence effectively emulsified most of the *Braer*'s 600,000 barrels of Gulfax crude with sea water. As a result, the oil naturally dispersed, biological damage was minimized, and most of Shetland's coastline was untouched. Bottom sampling later found perhaps 100,000–200,000 barrels distributed over a large portion of the seabed between Shetland and the Scottish mainland in two sedimentary basins. It is assumed that this seabed oiling resulted from the intense surface mixing of seawater, oil, and sediment which caused the oil to sink.

ADDENDUM 2

Preparation for a Tank Vessel Examination

U.S. Coast Guard

To Ship masters and Agents:

The following list has been made to help you prepare for your upcoming Coast Guard Examination. This is not an all inclusive list of a complete examination and some things may not apply to your vessel. You should make all applicable items ready and available for examination:

- I. If you are equipped with a cargo pump room, a gas-free Chemist's Certificate will be required prior to the examination of the pump room. Failure to obtain the certificate will result in cargo operation delays.

Ballast Tank - If the vessel is more than 10 years old, a Certified Marine Chemist's Certificate will be required for at least one ballast tank located in the cargo block, mid-ship half length section. Arrange which ballast tank with the CG dispatcher or CG Inspector.

- II. Provide a copy of the following papers or documents:

- Classification Document
- Classification Society status report
- Latest Drydock survey and special survey gauging reports
- Certificate of Registry
- Cargo Ship Safety Construction Certificate
- Cargo Ship Safety Equipment Certificate
- Safety Radiotelegraphy Certificate
- IMO Certificate of Fitness (Gas/Chemical Carriers)
- International Oil Pollution Prevention Cert. and Supp.
- Load Line Certificate
- IMO Certificate of Fitness
- IOPP Certificate and Supplement
- Certificate of Financial Responsibility
- Crew list
- A drawing of the cargo tank arrangement
- Safety Radio Telegraph
- Vapor Collection System Certification from Class Society
- Safe Manning Document

The following expiring documents will be removed by the USCG inspector when they leave your vessel. If you wish, make copies for your records. New documents will be issued at the conclusion of your examination:

Coast Guard Letter of Compliance or Tank Vessel Examination Letter, Subchapter "O" Endorsement

- III. Make the following documents or books available for inspection:

- Officer Competency Certificates (licenses)
- Current Health Certificates for all crew members (This is a medical examination stating that you are fit for duty and is valid for two years.)
- Procedures and Arrangements Manual or Operations Manual as applicable
- Approved Crude Oil Washing (COW) Manual
- Approved ballast manual (DCBT must include text of resolution 14 of MARPOL)

Oil/cargo record book
Oil transfer procedures
Trash log for compliance with MARPOL ANNEX V
Proof of hose testing
Shipping document and cargo manifest
Certificate of inhibition or stabilization of cargo
Declaration of Inspection if transferring bunker
Cargo information cards for the cargo on board
Waiver letters if any
IGS approval Cert.
TVEL _____ TVE Enclosure _____
Inclining experiment

IV. Be ready to calibrate and/or demonstrate the proper operation of the following:

Combustible gas detectors or fixed gas detection system (will require the proper span gas for calibration)
Oxygen analyzer
Toxic gas detector
Overboard discharge monitor
Cargo pump emergency shutdowns (remote and manual)
High level alarms (95% - where required)
Low level alarms (where required)
Overfill alarms (98% - where required)
Quick closing valves (remote and manual)

Be ready to demonstrate the proper operation of the following:

Inert Gas System Alarms

Low water flow or water pressure to the scrubber
High water level in the scrubber
High gas temperature on the discharge side of the blowers
Inert gas blow failure
High oxygen content at the discharge side of the inert gas blowers (greater than 8%)
Automatic control system power failure
Low water level in the deck water seal
Low gas pressure forward of the deck water seal (under 100 mm water gage)
High gas pressure forward of the deck water seal

Oily Water Separator Check

15 PPM alarm (test to be in accordance with system manufacturers instruction)
System auto stop
Recording device (if fitted)
Stock of manufacturers recommended spare parts and consumable supplies

Fire Fighting Systems

This test will require the use of two fire hoses and, if fitted with an on deck foam system, two foam monitors. Water only will be sent through the foam monitor.
Demonstrate pumps are capable of providing 75 psi at all stations
Operate all fire fighting pumps using fire hose/monitors
Fire control plan
Emergency gear locker
Semi-portable and portable extinguishers

Fire fighting outfits/suits (Non conducting boots and gloves, rigid helmet, lantern, axe, water resistant protective clothing)
SCBA 1200 Liter
Foam analysis
Fixed fire fighting (storage room for fire agent)
International shore connections

Steering Gear Systems

Operate the steering gear on each steering gear pump
Operate the steering gear in all modes of operation (wheel, hand, non-follow up, and emergency)
Demonstrate the steering failure alarms
Demonstrate the low hydraulic oil alarm in the reservoir

Emergency Generator/Accumulator Batteries

Demonstrate automatic starting feature
Demonstrate the manual transfer procedures

Vent Systems

Piping
P/V valves, flame screens, goosenecks
Expansion trunks

Pumprooms

Remote shutdowns at all stations
Overspeed trips
Low lube oil trip
Sources of ignition
Proper ventilation
Explosion proof fixtures
Stuffing boxes gas tight glands
Gasfree

Lifesaving Equipment

Current servicing of liferafts (retro fit of reflective tape, installed thermal protective aids)
Proper stowage of LR including weak link attachment
Lifeboats davits and winches properly rigged
Lifeboats (falls end for ended, renewed), muster lists, embarkation lighting, drills in log
Lifebuoys
Public address system
Life jackets
Immersion suits

Navigation and Communication Systems

Proper operation of radars and ARPA
Current U.S. or foreign charts and publications
Navigation light operation
Echo depth sounder and recorder
Rudder angle indicator
Bridge to steering communications (intrinsically safe radios)
SATNAV operation

Gyro and repeaters
Magnetic compass and deviation log
Maneuvering characteristic chart
Emergency radios (portable/lifeboat)
EPIRB's
Parachute flares
Channel 16 on bridge

Habitation/ILO

Minimum age crewmember 15
Hospital space
Crew's room and lounge
Galley (grease traps readily removable, fire damper, arrangement to secure fans, fixed means to extinguish a fire)
Means of escape (at least two widely spaced)

Engine Room

Non conducting mats at switchboards (front, sides, and rear)
Bilge pumps
Skylights (no glass or wood)
Main propulsion control
Oil placard
Engine room ventilation shutdowns
Operate the engine room ventilation shutdowns.
Fuel oil cutoff valves

Miscellaneous

Oil in prohibited spaces – forward of the collision bulkhead

IGS CHECK OFF LIST

1. IGS SYSTEM APPROVAL BY _____ DATE _____
 2. IGS SOURCE: BOILER (FLUE GAS) _____ GENERATOR _____
 3. UPTAKE VALVES (FLUE GAS SYS) OPERATIONAL _____
 4. SCRUBBER
 - A. PRIMARY WATER SUPPLY _____ DOESN'T INTERFERE WITH FIRE FIGHTING CAPABILITY _____
 - B. ALTERNATE SOURCE _____
 - C. SCRUBBER LEVER OR FLOW INDICATOR _____
 5. BLOWERS
 - A. AT LEAST TWO _____ TOTAL CAPACITY _____
(MUST BE 125% OF TOTAL CAPACITY OF CARGO PUMPS)
 - B. BOTH TESTED _____
 6. REGULATING VALVE OPERATIONAL _____
 7. FRESH AIR INTAKE CLOSED WITH BLANK FLANGE _____
 8. DECK WATER SEAL
 - A. TYPE (WET, SEMI-DRY, DRY) _____
 - B. WATER SUPPLY _____
 - C. HEATING COIL _____
 9. PRESSURE/VACUUM BREAKER
 - A. TYPE (LIQUID OR HIGH VELOCITY VENT) _____
 - B. IF LIQUID, LIQUID USED _____
 10. DECK PIPING
 - A. AUTOMATIC NON RETURN VALVE _____ STOP VALVE _____
(FITTED JUST AFTER DECK WATER SEAL)
 - B. CONDITION OF PIPING _____
 - C. FITTED WITH SHUTOFF VALVE OR BANJO FLANGE AT EACH TANK
YES/NO (INCLUDING SLOP TANKS)
 11. ALARMS AND INSTRUMENTATION
 - ALARMS:
 - A. HIGH O₂ (8%) _____ TESTED _____
 - B. HIGH TEMP _____
 - C. LOW IG PRESSURE _____ HIGH IG PRESSURE _____
 - D. IG BLOWER FAILURE _____
 - E. POWER FAILURE TO AUTOMATIC GAS REGULATING VALVE _____
 - INSTRUMENTATION:
 - A. O₂ LEVEL (% BY VOL) RECORDER _____
 - B. IG PRESSURE RECORDER _____
 - C. O₂ INLINE ANALYZER - TYPE _____ SPANNED _____
 - D. READOUTS AVAILABLE TO CARGO OFFICER _____
 12. SYSTEM SHUTDOWNS:
 - A. LOSS OF WATER SUPPLY TO DECK WATER SEAL _____ **ALARM**
 - B. HIGH IG TEMPERATURE _____ **ALARM**
 - C. LOW WATER LEVEL/FLOW IN SCRUBBER _____ **ALARM**
 - D. HIGH WATER LEVEL IN SCRUBBER _____ **ALARM**
 - E. REMOTE OUTSIDE OF SPACE _____
-

ADDENDUM 3

Washington State Office of Marine Safety

Agency Programs

After the Exxon Valdez spill in 1989 and two major spills along the Washington coast in 1988 and 1991, the Washington State Legislature passed the Oil Spill Prevention and Response Act of 1991. This legislation:

- Created the Office of Marine Safety (OMS),
- Established a reserve account in the event of a major oil spill, and
- Funded other spill related activities.

OMS' mission is to reduce the risk of oil spills in Washington waters by promoting safe marine transportation. The agency's programs focus specifically on improving human performance as the most effective means to prevent oil spills.

Vessel Screening

The Screening Program evaluates cargo and passenger vessels entering Washington waters for relative risk posed to public safety and the marine environment. The OMS Screening Program uses a database of risk-related vessel data and a risk matrix based upon expert opinion of experienced Puget Sound mariners to screen vessels. The matrix prioritizes ships for boarding and inspection by monitoring personnel in the OMS field offices.

Vessel Monitoring

The purpose of the Monitoring Program is to monitor vessels and evaluate compliance with prevention plans, contingency plans, and other state, federal, and international laws. The program focuses on vessels identified by the Screening Program as a high priority for boarding. The OMS Puget Sound field office began operating in November 1993, and field office staff daily board ships entering Puget Sound. OMS opened a Columbia River field office in Portland, Oregon in July 1994. The Columbia River field office is a joint venture with Oregon's Department of Environmental Quality.

Prevention Planning for Tank Vessels

The Tank Vessel Prevention Planning Program provides the best achievable protection of Washington's marine environment. Beginning June 7, 1995, owners and operators of tankers and tank barges must submit oil spill prevention plans demonstrating compliance with best achievable protection standards in four major categories:

- Operating Procedures;
- Personnel Policies;
- Management Practices; and
- Technology

Education and Technical Outreach

The Education and Technical Outreach Program targets specific pollution causing events and develops and implements solutions to these problems. OMS identified bunkering as its first priority for education and technical outreach. OMS worked with a technical advisory committee to develop bunkering procedures. In August 1994, these procedures were adopted as regulations effective October 1994. OMS is now implementing an education and monitoring program to reinforce these bunkering procedures.

Vessel Contingency Planning

All tank vessels and cargo and passenger vessels of 300 gross tons or greater must file oil spill contingency plans with OMS. The Contingency Planning Program is responsible for ensuring the capability for an effective response to vessel oil spills in Washington State waters. This is accomplished by reviewing and approving vessel oil spill contingency plans and evaluating drills. The Contingency Planning Program also reviews and approves primary spill response contractor applications.

Marine Information System

The OMS Marine Information System contains information on ships and casualties, vessel prevention and contingency plans, agents, owners, and other relevant data. OMS is now entering world-wide data on casualties, events, and personnel into the system. The system was developed for OMS, and is on-line and available to all OMS employees. OMS' Screening Program relies heavily on this information.

Vessel Investigations

Vessel incidents provide a unique opportunity to determine what went "right" and "wrong" in a particular vessel operation. OMS investigations focus on the human and organizational factors that lead to vessel incidents. Each investigation is an opportunity to develop prevention methods that may reduce the possibility of a similar incident occurring in the future. OMS investigates oil spills, groundings, fires, explosions, sinkings, collisions, allisions, losses of propulsion or steering systems, and incidents involving human error. Vessel investigations are entered in OMS' database and may be used to screen a vessel upon its next arrival into Washington waters.

Interagency Coordination

Comprehensive prevention planning involves a high degree of interagency coordination with agencies and governments that share a responsibility for the Pacific Coast, Puget Sound, and the Columbia River. OMS works closely with the United States and Canadian Coast Guards, the Washington State Department of Ecology, the Oregon Department of Environmental Quality, British Columbia, and other West Coast states to avoid duplication of effort and maximize the use of resources on spill prevention programs.

ADDENDUM 4

DET NORSKE VERITAS TECHNICA
RENSSELAER POLYTECHNIC INSTITUTE
THE GEORGE WASHINGTON UNIVERSITY

August 21, 1985

PRINCE WILLIAM SOUND RISK ASSESSMENT PROJECT WHITE PAPER EXECUTIVE SUMMARY

The Prince William Sound (PWS) risk assessment project has three primary objectives: (1) to identify, evaluate, and rank the risks of oil transportation in PWS, (2) to identify, evaluate, and rank proposed risk reduction measures, and (3) to develop a risk management plan and risk management tools that can be used to support a risk management program. The Prince William Sound risk assessment project is designed to provide system stakeholders with the information, techniques, and tools required to understand and to reduce the risk associated with the transportation of oil in PWS. The involvement of all TAPS shippers, the Regional Citizen's Advisory Council, Alyeska, the Coast Guard, and the State of Alaska DEC in the management of the project provides the study team with unique access to individuals and information and will ensure that all viewpoints are considered in the analysis.

The PWS risk assessment will not attempt to determine an "acceptable level of risk" a priori. Rather, the analysis will describe and measure the current level of risk in the system, will identify and measure the potential effectiveness of risk reduction measures, and will identify and rank potential system improvements according to effectiveness, cost, and implementation feasibility. The degree to which these improvements are accepted and implemented by the steering committee and other system stakeholders will define the level of system risk that is accepted. The determination of acceptable risk will be a product of the PWS analysis, not an initial parameter subjectively determined or a value calculated from some other environment. The products of the risk analysis will produce a dynamic capability — the continuing ability to evaluate system changes and to monitor and manage the system.

I. INTRODUCTION

This white paper describes the framework, methods, and models that will form the basis of the PWS risk assessment. The study scope will address the risks of marine oil transportation from the Valdez Marine Terminal to 20 miles outside of Hinchinbrook Entrance. It will examine causal and contributory factors such as marine traffic, weather, external environmental variables, human error, and mechanical failure. The study will address technical and operational aspects of the tanker fleet, regulatory requirements, and operating company management. Excluded from the scope of the study are events that could occur within the terminal itself or events caused by certain extremely low probability natural phenomena (e.g., a lightning strike).

The project approach will integrate a system oriented simulation-based methodology with the more traditional event oriented probabilistic approach. This combined approach will compensate for the inherent weaknesses in each method. Both structured expert judgment and historical data analysis will be used to support each element of the modeling process. The proposed peer review of the methodology by the National Academy of Sciences/ National Research Council Marine Board will affirm the technical validity of the work. The continuing dialogue between the study team and stakeholders throughout the project will ensure the results are realistic and viable.

II. DESCRIPTION OF PROJECT RESULTS

The project will deliver a range of products that will provide a basis for recommendations for the effective measurement, monitoring, and management of risk in Prince William Sound. These products will be delivered in five sets: (1) a description of the current system risk, (2) an evaluation of this current or baseline system risk, (3) a description of risk reduction measures, (4) an evaluation of risk reduction interventions, and (5) a computer-based risk management tool that can be used to support a risk management program.

1. *Risk Description:* Risk states and risk scenarios will be identified and described. Risk states are unique states of the system described by values of system variables such as wind, visibility, location, vessel type, ice conditions, and vessel traffic. Each risk state may be viewed as an opportunity for an incident. The probability that an incident will occur in any given state, however, varies significantly among risk states. The enumeration and description of risk states provide the basis for identifying high risk situations in the Sound and for developing strategies to minimize the incident potential of high risk conditions.

Risk scenarios are unique sets of ordered events (event trees or causal chains) that result in an incident of interest. The sequences are composed of the initiating event (fault or failure) and subsequent equipment and/or human failures that are part of the accident chain. Possible sequences of these events will be identified and described. Identification of these sequences is essential to the development of strategies that interrupt these chains.

2. *Risk Evaluation:* The baseline risk of the PWS system will be determined by evaluating both risk states and risk scenarios. The evaluation of a risk state requires the determination of two factors: the relative probability that an incident will occur given that the system is in a defined state, and the frequency of occurrence of the system state. The probability that an incident could occur during a given system state will be determined based on a combination of expert judgment and historical data. The frequency of occurrence of system risk states, or opportunities for incident, will be determined by a simulation model of PWS. The result of this analysis will be a ranking of system states based on the relative probability of incident occurrence.

The evaluation of risk scenarios requires the calculation of the probabilities for each step in the causal chain based on historical data or analytic models. The result of this evaluation will be a ranking, based on the absolute probability of occurrence per tanker transit, of the types of incident scenarios in PWS and the identification of the dominant causal factors for these events. The system and scenario evaluations will be combined to produce a description of the current or base line marine transportation risk for oil tankers in PWS.

The system simulation, after calibrations based on historical data and the scenario analysis output, will produce a risk profile of PWS that will estimate the frequency of occurrence of incident/system state combinations. This profile will, for example, allow the calculation of the probability of an unpowered grounding at Hichinbrook entrance during conditions of high winds and sea state. More traditional risk representations such as frequency vs. consequence and cumulative probability vs. consequence will be constructed. These distributions and the system profile produced by the simulation will be used as the basis for the evaluation of proposed changes to the system.

3. *Risk Reduction Description:* Risk reduction measures and system changes that have been proposed by prior studies, groups, and processes or currently exist in law and regulation will be identified and new initiatives will be identified. The risk reduction measures will be classified as to their nature and objective. Risk reduction measures may, for example, be classified as ship specific (e.g., inspections), operation specific (escort requirements), or system wide (VTS rules). The objective of risk reduction measures may be one or more of the following:

- to prevent errors or failures that can cause an incident (e.g., inspections, training programs, quality programs),

-
- to prevent an incident given that errors or failures have occurred (e.g., vessel traffic control, escort vessels),
 - to lessen the effects of an incident once it occurs (e.g., hydrostatic loading).

The potential cost (initial and operating, allocation of costs), and implementation difficulty (time required, technical and organizational difficulty) for each risk measure will also be identified and described. All proposed risk reduction measures will be examined for potential adverse human health and safety impacts.

4. *Risk Reduction Evaluation:* Risk reduction measures and system changes will be evaluated using a three step process. The first evaluation will be a straightforward evaluation of the effect of each proposed measure on the baseline risk of the PWS system. The effectiveness will be measured by the overall system risk reduction produced by the measure or change, the effect on dominant causal scenarios, and the effect on the spill risk profile of the system (the frequency vs. consequence distribution). The tools developed in the analysis will provide four additional evaluation capabilities. They will enable (1) the evaluation of the effect of removing or changing existing system restrictions or constraints, (2) the evaluation of the cumulative impact of groups of measures, (3) the evaluation of the effect of changes in system parameters (e.g., increase in non tanker vessel traffic, changing ice conditions), and (4) the identification and evaluation of secondary effects of changes that may be modeled in the system simulation. This secondary impact is an important area of investigation since an intervention that makes one section of the system safer may increase the risk in another section of the system or increase the overall system risk at a later time. Risk reduction measures that have a negative or negligible impact on the system or have an adverse safety or human health impact will be excluded from further evaluation.

The second evaluation of risk reduction measures will be two dimensional: the measures will be displayed on an effectiveness vs. cost plot and the relative cost effectiveness of measures will be calculated. This analysis will produce four risk reduction groups: (1) high cost – high effectiveness, (2) low cost – low effectiveness, (3) low cost – high effectiveness and (4) high cost – low effectiveness. Categories (1) and (2) and (3) will be evaluated in a third phase. Category (4) measures will be dropped from further evaluation since they will be cost ineffective and should not be implemented until and unless their effectiveness can be improved or their cost reduced. The final evaluation for selected measures will be a multidimensional evaluation using appropriate analytic techniques and computer-based modeling tools. This evaluation will allow a structured consideration of all the effectiveness, objective, cost, and implementation parameters described above. Although the analysis will be performed by the project team, the relative importance assigned to the attributes used in the analysis will be derived from interaction with stakeholders. The results of these three analyses will provide the basis for an integrated risk reduction strategy.

5. *Risk Management Tool:* The final product will be a computer-based tool for risk monitoring and risk management in Prince William Sound. The results of the simulation and risk mitigation modeling will be used to build a decision support tool that will enable managers to assess the risk level of the system based on current system parameters and to evaluate the risk impact of changes in the system. These changes could be the evaluation of new proposed risk mitigation measures (e.g., a technological improvement in the VTS), or could be changes in the system itself (e.g., increased vessel traffic or a change in the composition of vessel traffic in PWS).

III. PROJECT METHODOLOGY

Six project tasks are associated with the development of project deliverables. A seventh task consists of developing the final report and ensuring adequate public dissemination of the study results.

The first step toward the results is the development of a system description that identifies the system parameters and variables required for structuring risk models. Ship rides, interviews with experts and

stakeholders, and analysis of prior studies will provide the project team with essential knowledge of the system. The objectives of this task are to establish relationships with all relevant experts, to identify expectations and concerns, to obtain a global understanding of the system from first-hand experience, to identify the system parameters and variables that will be used in structuring risk models and to identify local data sources and obtain relevant data.

The system description provides a point of departure for the project's modeling and analysis work, tasks two and three. A novel approach has been adopted for this project: integrating expert judgment-based analysis with an analysis of historical data, and integrating a scenario based causal approach with a situational-based system analysis of risk in PWS. These tasks will involve extensive interaction with local experts identified in task one as well as intensive data analysis. Expert judgment will be elicited using structured interviews and questionnaires and analyzed and modeled using techniques developed by the project team in prior studies. Data that will be analyzed will include local data obtained from Coast Guard, state, industry sources, Coast Guard national casualty data, and international tanker accident data.

Tasks four and five are modeling and simulation tasks which will develop a system and event simulation that can be used to produce a risk profile of Prince William Sound. The risk profile produced by the simulation will identify high risk situations, how often they occur, and what causal factors produce them. The sequence analysis output will be used to simulate and evaluate the ordered sequences of events that could produce incidents.

Task six is the development and evaluation of risk reduction measures. Prospective risk mitigation measures will be identified, collated, and categorized based on interviews and the review of prior studies, reports, and commissions. A three-stage evaluation of proposed interventions and system changes will provide the basis for the development of an integrated risk management strategy and risk monitoring and management tools.

The project team will provide status reports, a draft final report, and a final report to the Steering Committee. Extensive information dissemination activities will be required to ensure that stakeholders not represented on the steering committee have the opportunity to understand the project's objectives, process, and results. The project team will facilitate the proposed Marine Board review by providing all necessary materials and information to the reviewers and by responding to their questions.

IV. BACKGROUND ISSUES: ACCEPTABLE RISK AND CONSEQUENCES

Two critical issues must be addressed in the assessment of risk in any complex system. The first is how to account for the distribution of potential impacts or consequences of events considered in the risk analysis. The second issue is how to define, establish, or calculate an acceptable level of risk for the system.

Risk has two components: the probability of occurrence of an incident, and the impact or outcome of the incident. One objective of risk analysis is to develop a relationship between probability and outcomes so that a system may be managed within a desirable risk contour. Management measures are taken to ensure that high impact events have an extremely low probability and more frequent events consist of low impact incidents. The events of concern (casualties or incidents involving tankers underway in PWS) have a potential for severe or even catastrophic oil outflows. The primary concern of this analysis will be, therefore, the determination of the probability of occurrence of these unwanted events and the identification and evaluation of measures required to prevent or reduce their effects. Consequences of a spill (the potential for environmental, human health, and social impacts and the feasibility of response) will be assumed to be a function of the spill location and system state determined from the system simulation, and the potential spill volume, as determined from the scenario and simulation analyses. A tanker casualty may result in an oil outflow that ranges from zero (no discharge) to the total loss of the cargo. The distributions of oil outflows for each type of potential casualty developed from world wide data and the PWS simulation will be used to develop an incident frequency vs. expected outcome distribution for PWS tanker related incidents. The incident type distributions will be used to calculate an expected spill value for each incident type. For the purposes of evaluating risk interventions and developing

risk management strategies, particular attention will be given to two critical values of spill volume, the expected and maximum outflows, determined from the potential spill size distributions for each incident scenario. The expected spill value calculated for each scenario analysis is anticipated to be equivalent to the loss of most of the cargo in one or more tanks. The simulation model, which will be based on the actual TAPS fleet, will be used to project the maximum spill size for each incident. The situational and scenario-based analysis will, therefore, support the creation of a consequence rating that will be used in the evaluation of risk reduction measures.

The second difficult issue that has complicated many risk assessments is the determination of the acceptable level of risk in a complex system. The determination of risk acceptability is essentially a sociological and political process that can be aided by analysis but cannot be delegated to the analyst. Acceptability implies a subject (who accepts the risk?) as well as an object (what risk should be accepted?). The difficulty of this process is illustrated by the fact that, although the Ports and Waterways Safety Act of 1972 directed the Coast Guard to determine the acceptable level of risk for U.S. Ports, the Coast Guard has not developed a methodology for making this determination. The PWS risk analysis will describe and measure the current level of risk in the system, and will identify, evaluate, and rank potential risk reduction measures. The level of risk accepted in the system is a dynamic quantity and will be defined for PWS by the degree to which system improvements are accepted and implemented. Risk levels for other ports in the United States and Europe, where available, will be compiled and used to provide a basis for comparison during this evaluation process. The determination of an acceptable level of risk will be a product of the project, not an a priori assumption.

Hawaii's Readiness to Prevent
and Respond to Oil Spills

**NONTANKER MARINE VESSELS IN HAWAII:
CONSIDERATIONS REGARDING THE OIL
POLLUTION ACT OF 1990**

Appendix 5

Noel A. Ludwig

February 1997

INTRODUCTION

Government agencies are currently implementing aspects of the Oil Pollution Act of 1990 (OPA 90), which legislated specific and comprehensive safety requirements for oil tankers using American ports. However, since OPA 90's impact on nontanker vessels consists mainly of insurance requirements for vessels over 300 gross tons, both federal and state regulations may be insufficient to safeguard against oil spills from nontanker vessels into Hawaiian waters.

While nontanker vessels are generally smaller than tankers, many are still capable of oil spills in excess of 10,000 gallons (the threshold for a major oil spill, for example, in Florida) and occasionally exceeding 100,000 gallons (the threshold for a major spill under federal law). For the purposes of this report, spills in the range of 10,000 to 100,000 gallons will be considered medium size, while those over 100,000 gallons will be considered large. In Hawaii, a number of domestic commercial fishing, charter fishing, tour, and tug vessels are capable of medium-sized spills. On the other hand, most cargo, cruise, and foreign commercial fishing vessels, as well as some tugs, are capable of large oil spills. Some cruise ships are even capable of very large oil spills (>1 million gallons). Older vessels are particularly visible in Hawaii's fishing industry, and many of these are uninsured. This situation, combined with the large percentage of marine vessels of all classes without oil pollution coverage, may be of some concern to both government officials and citizens in Hawaii.

This report characterizes the various classes of oceangoing vessels in Hawaii not covered under OPA 90, their potential for medium-to-large oil spills, and the legal inadequacies regarding them, then concludes with some suggestions for further discussion. Presentation of the subject matter is divided into four parts. The first section characterizes the fleet based in Hawaii today and also notes the presence of vessels that visit but are not homeported in the islands. The next two sections cover accidents involving these vessels and the vessels' insurance characteristics, respectively. Finally, some points of departure for resolving this potentially hazardous situation are presented for discussion.

For the purposes of this appendix, it would be optimum to categorize Hawaii's marine vessels according to fuel capacity, but what little data the U.S. Coast Guard has it holds in confidentiality. As a result, any description of the fuel capacity characteristics of this fleet involves a certain amount of extrapolation. Nonetheless, the data procured for this report should be sufficient to characterize vessels in the various classes covered below.

CHARACTERISTICS OF HAWAII'S MARINE VESSELS

All vessels in Hawaii must be either documented or registered. "Documentation" is required by the U.S. Coast Guard for all vessels over five tons net weight if they are commercial vessels; pleasure craft can be documented at the option of the owner. If a boat of any weight is not documented, it must be "registered" at the Harbors Division, Department of Transportation, State of Hawaii. Of the 16,612 registered and 1,146 documented vessels in Hawaii in 1984, approximately 80% were listed as pleasure boats, 10% as commercial fishing or charter boats, and the remaining 10% in other categories, including small tour boats (Skillman et al. 1984; Hamm and Quach 1989). Since owners of vessels which are already documented can also choose to register them, it is possible that some overlap exists between the two numbers, but if so it is undoubtedly minor.¹ The rapid influx of vessels — especially fishing vessels — into Hawaii from the late 70s to early 90s has decreased significantly in the last few years, and will probably remain fairly stable for some time. Indeed, the number of registered vessels actually dropped to about 14,000 in 1995, while the number of documented vessels had dropped to 1,038 by 1990 (LMR Fisheries Research 1992; Vessel Registrar, Hawaii State Department of Land and Natural Resources pers. comm.).

¹ When registering a vessel, the owner must provide proof of ownership, plus vessel name, identification number, length, hull material, hull manufacturer, location where vessel is kept, type of fuel and engine, principal use and whether or not the vessel has a radio. If the vessel is registered as commercial, the owner must state its tonnage as well.

The diesel engine, using screw propulsion, is the most common for virtually all usage categories of documented vessels. Outboard and inboard-outboard motors are the most common in nearly all usage categories for registered vessels. Larger vessels, which average 36 feet in length, tend to use diesel fuel. Smaller vessels, which average 16 feet in length, tend to use more refined fuel, which is less persistent in the environment when spilled (Skillman et al. 1984). Size classes and propulsion types are shown in Tables 1 and 2. Home islands are listed in Table 3. As may be seen in Table 1, already in 1984 at least 147 nontanker vessels longer than 60 feet were homeported in Hawaii, at least 47 of them longer than 100 feet. A large percentage of the vessels longer than 75 feet have fuel capacities above 10,000 gallons, the ramifications of which merit greater attention and concern. As will be seen below, a large proportion of visiting ships are also longer than 100 feet and have very large fuel capacities. For example, Table 4 displays the large sizes (and thus, by implication, fuel capacities) of the visiting foreign longliner fleet.

TABLE 1. Classification of Marine Vessels in Hawaii by Length and Usage

Length (ft.)	Recreational	Commercial Fishing	Passenger/Fishing	Passenger Carrying	Freight	Other/Not Specified	Total
<14	3,793	55	0	2	0	288	4,138
14-15	2,594	50	0	12	0	67	2,723
16-24	6,633	932	7	52	0	188	7,812
25-30	1,009	213	46	26	0	29	1,323
31-40	750	121	103	53	0	24	1,051
41-60	315	50	57	34	3	36	495
61-100	18	26	3	30	2	21	100
101-150	1	1	0	5	3	11	21
151-250	0	2	0	1	18	5	26
>251	0	0	0	1	7	2	10
Not Spec.	0	0	0	0	0	24	24
Total	15,113	1,450	216	216	33	695	17,723

Source: Skillman et al. (1984)

TABLE 2. Classification of Vessels in Hawaii by Type of Propulsion and Usage

Propulsion	Recreational	Commercial Fishing	Passenger/Fishing	Passenger Carrying	Other/Not Specified	Total
Gas	124	11	16	30	1	182
Diesel Oil	459	130	175	95	60	919
In/Outboard	11,060	1,283	25	56	321	12,745
Sail/In/Out	1,339	14	0	13	37	1,403
Sail Only	1,814	2	0	19	206	2,041
Other	315	10	0	2	62	389
Not Specified	2	0	0	1	60	63
Total	15,113	1,450	216	216	747	17,742

Source: Skillman et al (1984).

TABLE 3. 1984 Classification of Marine Vessels Responding to Questionnaires by Island

Island	Commercial	Charter	Recreational	"Passenger Carrying"	Total
Oahu	502	21	10,051	23	10,597
Hawaii	412	39	1,763	11	2,225
Kauai	225	6	986	20	1,237
Maui	132	14	913	32	1,091
Molokai	31	2	271	1	305
Lanai	7	0	55	1	63
Total	1,309	82	14,039	88	15,518

Source: Skillman and Louie (1984).

TABLE 4. Lengths of Foreign Longline Vessels Visiting Hawaii, 1986-88

Length (ft.)	1986	1987	1988
49-75	1	0	4
76-100	63	83	98
101-125	124	149	156
126-150	276	250	198
151-175	286	273	282
176-200	54	62	104
201-225	4	5	6
225-250	1	1	2
251-275	0	3	1
276-300	1	6	4
301-325	3	4	4
325-350	0	3	6
351-375	1	2	1
376-400	0	1	0
>401	0	4	6
Total	814	846	872

Source: Lucas and Iversen (1992).

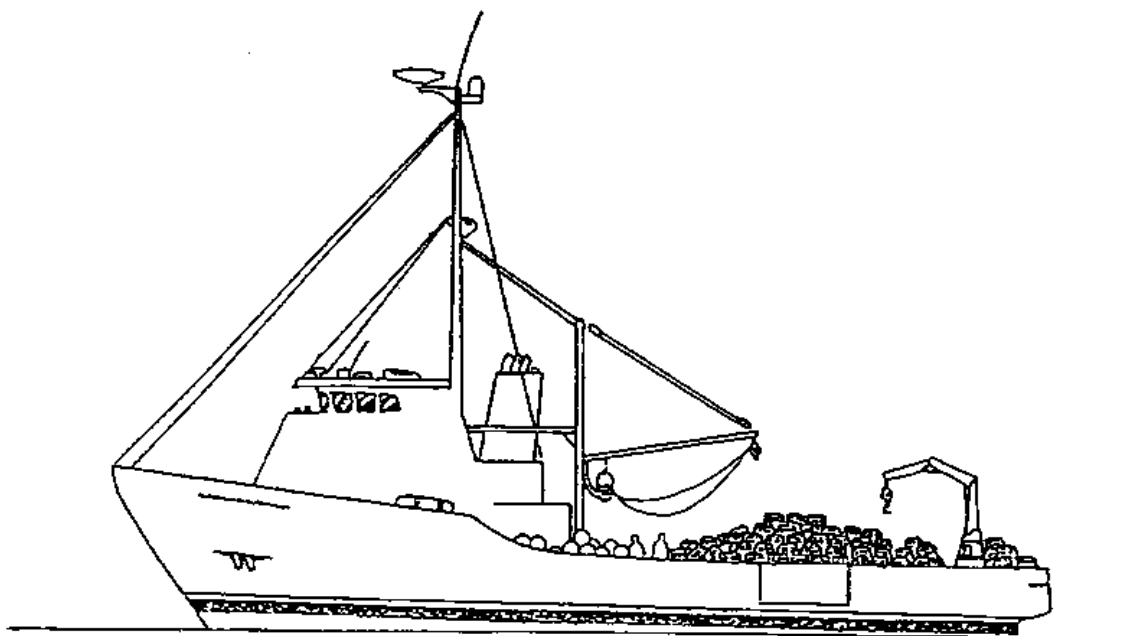
Commercial Fishing Vessels

Although the vessels used in Hawaii's fisheries can essentially be divided into commercial, charter, and recreational fishing boats, to a limited extent the classes overlap. Some confusion even exists over what constitutes a "commercial fisherman," which state law defines as anyone who has a commercial fishing license, yet which state vessel loan applications and dock space criteria define as anyone who derives at least 51% of their gross income from fishing (Department of Land and Natural Resources 1979). Thus, some care must be taken, for example, when interpreting the numbers of commercial fishing boats.

Hawaii's commercial fishing fleet reportedly consists of approximately 1,500 vessels (Hamm and Quach 1989), of which 525 boats could be considered full-time commercial or charter-boat fishing operations as of 1990 (Table 3). The majority of boats take part in the troll, handline, and longline fisheries working out of Honolulu Harbor and Kewalo Basin. Although the fleet is never all in port at any one time except during times of inclement weather, all available berths are usually filled (U.S. Dept. of Transportation 1992; WPRFMC

1994). This lack of berths, plus the usually low profits and the fact that all fisheries except for some pelagic tunas are currently operating at or near (and in some cases beyond) maximum sustainable yield, suggests that the fleet will not grow significantly in the near future without major improvements in docking facilities or procedures (LMR Fisheries Research 1992).²

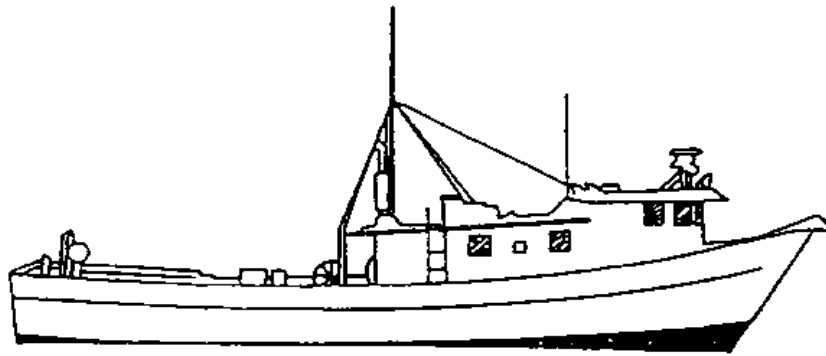
The large majority of local commercial fishing vessels are less than 100 feet long. Many of these are multipurpose vessels (i.e., those capable of entering more than one fishery) which range in length from medium (40 to 75 feet) to large (longer than 75 feet) (Figures 1 and 2). In May 1995, at least 55 large commercial fishing vessels were operating out of Hawaii, essentially all of them multipurpose vessels participating in the longline, bottomfish, and lobster fisheries. These are generally newer, steel-hulled vessels ranging up to about 110 feet in length (Pooley 1993 and pers. comm.) and averaging 80 to 90 feet. Fuel capacities range up to 40,000 gallons, averaging between 20,000 and 25,000 gallons (Department of Land and Natural Resources 1979; Rusty Nall, Pacific Environmental Co. pers. comm.).



110 feet

Figure 1. Drawing of a typical large multipurpose fishing vessel, here rigged for the lobster fishery. From Clarke and Pooley (1988); used with artist's permission.

² Longline and albacore vessels have, however, been observed to "raft" up to four deep in Kewalo Harbor, meaning that four or more vessels may use the same berth (Samuel Pooley, National Marine Fisheries Service pers. comm.).

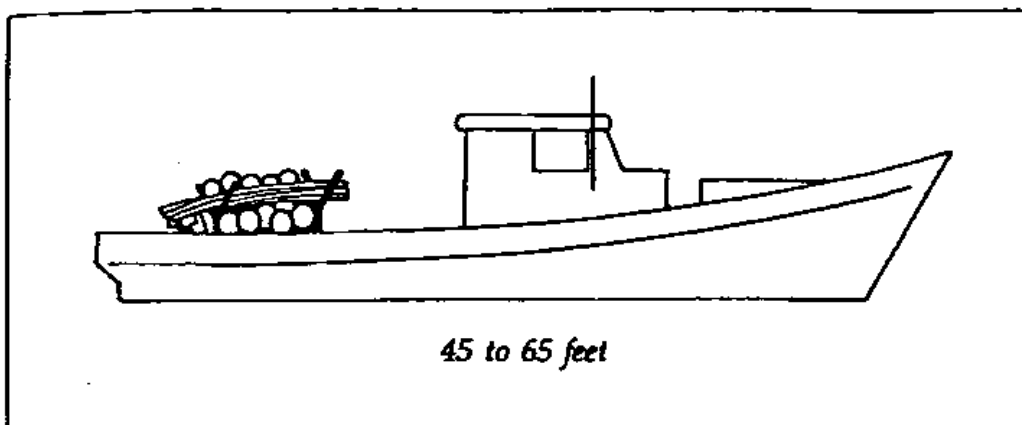


65 to 90 feet

Figure 2. Drawing of a typical modern, medium-length Hawaii longline vessel. From Pooley (1993); used with artist's permission.

Any categorization of vessels is complicated by the presence of multipurpose boats and the range of sizes found in vessels of any one fishery. The number of medium multipurpose vessels is thus somewhat uncertain and best divided into groups according to their major fishery, as discussed in the following paragraphs. Furthermore, while Table 1 provides a useful breakdown of Hawaii-based vessels, it must be kept in mind that many of the 1,450 registered commercial fishing vessels in the table are actually charter vessels operated by fishermen who carry commercial fishing licenses.

Hawaii's longline fishery has seen a dramatic increase in permitted vessels over the last decade, from as few as 15 in the early 1980s to 156 in 1991 and 165 in 1992 (Boggs and Ito 1993; Pooley 1993; Nitta and Henderson 1993). However, since then the number has crept up only to 167, of which 55 are longer than 75 feet, and is currently capped. Active in Hawaiian waters at present are 122 of the longliners, 44 of which are longer than 75 feet (Dollar 1994; Samuel Pooley, National Marine Fisheries Service pers. comm.). Although a moratorium was placed on vessels entering the Northwest Hawaiian Islands (NWHI) longline fishery in 1991, an amendment made in June 1994 allowed all permit holders to upgrade their vessels to the length of the longest vessel active during the moratorium, or 101 feet (Dollar 1994). Another amendment opened up a loophole allowing the 45 or so inactive permits to be sold or transferred to incoming vessels (Tummons 1994c). Of the 112 medium-length vessels currently permitted to participate in Hawaii's longline fishery, 42 are less than 56 feet long and 70 are between 56 and 74 feet in length (Dollar 1994). Most of these are fairly old, wooden-hulled sampans (Figure 3).



45 to 65 feet

Figure 3. Drawing of a typical older Hawaii longline sampan. From Pooley (1993); used with artist's permission.

From interviews with companies in Honolulu that refuel boats, local longliners may be divided into single-engine (6,000 to 8,000 gallon fuel capacity) and double-engine (16,000 to 20,000 gallon capacity or more) boats which coincide with medium and large longliners, respectively. The single-engine boats are mostly moored at Kewalo Basin in Honolulu. The double-engine boats are moored in Kewalo and Honolulu Harbors (Piers 16, 17, and 37). Some boats are also moored at Kawaihae Harbor on the island of Hawaii. In addition to diesel fuel for the main engines, fuel is used for auxiliary engines and generators (e.g., powered line throwers), and vessels usually carry at least 20 gallons of lubricating oil.

The number of longline fishing vessels active in the Pacific stabilized at around 1,400 in 1987, nearly all of them either Japanese- or Korean-flagged – up from a mere 700 in 1984 (Doulman 1986; Lucas and Iversen 1992). For example, in 1988 there were 872 port calls into the Port of Honolulu by foreign fishing vessels alone, more than 90% of which were tuna longliners. These vessels were typically between 76 and 200 feet in length, but ranged up to more than 400 feet long (Table 4; Lucas and Iversen 1992). On any given day in 1995, half a dozen or more were docked in Hawaii, using their own tanker vessels for refueling. For example, a random sample in May 1995 showed that the *Hakuru Maru* (171 ft.), the *Kensho Maru* (182 ft.) and the *Zenko Maru* (186 ft.) were all docked in Honolulu Harbor. The Japanese and Korean fleets use very large motherships and refrigerated cargo ships, both of which also call regularly at Honolulu. A large percentage of these foreign vessels are heavier than 300 gross tons, and are thus required under OPA 90 to show proof of liability insurance in order to be allowed access to Hawaiian ports. Yet their sheer numbers could tax local authorities to the point where some of the smaller vessels slip through without demonstrating this sufficiently.

Recently, several owners of large foreign longliners inquired into the feasibility of basing their operations out of Hawaii, possibly by buying up some of the NWHI longline permits made available in 1994. Lucas and Iversen (1992) speculated that “many more” than 30 of these could eventually be homeported in Honolulu. Most of these longliners have capacities of 100,000 gallons or more (Rusty Nall, Pacific Environmental Co. pers. comm.), which would constitute a major oil spill under OPA 90 should one of these vessels break up in Hawaiian waters with a full load of fuel. Around 180 foreign and domestic longliners are likely to be present in Hawaiian waters at any one time, including perhaps a dozen or more large foreign longliners together holding two to three million gallons of “floating oil.” Their presence, if left unregulated, presents probably the largest oil spill threat in Hawaiian waters at this time.

Longliners aside, the commercial fishing industry in Hawaii can be divided into pelagic handline (*ika-shibi*), pole-and-line (*aku*), trolling (pelagic and bottomfish), lobster, shrimp, and precious coral segments. In addition to these, it is likely that a proportion of the Pacific purse seine fleet (115 vessels in 1984) and albacore boats (30 or more in 1979) visit Hawaii each year (Department of Land and Natural Resources 1979; Boehlert 1993; Doulman 1986).

Pole-and line (*aku*) boats (Figure 4) brought in over 99% of the (skipjack tuna) catch until the late 1970s, but by 1990 their share had fallen to 72%. The number of pole-and-line boats has fallen as well, from 15 in 1971 to five in 1992, no more than four of which were fishing full time (Boggs and Kikkawa 1993; LMR Fisheries Research 1992). One *aku* vessel, 72 feet in length, sank outside of Keehi Lagoon as this report was being prepared, spilling at least 500 gallons of diesel fuel (Honolulu Advertiser 6 May 1995, p. A4; Neil Hurley, U.S. Coast Guard pers. comm.). Pole-and-line vessels generally work out of Kewalo Basin and Kaneohe Bay on Oahu, though one or more may operate out of Hilo. These vessels are all at least 25 years old, and most are fairly large, ranging up to 90 feet in length. Most have a capacity of about 10,000 gallons of diesel fuel, some of which is used for auxiliary engines such as that which powers their pump spray systems (Boggs and Ito 1993). They also carry about 100 gallons each of lube oil and hydraulic oil, which present perhaps an even greater risk than the fuel oil because of their environmental persistence (Department of Land and Natural Resources 1979; Boggs and Ito 1993; Boggs and Kikkawa 1993; Rusty Nall, Pacific Environmental Co. pers. comm.).

Shrimp and lobster boats in Hawaii have varied in number from four to more than 16 since 1983 (Clarke and Pooley 1988; Polovina 1993). At present, nearly all are medium-to-large multipurpose vessels which also take

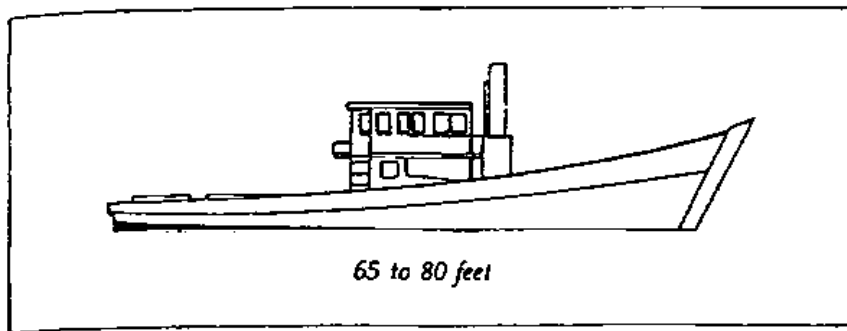


Figure 4. Drawing of a typical Hawaii pole-and-line (aku) vessel. From Pooley (1993); used with artist's permission.

part in the longline fisheries (Figure 1). These vessels range from 62 to well over 100 feet in length and from 6,000 to 40,000 gallons in fuel capacity (Table 5; Polovina 1993). Many of the smaller vessels (Figure 5) are also part-time albacore trollers. In 1990, 14 vessels participated in the NWHI lobster fishery and only one in the shrimp fishery; 12 of the 14 lobster boats were over 10 years old, and three were over 20 years old. Only one — a multipurpose vessel — was being used strictly for the lobster fishery, highlighting the fact that much of Hawaii's fishing fleet is aging. These boats averaged about two months at sea per trip, and thus filled their fuel tanks to the brim prior to each of their three or so trips per year (Polovina 1993).

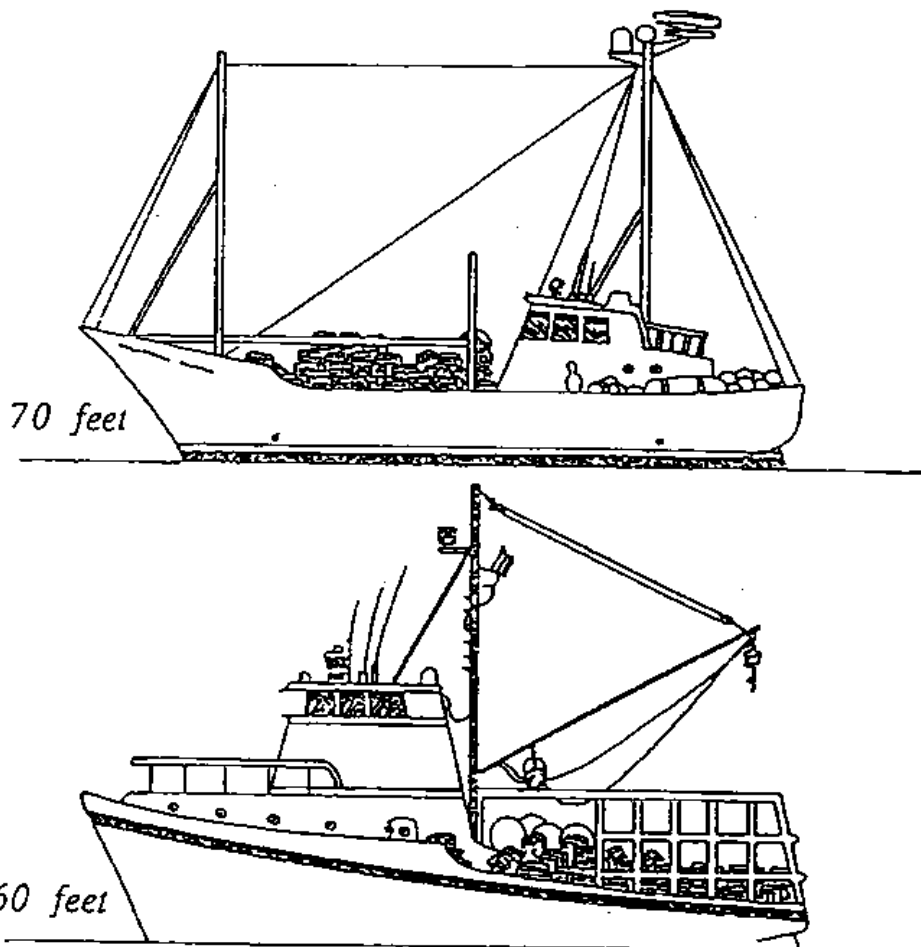


Figure 5. Drawings of typical medium-length Hawaii lobster vessels. From Clarke and Pooley (1988); used with artist's permission.

TABLE 5. Classification of Lobster Vessels in Hawaii

Class	No. of Boats	Length	Fuel Capacity (gals.)	Hull Age (yrs.)
I	5	99-175 (Average 115)	25,000-40,000 (Av. 31,400)	Average 9.5
II	3	62-88 (Average 73)	6,000-30,000 (Av. 14,200)	Average 11.0
III	7	63-66 (Average 72)	6,500-15,000 (Av. 15,500)	Average 11.2
0	1	Had permit, but fishing was sporadic.		

In March 1992, the Western Pacific Regional Fishery Management Council (WPRFMC) set up a limited-entry system for the Hawaiian lobster fleet, which set the maximum at 15 vessels for any given season. Operational difficulties and cost constraints favor the "midsize" vessels of 65 to 100 feet in length (Clarke and Pooley 1988; Polovina 1993), and vessels of this size group will likely make up the bulk of Hawaii's lobster fleet in the future. In 1993, a closed season eliminated all activity in Hawaii's crustacean fisheries (Tummons 1994a), but harvesting recommenced in 1994 at a lower level (Samuel Pooley National Marine Fisheries Service pers. comm.).

Handline vessels may be divided into pelagic and deepwater (bottomfish) handliners. The pelagic handline (*ika-shibi*) fishery grew from fewer than 40 boats in 1976 to at least 230 vessels by 1980, but decreased somewhat in recent years as several boats moved into the longline fishery (Boggs and Ito 1993; Pooley 1993). Of the 1,100 or so deepwater handliners, all but approximately 35 fish around the main Hawaiian Islands (MHI) (LMR Fisheries Research 1992). These are usually smaller vessels, ranging from 12 to 50 feet in length, with most in the 32-45 foot range (Figure 6; Pooley 1993). The deepwater handline fishery in the western NWHI currently consists of eight vessels (LMR Fisheries Research 1992; Tummons 1994b), generally 48- to 65-foot multipurpose vessels with "extended fuel and hold capacity" (Figure 7). These vessels can upgrade to 60 feet in length according to the current moratorium. Twenty-seven or more vessels have permits from WPRFMC to conduct deepwater handlining in the *eastern* NWHI, where there is no limit on permits at present. This number includes 15 vessels which fished only part-time in 1990 (LMR Fisheries Research 1992; Tummons 1994b).

Fuel capacity is generally around 15,000 to 20,000 gallons for the larger handline vessels, both pelagic and bottomfishing. Like other fishing vessels, handline boats use additional fuel for auxiliary generators, specifically for hydraulic gurdies which deploy the "handlines" (Smith 1993; Garlow Petroleum pers. comm.). The NWHI bottomfish handline fisheries have been managed on a limited-entry basis since 1989, so the number of vessels there is not expected to grow significantly. Indeed, in recent years the bottom fisheries of both the MHI and the NWHI appear to have exceeded maximum sustainable yield (Haight et al. 1993), leading one to conclude that the number of boats participating in the bottomfish handline fishery may drop in the years to come.

The troll fishery employed 160 full-time commercial vessels in 1976, ranging from 25 up to 85 feet long (Figure 7). This number swelled in the mid-1980s when rising prices for albacore tuna enticed mainland vessels to join the fleet. Between 10 and 20 of these have relocated to Hawaii and are generally 65 to 85 feet in length (Department of Land and Natural Resources 1979; Boggs and Ito 1993; Pooley 1993). Fuel capacity of those albacore boats which ply waters close to the MHI averages about 5,000 gallons, but those which frequent the NWHI often have fuel capacities in excess of 10,000 gallons (Diamond Head Petroleum pers. comm.). The number of active vessels is indeterminant at present, but is probably quite large since the commercial and

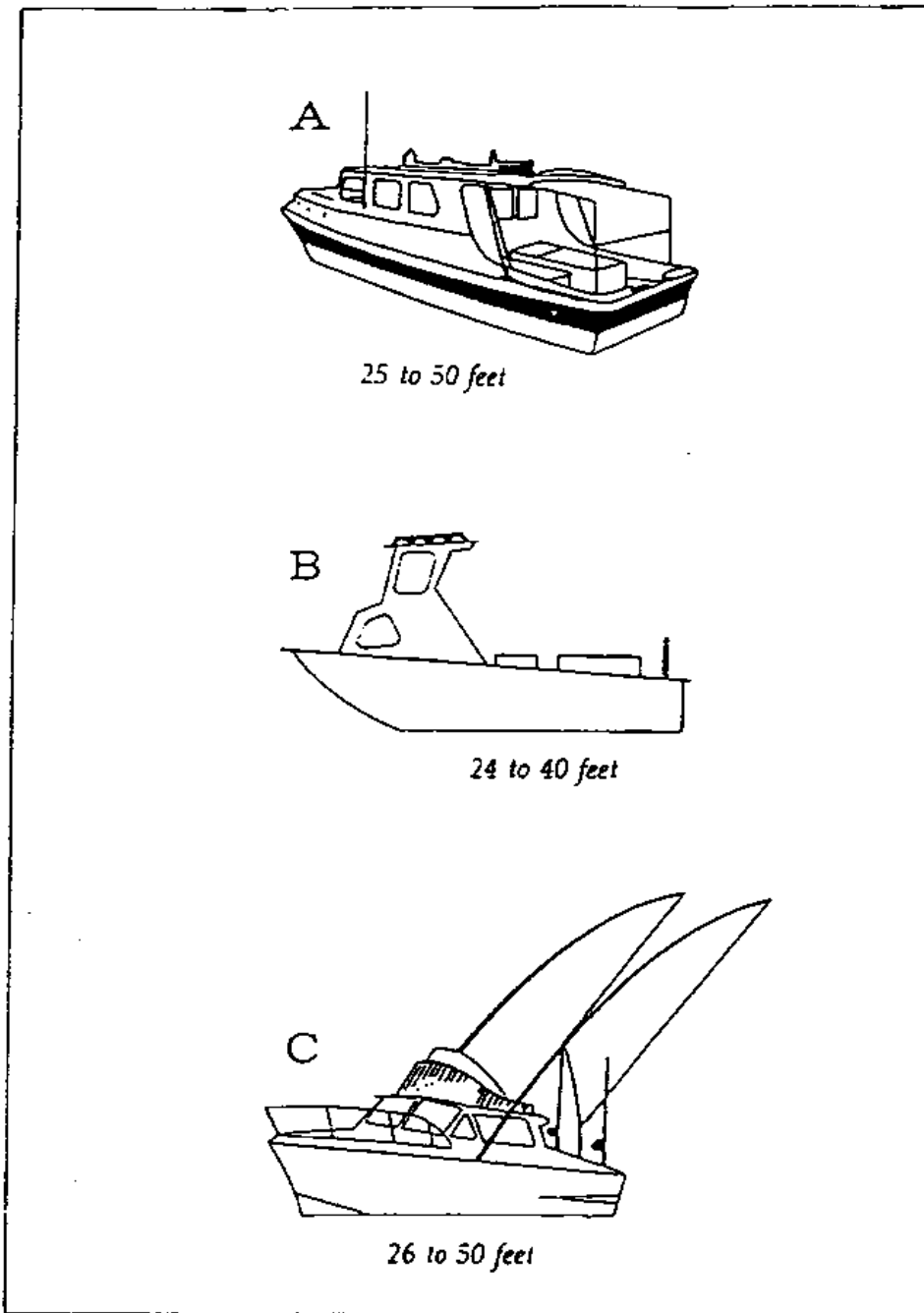


Figure 6. Drawings of typical MHI (a) bottomfish, (b) pelagic handline, and (c) trolling vessels. From Pooley (1993); used with artist's permission.

charter troll fleets together are estimated to range between 500 and 750 vessels (WPRFMC 1994). Yet some of these boats also take part in the lobster and handline fisheries, so there may be some overlap in numbers. Trolling, conducted throughout the Hawaiian Islands and usually within 20 miles of shore (Boggs and Ito 1993; Pooley 1993), places all of these boats in the proximity of reefs.

There has been no ship-based coral fishery in Hawaii since 1978, except for a single harvesting attempt in 1988. Yet a survey of the Hancock Seamounts scheduled to take place sometime in the next few years could revitalize this industry (Grigg 1993, and pers. comm.).

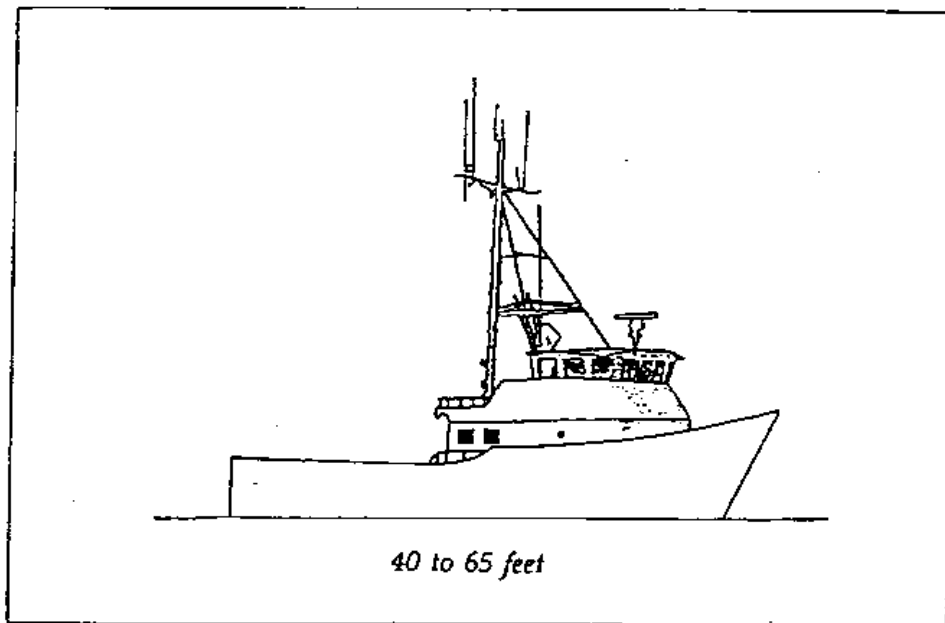


Figure 7. Drawing of a typical medium multipurpose fishing/NWHI bottomfish vessel. From Pooley (1993); used with artist's permission.

Charter Fishing Vessels

Though less confusing than the composition of Hawaii's commercial fishing fleet, the local charter fishing fleet is still somewhat complex in makeup. In part, this is because the U.S. Coast Guard and the state Harbors Division classify vessels differently. For example, in 1982, the combination of "charter fishing" vessels documented by the U.S. Coast Guard and "passenger fishing" vessels registered by the Hawaii Harbors Division produced a list of 214 boats in Hawaii's charter fishing industry, according to a document by Samples et al. (1984). Yet the same document later estimates that the fleet comprises only 119 boats, a number which is echoed by other authors (e.g., Helvey et al. 1987). Of the 214 vessels in Samples et al. (1984), about half (51%) had fished commercially in 1982, suggesting a partial resolution to this discrepancy. A further 8% of the vessels had participated in commercial tours. The number of active vessels has increased along with tourism, and the number of commercial and charter troll vessels together is probably between 500 and 750 at present (Samples et al. 1984; Boggs and Ito 1993; WPRFMC 1994).³

A telephone survey by the author (May 1995) of currently registered/ documented charter fishing vessels in April 1995 produced a figure of about 50 boats on Oahu, between 50 and 75 on the Big Island, and between 20 and 50 on the other islands, thus supporting a number somewhere between 120 and 175 vessels in operation today. Of the vessels which listed a base of operations in 1982, about half (48%) were homeported on the Big Island, followed by Oahu (27%), Maui (17%), Kauai (8%), and Molokai (3%) (Table 3). Of the vessels which listed lengths, the range was from 20 to 59 feet, averaging 36 feet (43 feet on Oahu). Fuel capacity averages about 500 gallons, with the largest being 1,600 gallons. The *mean* vessel age was 11 years (13 years on Oahu), while the *median* age was only four years – demonstrating a preponderance of young vessels supplemented by a few much older vessels. Of vessels described, 88% were powered by diesel engines (100% on Oahu and 96%

³ Under Hawaii Revised Statutes, Article 189-2, charter boat operators are required by law to register as commercial fishermen if they catch and sell even a single fish per year (Smith 1993). This allows estimation of the total number of fishing vessels in Hawaii, but further blurs the line between commercial and charter fishing vessels.

on the Big Island) and 12% by gas engines. At the time, vessels on Maui (for example) had an average remaining operating life estimated at only nine years, so these demographics may have changed somewhat in the intervening years (Samples et al. 1984). Most charter vessels conduct troll fishing (Boggs and Ito 1993), operating within a few miles of both shore and reefs.

Recreational Boats

In 1991 there were an estimated 12,690 "personal boats" in Hawaii, of which approximately 74% were engaged in fishing as their primary activity (Smith 1993). The exact number is difficult if not impossible to produce since Hawaii is one of the few coastal U.S. states which does not require a saltwater recreational fishing license (Smith 1993). About 90% of Hawaii's recreational boats have lengths of 24 feet or less, while the rest range from 25 up to more than 100 feet in length (Table 1). Although the small- to medium-size boats generally use inboard/outboard motors and a mere 10–20 gallons of fuel (Table 2), the larger recreational boats have capacities which range up to about 1,200 gallons and average approximately 500 gallons (from author's telephone interviews with fuel truck operators, May 1995). In spite of their great numbers, personal boats are thus the least likely of the vessels operating in Hawaiian waters to cause damage to the environment. The recreational vessel distribution in Hawaii is presented in Table 3.

Commercial Tour Boats

Most tour boats operate out of Keehi Lagoon, Honolulu Harbor, and Kewalo Basin on Oahu, and Lahaina on Maui (Markrich 1990; U.S. Dept. of Transportation 1992). Table 3 shows their approximate distribution. The Maui boats are mostly small, six-passenger motor/sail cruise boats. The Oahu boats range from this size up to the large, steel-hulled vessels used for dinner cruises (such as the *Navatek* and the *Star of Honolulu*) as well as glass-bottomed boats and semi-submersibles. Glass-bottom boats are currently operating on Oahu, Maui, and Kauai (Markrich 1990).

Fuel capacity in tour boats varies from about 100 gallons for the smaller vessels to 1,600 gallons for the *Starlet*, 6,000 gallons for the *Navatek* and 25,000 gallons for the *Star of Honolulu*. Glass-bottom boats have surprisingly small tanks: the *Holoholokai*, perhaps the largest in Hawaii, has a capacity of only 120 gallons. In the submarine tour business, surface boats average about 500 gallons in fuel capacity, ranging up to 2,800 gallons for Atlantis Submarine's 79-foot *Discovery*. Semi-submersibles such as that used by Nautilus Tours have a fuel capacity of only 200 gallons, divided into four separate tanks, and actual submarines such as those operated by Atlantis Submarines are powered only by batteries (from author's telephone interviews with fuel truck operators). Several of the sailboats and catamarans based near Waikiki and Lahaina have inboard-outboard motors on board, but rarely are more than five gallons of fuel taken on board.

Other Charter Boats

This category includes dive boats and research vessels, the former active mainly around Maui and Molokini islet. Indeed, several dive boats may be present at one time inside Molokini crater, since all associated dive tour companies concentrate their activities during midday, when hundreds of tourists may be in the water at once (Markrich 1990). In 1989, the number of dive tour operators was estimated at 34 (15 on Oahu). Some of these operated more than one vessel, and many also offered tours, complicating any statistical compilations (LMR Fisheries Research 1992). Dive boats average around 200 gallons fuel capacity (from author's telephone interviews with fuel truck operators). As may be seen in Table 1, the number of "passenger carrying" vessels in Hawaii — including both this category and tour vessels — equalled 216 in 1984.

Cruise Vessels

Honolulu Harbor has berthing space for three large passenger cruise ships, and the Big Island, Maui, and Kauai each have space for one cruise vessel. The largest companies serving Hawaii are American Hawaii Cruises, Aloha Pacific Cruises, Trans-Pacific Cruises, and Cunard Line. The last of these operates the Queen Elizabeth

II, the largest cruise ship afloat, which has a fuel capacity of 4,381.4 tons or 3.3 million gallons (Reed Kaina Schaller Advertising, Inc. 1988; Cunard Line Customer Services pers. comm.).

Cargo Vessels and Tugs

As may be seen in Table 1, in the 1980s there were at least 33 cargo vessels documented in Hawaii, in addition to which a number of foreign cargo vessels visit the islands each year. Indeed, over 1,800 overseas vessels arrived at Honolulu Harbor alone in 1986, many of which were cargo vessels (Nakayama 1987). Of the cargo vessels which visit Hawaii annually, over 90% are nontanker vessels (U.S. Department of Commerce 1985). The Hawaii-based company with the largest number of cargo vessels is the Matson Company, which had nine such vessels in the Hawaiian circuit in July 1995. Average fuel capacity of these is about 882,000 gallons (21,000 barrels), and these vessels typically leave port with about 693,000 gallons (16,500 barrels) of fuel on board. The largest Matson ship is the 760-foot *Matsonia*, whose capacity is somewhat greater (Dale Hazel Hirsch, Matson Navigation pers. comm.).

Over 30 tugs work out of Honolulu Harbor alone, ranging from inner-harbor ship-assist tugs to interisland and ocean-going tugs (Reed Kaina Schaller Advertising, Inc. 1988). One of the larger tug companies in Hawaii is Smith Maritime, which operates nine tow boats and various other vessels. Smith's largest tow boat, the *Niolo*, has a fuel capacity of 120,000 gallons (Jack Smith, Tow Boat Services Management pers. comm.).

Cruise liners, cargo vessels, and tugs thus have fuel capacities greater than all but the largest nontanker vessels in any other class and often comparable to the tankers and tank barges so carefully regulated under OPA 90.

MARITIME ACCIDENTS AND OIL SPILLS IN HAWAIIAN WATERS

The U.S. Coast Guard reported 557 oil spills around the state in 1990, up 200% from 1980.⁴ Most of these spills were small, from 10 to 100 gallons, but in some instances, fairly minor spills have generated major headaches and cleanup costs: although it apparently consisted of a more persistent crude oil — and thus represents a worst-case scenario — a mere 120 gallons from a Barber's Point tanker spill in 1984 was sufficient to close 20 miles of beach on Kauai, requiring six days and \$150,000 to clean up. Spills can also be exacerbated under certain conditions, expanding up to 500% in volume through emulsification (Pfund 1992a). The Coast Guard is unable to report what percentage of the 557 spills above from 1990 involved marine vessels, but it reported 79 spills from fishing vessels in Kewalo Harbor alone in 1990, up from 40 in 1989 (*Honolulu Star-Bulletin*, December 1990, p. A1). Many more spills occur elsewhere, involve other types of vessels, go unreported, or have uncertain sources. Undoubtedly, Hawaii is vulnerable to vessel-based spills due to its mid-ocean location.

Unfortunately, data on vessel-based oil spills in Hawaii are spotty, and much must be inferred from other data. According to Markrich (1990), who gleaned his data from *The Honolulu Advertiser* and *The Honolulu Star-Bulletin* articles from 1965 to 1985, a total of 366 separate 'accidents' were reported in Hawaiian waters during this period, only 141 of which were recorded in the Coast Guard data base. And according to insurance specialists interviewed by Markrich (1990), these 366 incidents probably represent only about half of the accidents which actually occurred, a discrepancy due in part to the lack of a central depository in Hawaii for marine insurance records.⁵ Although Markrich does not identify the number of accidents which resulted in spilled oil, the most common accidents in his tables are grounding (23%) and collision (18%). Since a full 43%

⁴ In part, this is due to improved documentation of oil spills in more recent years

⁵ According to Capt. Samuel E. Burton, U.S. Coast Guard (pers. comm.), many unreported accidents were probably too minor to require reporting to the Coast Guard under existing state and federal laws..

of these accidents occurred offshore of Oahu, some threat of adverse impacts to Hawaii's beaches and tourist industry from vessel-based oil spills can be inferred, with damage and cleanup costs inflated accordingly. Relevant data are summarized in Tables 6 through 10.

Of course, the refined fuel and diesel oil used by Hawaii's commercial fishing, charter, and recreational boats are of less concern than the heavy crude oil carried by tankers regarding coating of beaches and coastal areas, but are of equal or greater concern regarding living marine resources because of their toxicity. As noted above, while tankers and vessels weighing 300 gross tons or more are regulated under OPA 90, other vessels are not.

Overall, the number of commercial fishing vessel accidents which were reported increased from five or less per year in the 1960s and 1970s to 20 per year in the 1980s, according to Markrich (1990). Fishing vessels displayed by far the greatest rise in accidents of any vessel type over this period. Indeed, two of the (at the time) eight *aku* boats sank in 1990 alone; another sank and spilled 500 gallons of fuel as this report was being prepared (*Honolulu Advertiser*, 6 May 1995, p. A4). About 25% of all fishing boat accidents occurred inside or within one mile of a harbor, and about half of the accidents occurred around Oahu (Markrich 1990; LMR Fisheries Research 1992; Table 7).

TABLE 6. Classification of Marine Accidents by Type of Nonrecreational Vessel, 1965-85 (percentages)

Accident	Commercial Fishing (%)	Charter Fishing (%)	Other Charter (%)	Tour (%)	Total %
Grounding	23	14	35	33	23
Collision	15	27	12	15	18
Fire	5	7	6	2	5
Explosion	2	4	0	1	2
Foundering	19	15	6	2	13
Capsizing	1	1	6	1	1
Structural Failure	23	8	6	4	13
Other	15	24	30	39	24
Total %*	103	100	101	97	99

*Deviation from 100% due to rounding.

Source: Markrich (1990).

TABLE 7. Classification of Marine Accidents by Type of Nonrecreational Vessel, 1965-85 (percentages)

Island	General Purpose (%)	Longline (%)	Aku (%)	Lobster and Shrimp (%)	Ika-shibi (%)	Unknown (%)	Total %
Oahu	48	47	65	47	0	100	48
Hawaii	14	17	4	0	100	0	16
Kauai/Niihau	21	5	9	17	0	0	14
Maui/Kahoolawe	6	5	13	17	0	0	7
Molokai	7	5	9	0	0	0	6
Lanai	0	0	0	17	0	0	1
NWHI	4	17	0	33	0	0	8
Other	0	3	0	0	0	0	1
Total %*	100	99	100	101	100	100	101

*Deviation from 100% due to rounding.

Source: Markrich (1990).

TABLE 8. Classification of Marine Accidents by Type of Tour Vessel, 1965-85 (percentages)

Accident	Sightseeing Tour (%)	Dinner Cruise/ Catamaran (%)	Glass-Bottom Boat (%)	Other (Raft) (%)	Total %
Grounding	30	42	33	0	33
Collision	14	20	17	0	15
Fire	2	4	0	0	2
Explosion	0	4	0	0	1
Foundering	2	0	17	0	2
Capsizing	0	4	0	0	1
Structural Failure	18	4	34	0	14
Other	34	23	0	100	29
Total %*	100	101	101	100	97

*Deviation from 100% due to rounding.

Source: Markrich (1990).

TABLE 9. Classification of Marine Accidents Involving Charter Fishing Vessels, by Island, 1965-1985 (percentages)

Accident	Oahu (%)	Hawaii (%)	Kauai/ Niihau (%)	Kahoolawe/ Maui (%)	Molokai (%)	Total State (%)
Grounding	7	19	0	28	0	14
Collision	29	17	0	34	0	24
Fire	9	6	0	12	0	7
Explosion	0	11	0	0	0	4
Foundering	9	22	60	6	0	15
Capsizing	0	3	0	0	0	1
Structural Failure	11	11	0	6	100	11
Other	35	11	40	17	0	24
Total %*	100	100	100	103	100	100

*Deviation from 100% due to rounding.

Source: Markrich (1990).

TABLE 10. Classification of Marine Accidents Involving Tour Vessels, by Island, 1965-85 (percentages)

Accident	Sightseeing Tour (%)	Dinner Cruise/ Catamaran (%)	Glass-Bottom Boat (%)	Other (Raft) (%)	Total (%)
Oahu	38	27	17	0	32
Hawaii	6	4	0	0	5
Kauai/Niihau	6	4	17	100	8
Maui/Kahoolawe	40	54	67	0	45
Molokai	10	8	0	0	8
Lanai	0	4	0	0	1
Total %*	100	101	101	100	99

*Deviation from 100% due to rounding.

Source: Markrich (1990).

While many of the older, less seaworthy commercial fishing boats have been phased out in recent years, they have been replaced by larger boats often operated by crews unfamiliar with Hawaiian waters and sea conditions. One notable example was the *Friendship*, a 65-foot fishing boat which ran aground outside Kewalo Basin with nearly 10,000 gallons of fuel on board in October 1994 (Figure 8). Fortunately, the weather was calm and less than 1,000 gallons leaked out before the rest was pumped into salvage boats. The accident nonetheless forced the closing of an area from Honolulu Harbor to 200 yards east of Kewalo Basin to all surfing and swimming (*Honolulu Advertiser*, 25 October 1994, p. A1 and 26 October 1994, p. A2). (The area affected, however, is not normally used for swimming, and closure only lasted a few days. Samuel E. Burton, U.S. Coast Guard pers. comm.). The problem is further highlighted by the grounding of the *Jin Shiang Fa*, a 137-foot Taiwanese longliner, on Rose Atoll — a wildlife refuge near American Samoa — in October 1993. All 100,000 gallons of diesel fuel in the vessel's fuel tanks were lost, creating an oil slick 11 miles long which significantly impacted marine life over one third of the atoll (*Honolulu Star-Bulletin*, October 1993, p. A4 and 17 January 1994, p. A2; Capune 1995). While few if any of the local fishing boats fall into this size group, larger foreign longliners with this fuel capacity routinely stop over in Honolulu. Under the National Contingency Plan (NCP), 100,000 gallons constitute a major spill, and the cost of cleanup and lost revenue to the state could be considerable.

Charter fishing boats accounted for 32% of all maritime accidents reported statewide between 1965 and 1985, 26% of which involved hull damage. Approximately half of these accidents took place on Oahu, followed by the Big Island, Maui, and Kanai (Markrich 1990). Other charter boats, including dive boats and research vessels, accounted for only 5% of all maritime accidents, but 31% of all monetary losses statewide during these years. Seven such incidents involved dive boats, mostly off of Maui, Lanai, and Molokini, at least two of which involved groundings (Markrich 1990). Table 8 shows that collisions and groundings together account for over a third of all accidents involving charter vessels in Hawaii. Of course, not all of these resulted in spilled oil, but lacking data specifically detailing such spills, the data still demonstrate the existence of a palpable threat of oil spills from such vessels.

For tour vessels, Maui and Oahu have roughly equal numbers of accidents. On Oahu the large vessels are dominant in numbers of both vessels and accidents, accounting for 60% of the island's tour boat-related incidents and 81% of its tour boat-related monetary losses between 1965 and 1985. Of these incidents, 30% on all islands involved groundings. Accidents involving catamarans are again split roughly equally between Maui and Oahu. Of all accidents involving catamarans, 38% between 1965 and 1985 resulted in hull damage, most often in and around harbor areas (65%) and on reefs (23%). During these years, six accidents involved glass-bottom boats, two of which involved groundings on reefs and one of which was a total loss (Markrich 1990). Table 9 shows that the two most significant causes of accidents among tour boats during these years were again grounding and collision.



Figure 8. *The Friendship*, a Hawaii-based longliner, sinking outside of Kewalo Harbor in October 1994. *The Nakue*, a Marine Logistics, Inc. pollution response vessel, stands off to the right. Photography by Jackie Miller.

Certainly, a noticeable percentage of these accidents involve oil spills. Worldwide, in 1989 and 1990, passenger vessels and fishing vessels accounted for 15% of the collisions and 35% of the groundings that spilled more than 10,000 gallons of fuel per accident (Pfund 1992b). Based on the nine-year period from 1983 to 1991, the probability of a 10,000 to 20,000 gallon oil spill in Hawaiian waters is once in 2.25 years, and that of a 40,000 to 50,000 gallon spill is once in 4.5 years, whereas the probability of a catastrophic spill of more than 10 million gallons (i.e., tanker-based) is only once in 135 years (Lee 1992). As an example, in Kewalo Basin alone, the number of oil spills jumped from 40 in 1989 to 79 in 1990. Although most of these were suspected to result from "midnight (clandestine) dumping" by fishing boats rather than accidents, they were still vessel-based. Cleanup of the Kewalo spills, estimated to average between 50 and 100 gallons, cost about \$1,000 apiece (*Honolulu Star-Bulletin*, December 1990, pp. A1 and A10).

Such statistics suggest that at the very least these vessels should be required to post a liability insurance certificate in order to operate (Pfund 1992b). At present, small-to-medium vessels responsible for oil spills can only be fined up to \$10,000 by the state. Those vessels reporting their spills generally receive an even smaller fine for "owning up and acting responsibly" (*Honolulu Star-Bulletin*, December 1990, pp. A1 and A10). While spillers, if identified, are billed for the cost of the cleanup, many of these vessels — indeed, the ones most likely to spill — are often unable to pay.

THE OIL POLLUTION ACT, INSURANCE, AND HAWAII'S NONTANKERS

In the wake of the *Exxon Valdez* oil spill on March 24, 1989, the U.S. Congress passed the Oil Pollution Act of 1990 (OPA 90), which defines the rights and roles of affected states in dealing with oil spills in their waters. OPA 90 created a \$1 billion oil spill liability trust fund to enable the federal government to respond quickly to oil spills, and preserved for states the right to enact stricter legislation.

In full effect starting in 1995, OPA 90 makes owners of all vessels in American waters liable for damages and cleanup costs of oil spills emanating from their vessels up to \$600 per gross ton or \$500,000, whichever is greater. There are a number of ways in which this liability cap may be broken, including cases of gross negligence (Title I, Sections 1002 and 1004; Barry Ogilby, Carlsmith, Ball, Wichman, Case, and Ichiki, Attorneys at Law pers. comm.). This legislation foreshadows a problem particularly for Hawaii, which not only lacks a specific plan for prevention of oil spills (Rappa and Moravcik 1992), but which also has a number of older, small-to-medium sized boats which operate routinely in its rough offshore waters and near its coral reefs. In addition, Hawaii's oil spill contingency plan, the State Oil and Hazardous Substances Emergency Response Plan — which delineates the state's duties in case of an oil spill — has not yet been thoroughly tested to determine its viability (Rappa and Moravcik 1992). This plan should be augmented by a prevention plan ensuring, among other things, that all vessels with fuel capacities of 10,000 gallons or more receive annual safety inspections.

OPA 90 goes on to state that the responsible party for any vessel over 300 gross tons must "establish and maintain . . . evidence of financial responsibility sufficient to meet the maximum liability" to which it could be subject in the event of an oil spill. "Financial responsibility" is defined as "evidence of insurance, surety bond, guarantee, letter of credit, qualification as a self-insurer, or other evidence of fiscal responsibility" (Title I, Section 1016). However, OPA 90 places no such requirements on owners of vessels smaller than 300 gross tons. Nor does the State of Hawaii, although the U.S. Coast Guard has implemented rules which "provide a satisfactory methodology to prove financial responsibility" in such vessels (Barry Ogilby, Carlsmith, Ball, Wichman, Case and Ichiki, Attorneys at Law pers. comm.).

Hawaii has no limits at present on oil spill liability except for interisland tankers (Rappa and Moravcik 1992). Yet a significant majority of the commercial fishery fleet in Hawaii does not carry pollution insurance, or indeed insurance of any kind. In 1982, Karl Samples found that nearly 75% of Hawaii's fishing boat owners responding to surveys had no vessel insurance coverage whatsoever, and it may be assumed that a majority of

those who did not respond had either been denied coverage or had not applied for it. A majority of uninsured respondents (77%) cited the high cost of insurance as the main factor prohibiting coverage, while 11% did not feel insurance was necessary and 6% had been rejected as bad risks (Samples 1982). A telephone interview with John Grosseto (June 1995), head of one of the larger marine insurance agencies in Hawaii, confirmed this information. Indeed, Grosseto estimated that much more than half of the commercial fishing fleet is totally uninsured, while half or less of those who are insured have also bought pollution insurance, which is optional under OPA 90 for nontanker vessels smaller than 300 gross tons. Thus, should a large uninsured fishing vessel spill all or most of its fuel along Hawaiian shores, the damage and cleanup costs could not be ameliorated by the vessel's owner, whose major asset is now a pile of scrap awash on a reef.

Grosseto notes that while hull insurance costs from 2.5% to 12% of the hull value and liability insurance costs \$3,000 to \$7,000 per crew member, pollution insurance costs only \$500 to \$1,000 per commercial fishing vessel and \$400 to \$700 per charter fishing vessel. Thus, pollution coverage is only a small addition to the total cost of insurance coverage and, should the state mandate oil pollution coverage for certain vessels, compliance with such a requirement could require less enforcement than do requirements for other types of insurance. The benefits of such requirements are readily apparent when one considers that the average cleanup of a 10,000 gallon spill of diesel fuel is about \$20,000 (John Grosseto, Grosseto Marine Insurance pers. comm.; Rusty Nall, Pacific Environmental Co. pers. comm.)

Of the charter fishing and tour vessels, Grosseto estimates that close to 100% have basic insurance coverage, since it is required in order to obtain docking space. However, of the recreational boats, again many and probably most are totally uninsured. Since pollution coverage is optional for these boats as well, it is likely that a large proportion of those with basic coverage have not opted for pollution coverage (John Grosseto pers. comm.). Indeed, even such high-technology and high-profile vessels as the *Navatek* have not made use of pollution insurance (Jim Cummings, Island Navigation pers. comm.).

The problem of insuring these vessels is compounded by a variety of factors. In particular, the U.S. Coast Guard has limited authority and physical resources to enforce regulations, and its Fishing Vessel Safety Decal Program is voluntary. As a result, many commercial fishing vessels are not routinely inspected for seaworthiness or safety equipment. Those inspections which do take place are conducted by marine surveyors at the request of insurance companies. These surveyors are unregulated and have no national standard for conducting surveys. Thus, some vessels are declared seaworthy regardless of condition, at a time when they must traverse ever-increasing distances in order to make their voyages profitable (Markrich 1990). While these distances place the vessels far from MHI shores for an increasingly large portion of their trip, they also place additional constraints on safety expenditures while at the same time increasing the amount of fuel which must be taken on prior to leaving port.

Perhaps partly as a result of this trend, there has been a notable rise in reported fishing vessel accidents over the last 20 years (Markrich 1990). (Alternatively, reporting may have simply improved throughout this period, especially since monetary losses and awards also jumped alarmingly over the same 20 years. Capt. Samuel E. Burton, U.S. Coast Guard pers. comm.) By the early 1980s, an average of 250 fishing boats were sinking per year off American shores. In Hawaii, from 1982 to 1987 alone, marine insurance rates for commercial fishing boats jumped 400%, while rates for charter boats and tour boats increased 15% or less. In some instances, fishing boat owners already operating under a slim margin of profit have been saved from bankruptcy only because banks are unwilling to repossess boats that they know cannot be resold for a reasonable amount (Markrich 1990). Percentages of fishing crews killed per year in U.S. waters have decreased since the mid 80s, but commercial fishing is still the most hazardous industrial occupation in the country (Samuel Burton, U.S. Coast Guard pers. comm.).

For the tour and charter boat industry, the situation is much more optimistic, as reflected in their very high rates of basic insurance coverage. Yet even here, problems loom. In 1986 and 1987, several large marine insurance companies dropped their Hawaii accounts due to the small size of the market, forcing the remaining companies

to raise their rates (Markrich 1990). In addition, the skyrocketing number of personal injury cases — estimated to have increased by 300% between 1982 and 1987 alone — and associated awards will likely have reverberations in terms of rate increases, making insurance costs even more prohibitive. As a result, many Hawaii boat owners either dropped insurance altogether or switched to foreign insurers in places like Brazil and the Bahamas. These companies are generally seen as unreliable in terms of paying their claims (Markrich 1990), and doubtless the incentive for oil pollution coverage through such companies is marginal at best.

CONCLUSIONS AND RECOMMENDATIONS

There may be a need for Hawaii to address a potential gap in its measures protecting the state from damage caused by oil spills by vessels not adequately covered by OPA 90. Although it is beyond the scope of this document to undertake a detailed cost-benefit analysis of this issue, it should be obvious to the reader that there is cause for some concern. In particular, insurance regulations imposed by the U.S. Coast Guard and the State of Hawaii may be insufficient to provide a reasonable measure of cost recovery from oil spills emanating from such vessels.

A large proportion of nontanker vessels in Hawaii — particularly those of the commercial fishing fleet — are without any insurance at all, much less any oil pollution coverage. Damage to such uninsured vessels which results in oil spilled into Hawaiian waters often forces the federal or state government to foot the bill for cleanup costs, recovery of which can be problematic and time-consuming if it happens at all. Thus, insurance requirements up to and including oil spill insurance should be mandated for all vessels capable of spilling 10,000 gallons or more into Hawaiian waters. In addition, the state should increase the dollar amounts of fines it levies against parties responsible for medium sized oil spills, a strategy which has had success as a deterrent against vessel based spills in California (Barry Ogilby, Carlsmith, Ball, Wichman, Case, and Ichiki, Attorneys at Law pers. comm.).

On the other hand, most of these fishermen are operating with marginal profit and may be reluctant to pay Hawaii's climbing insurance rates. To alleviate this, both Samples (1982) and Markrich (1990) have suggested that these fishermen form co-ops which will enable them to acquire group coverage at reduced rates. The state should do all it can to facilitate such actions. In conjunction with such requirements, the state should reinstate its recently discontinued registration/documentation of marine vessels based in Hawaii, especially those over five tons. As suggested in the 1990-95 Hawaii Fisheries Plan, the state should also establish a specific registration for commercial fishing vessels (LMR Fisheries Research 1992).

As with dock space criteria for charter fishing vessels, all boats over five tons (or all boats with over 10,000 gallons of fuel capacity) should be required to show proof of insurance before they are allowed to acquire fishing licenses. As a parallel example, any vehicle in Hawaii used to transport hazardous waste (which includes flammable fuels) must take out a \$5 million liability insurance policy (recently increased from \$1 million following California's lead) before a "Hazmat" license is issued, and Hawaii has one of the most lenient permitting requirements in the country for such transport (Unitek Environmental Services pers. comm.). Oil is not classified as hazardous waste when being used as fuel, but the volumes are similar whether the vessel is a hazardous materials truck, a fuel transport truck, or a fishing vessel and of these, only fishing vessels are without insurance requirements. Thus, Hawaii's marine vessel regulations may be outdated as a result of heightened awareness of oil spill risks over the last decade. On the other hand, Hawaii's fleet of recreational boats — most of which are too small to entail much concern regarding oil spills — would probably best be served through other methods, such as educational programs.

Since, as noted above, vessel inspections by marine surveyors are often inadequate, the state should require insurers of marine vessels to undertake a full survey of a boat's seaworthiness as a prerequisite for insurance, and should set guidelines as to what constitutes a thorough survey. In addition, a central depository of insurance-related information for marine vessels should be set up by the state. This depository would allow the public to monitor the state's compliance with these regulations, and help determine liability in the event of an

oil spill. Further suggestions for Hawaii include reconciling different versions of what constitutes a commercial fishing boat and what constitutes a charter fishing boat, so that the former may be more adequately monitored; requiring saltwater recreational fishing licenses; and constructing a specific statewide plan covering all aspects of oil spill prevention.

Although such regulation would be problematic both for Hawaii's fishing fleet and for the cash-strapped state government, it would likely pay for itself in the long run by reducing the number and costs of mid-size oil spills. Perhaps some of these savings could then be used to help finance programs aiding Hawaii's fishermen in acquiring insurance, thus completing the cycle. Such legislation would also serve to improve safety in Hawaiian waters and reduce the number of search-and-rescue missions the Coast Guard must undertake.

REFERENCES

- Boehlert, G.W. 1993. The fisheries of Hawaii and U.S. associated Pacific Islands. *Mar. Fish. Rev.* 55(2):1-2.
- Boggs, C.H. and R.Y. Ito. 1993. Hawaii's pelagic fisheries. *Mar. Fish. Rev.* 55(2):69-82.
- Boggs, C.H. and B.S. Kikkawa. 1993. The development and decline of Hawaii's skipjack tuna fishery. *Mar. Fish. Rev.* 55(2):61-68.
- Burton, S.E. U.S. Coast Guard, Honolulu Office. June 1995. Personal communication.
- Capune, W.K. 1995. Shiang Fa study: What could have been done? In *International Oil Spill Conference Proceedings: Achieving and Maintaining Preparedness* 1017-8. American Petroleum Institute Publication No. 4620, Washington, D.C.
- Clarke, R.P. and S.G. Pooley. 1988. *Economic Analysis of Lobster Fishing Vessel Performance in the Northwestern Hawaiian Islands*. NOAA-TM-NMFS-SWFC-106. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center, U.S. Department of Commerce, Honolulu.
- Cummings, J. 1995. Island Navigation Company. Personal communication.
- Cunard Line Cruises. 1995. Customer Services Representative. Personal communication.
- Department of Commerce, U.S. Government. 1985. *Report for the U.S. Department of Commerce Covering Domestic Ocean Commerce from Hawaiian Ports to All Domestic Ocean Ports by All Types of Vessels and on All Commodities for Calendar Year 1984*. Washington, D.C.
- Department of Land and Natural Resources, State of Hawaii. 1979. *Hawaii Fisheries Development Plan*. Honolulu.
- Department of Transportation, U.S. Government. 1992. *Federal Register, Part II: Coast Guard*. Washington, D.C.
- Diamond Head Petroleum Company. 1995. Personal Communication.
- Dollar, R.A. 1994. *Annual Report of the 1993 Western Pacific Longline Fishery*. Admin. Rep. H-94-06. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center, U.S. Department of Commerce, Honolulu.
- Doulman, D.J. 1986. The tuna industry in the Pacific Islands region: Opportunities for foreign investment. *Mar. Fish. Rev.* 48(1):15-22.
- Garlow Petroleum Company. 1995. Personal Communication.
- Grigg, R.W. 1993. Precious coral fisheries of Hawaii and the U.S. Pacific Islands. *Mar. Fish. Rev.* 55(2):50-60.
- Grigg, R.W. 1995. Department of Oceanography, University of Hawaii. Personal communication.
- Grosseto, J. 1995. *Grosseto Marine Insurance*. Personal communication.

-
- Haight, W.R., D.R. Kobayashi, and K.E. Kawamoto. Biology and management of deepwater snappers of the Hawaiian archipelago. *Mar. Fish. Rev.* 55(2):20-27.
- Hamm, D.C. and M.M.C. Quach. 1989. *Fishery Statistics of the Western Pacific: Volume IV*. Admin. Rep. H-89-1. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center, U.S. Department of Commerce, Honolulu.
- Hazel Hirsch, D. 1995. Matson Navigation Company. Personal communication.
- Helvey, M., S.J. Crooke, and P.A. Malone. 1987. Marine recreational fishing and associated state federal research in California, Hawaii and the Pacific Island Territories. *Mar. Fish. Rev.* 49(2):8-14.
- Honolulu Advertiser*, October 1994, p. A1; 26 October 1994, p. A3; 6 May 1995, p. A4.
- Honolulu Star-Bulletin*, December 1990, pp. A1 and A10; 19 October, 1993, p. A4; 17 January 1994, p. A2.
- Hurley, N. 1995. U.S. Coast Guard, Honolulu Office. Personal communication.
- LMR Fisheries Research, Inc. 1992. *Hawaii Fisheries Plan, 1990-1995*. Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii, Honolulu.
- Long, R.C. 1995. Fishing industry and community support. In *International Oil Spill Conference Proceedings: Achieving and Maintaining Preparedness 952-3*. American Petroleum Institute Publication No. 4620, Washington, D.C.
- Lucas, L.E. and R.T.B. Iversen. 1992. *Foreign Flag Fishing Vessel Expenditures in the Port of Honolulu, 1986-88*. UNIHI-SEAGRANT-ME-92-01. University of Hawaii Sea Grant College Program, Honolulu.
- Markrich, M. 1990. *Marine Accidents and Marine Insurance in Hawaii*. UNIHI-SEAGRANT-ME-92-01. University of Hawaii Sea Grant College Program, Honolulu.
- Nakayama, M. 1987. *Maritime Industries of Hawaii: A Guide to Historical Resources*. Hawaii Foundation on Culture and the Arts, Honolulu.
- Nall, R. 1995. Pacific Environmental Company. Personal communication.
- Nitta, E.T. and J.R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. *Mar. Fish. Rev.* 55(2):83-92.
- Ogilby, B. Carlsmith, Ball, Wichman, Case and Ichiki, Attorneys at Law. 1995. Personal communication. *Oil Pollution Act of 1990*. United States Public Law 101-380, August 1990.
- Pfund, R.T. 1992a. The vulnerability of Hawaii to a major at-sea oil spill. In *Oil Spills at Sea: Potential Impacts on Hawaii 1-14*. UNIHI-SEAGRANT-CR-92-06. University of Hawaii Sea Grant College Program, Honolulu.
- Pfund, R.T. 1992b. Analysis of the causes and prevention of oil spills. In *Oil Spills at Sea: Potential Impacts on Hawaii*, pp. 107-128. UNIHI-SEAGRANT-CR-92-06. University of Hawaii Sea Grant College Program, Honolulu.
- Polovina, J.J. 1993. The lobster and shrimp fisheries of Hawaii. *Mar. Fish. Rev.* 55(2):28-33.
- Pooley, S.G. 1993. Hawaii's marine fisheries: Some history, long-term trends, and recent developments. *Mar. Fish. Rev.* 55(2):7-19.
- Pooley, S.G. 1995. National Marine Fisheries Service. Personal communication.
- Rappa, P. and P. Moravcik. 1992. An evaluation of state and federal statutes on oil spill response and Hawaii's response preparedness. In *Oil Spills at Sea: Potential Impacts on Hawaii*, pp. 87-106. UNIHI-SEAGRANT-CR-92-06. University of Hawaii Sea Grant College Program, Honolulu.
- Reed Kaina Schaller Advertising, Inc. 1988. *Hawaii Handbook 1988-1989*. Reed Kaina Schaller Advertising, Inc., Honolulu.
-

-
- Samples, K.C. 1982. *Commercial Fishing Vessel Safety and Insurance in Hawaii: An Economic Perspective*. UNIHI-SEAGRANT-WP-00-51. University of Hawaii Sea Grant College Program, Honolulu.
- Samples, K.C., J.N. Kusakabe, and J.T. Sproul. 1984. *Description and Economic Appraisal of Charter Boat Fishing in Hawaii: Final Report*. Department of Agricultural and Resource Economics, University of Hawaii, Honolulu.
- Skillman, R.A., J.C. Cooper and D.R. Locey. 1984. *Inventory of U.S. Vessels in the Central and Western Pacific: Phase 1 – Summary of Public Record*. Admin. Rep. H-84-8. Honolulu Laboratory, Southwest Fisheries Center, National Marine Fisheries Service, Honolulu.
- Skillman, R.A. and D.K.H. Louie. 1984. *Inventory of U.S. Vessels in the Central and Western Pacific. Phase 2 – Verification and Classification of Hawaiian Vessels*. Admin. Rep. H-84-12. Honolulu Laboratory, Southwest Fisheries Center, National Marine Fisheries Service, Honolulu.
- Smith, J. 1995. Tow Boat Services Management. Personal communication.
- Smith, M.K. 1993. An ecological perspective on inshore fisheries in the main Hawaiian islands. *Mar. Fish. Rev.* 55(2):34-49.
- Tummons, P. 1994a. DLNR does nothing to protect islands' stocks of prized bottomfish. *Environ. Hawaii* 4(9):1-6.
- Tummons, P. 1994b. In waters off Northwestern Islands, bottomfish seem to be in good shape. *Environ. Hawaii* 4(9):6.