Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT

M02W0147

CAPSIZING AND LOSS OF LIFE

SMALL FISHING VESSEL *CAP ROUGE II*

OFF ENTRANCE TO FRASER RIVER, BRITISH COLUMBIA

13 AUGUST 2002

Canada

Marine Investigation Report

Capsizing and Loss of Life

Small Fishing Vessel *Cap Rouge II*
Off entrance to Fraser River, British Columbia
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Report Number M02W0147

Synopsis

On the morning of 13 August 2002, the commercial salmon fishing vessel *Cap Rouge II* was bound for the entrance of the main arm of the Fraser River, British Columbia. When the vessel was approximately two miles south of Sand Heads Light, it capsized with seven persons on board. Two persons abandoned the vessel and climbed into a skiff being towed by the fishing vessel. Five persons, including two children, remained within the overturned hull and drowned.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 Particulars of the Vessel

	Cap Rouge II
Official Number	348903
Port of Registry	Vancouver, British Columbia
Flag	Canada
Type	Salmon seine commercial fishing vessel
Gross Tons[1]	47.3
Length	14.7 m
Built	1974, Surrey, British Columbia
Propulsion	One 275 hp Caterpillar diesel engine
Cargo	Estimated 10 365 kg of salmon
Crew members	5
Guests	2
Owner	Private Owner, Galiano Island, British Columbia

1.1.1 Vessel Description

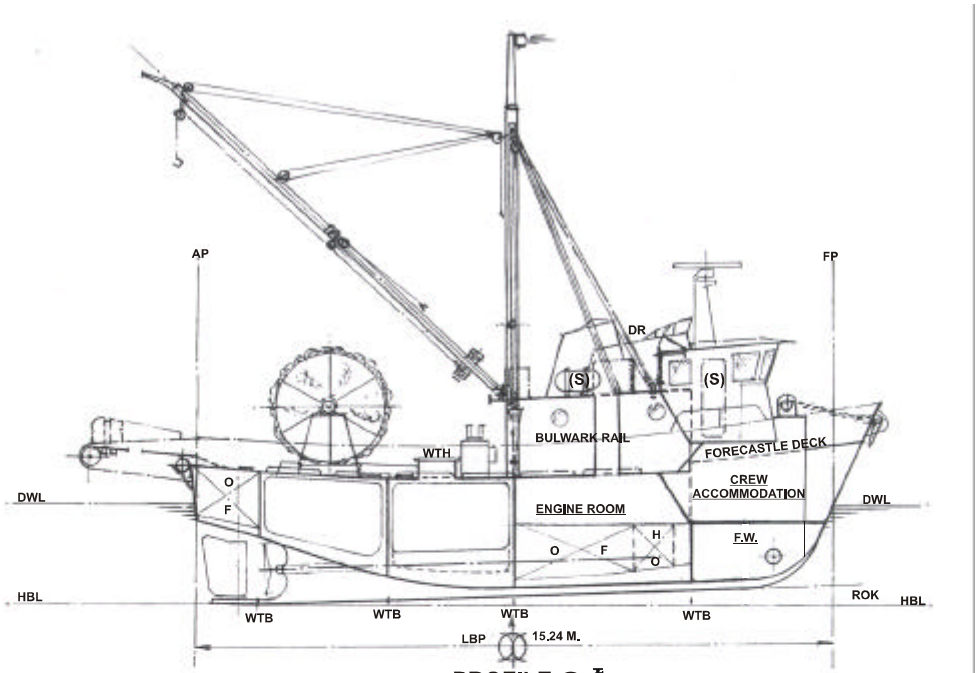
The *Cap Rouge II* was a small fishing vessel of closed construction, having an all-welded aluminum single-chine hull with a transom stern, incorporating an hydraulic fish loading ramp which was generally maintained in the raised position. The hull below the main deck was subdivided by transverse watertight bulkheads, enclosing (from forward) the crew accommodation space, engine room, two forward and two after insulated fish holds divided by a centreline bulkhead, and a lazarette in which the hydraulic steering gear was located. Built-in diesel tanks were arranged on the port and starboard sides of the engine room and the lazarette, and a fresh water storage tank was located under the crew accommodation forward of the engine room. The vessel was powered by a marine diesel engine with a reverse/reduction gear box driving a single fixed-pitch propeller and was fitted with a single plate centreline rudder (see Figure 1).

[1] Units of measurement in this report conform to International Maritime Organization standards or, where there is no such standard, are expressed in the International System of Units.

The vessel was generally engaged in seine fishing operations and was equipped with an hydraulic purse seining winch and net storage drum. The main mast, located near midships, was rigged with a cargo boom, fitted with hydraulic topping lift and vanging winches. The mast was also fitted with a crosstree and rigging, providing for the vertical stowage and deployment of a pair of outrigger booms, equipped with roll reduction paravanes (often referred to as stabilizers).

An aluminum superstructure enclosed the wheelhouse, captain's cabin, galley, mess, washroom, engine room access, and escape hatch. A weathertight hinged door, giving access to the forecastle deck, was located on the starboard side of the wheelhouse. A combined hinged hatch cover and door on the centreline at the after end of the wheelhouse provided an alternative exit and also gave access to the outside steering position, located on top of the main deckhouse (see Photo 8). A weathertight hinged door, giving access from the galley to the after end of the main deck, was located to starboard of the centreline in the after end bulkhead of the deckhouse.

The raised wheelhouse was arranged with a comprehensive outfit of communications and navigation equipment, including radar, VHF radio, depth sounder, compass, autopilot, navigation lights and sound signals control panels.



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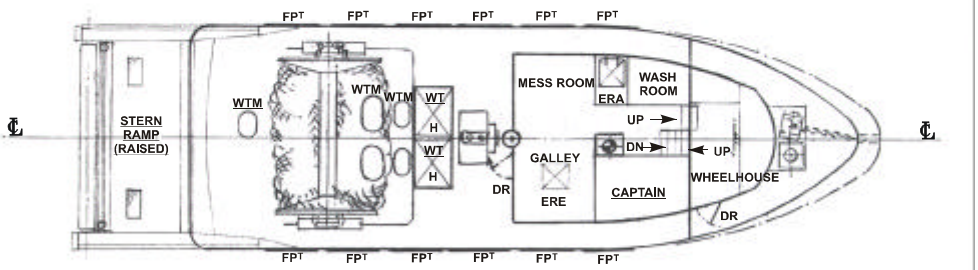
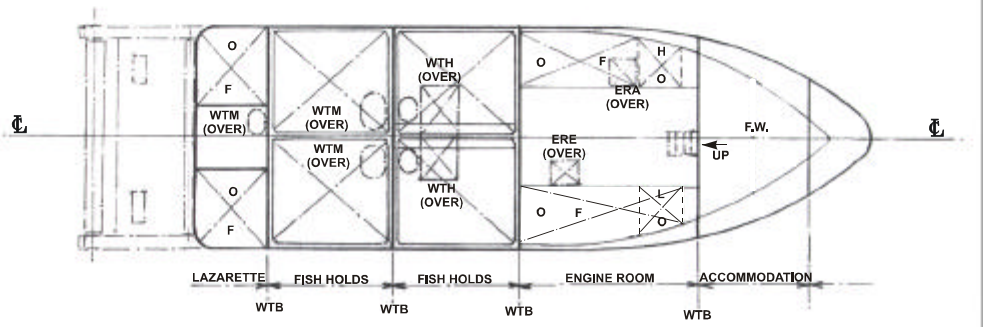


PLAN VIEW OF MAIN DECK



PLAN VIEW BELOW MAIN DECK

AP	AFT PERPENDICULAR	WTB	WATERTIGHT BULKHEAD
FP	FORWARD PERPENDICULAR	WTM	WATERTIGHT MANHOLE
℄	CENTRE LINE	WTH	WATERTIGHT HATCH
D WL	DESIGNED WATERLINE	ERA	ENGINE ROOM ACCESS
HBL	HYDROSTATIC BASELINE	ERE	ENGINE ROOM ESCAPE
ROK	RAKE OF KEEL	O.F.	OIL FUEL
FPT	FREEING PORT	L.O.	LUBRICATION OIL
(S)	STARBOARD (ONLY)	H.O.	HYDRAULIC OIL
DR	WEATHERTIGHT DOOR	F.W.	FRESH WATER
→ UP	STAIRS LEAD UP	→ DN	STAIRS LEAD DOWN

Figure 1. Outline general arrangement

1.2 Fishery Opening

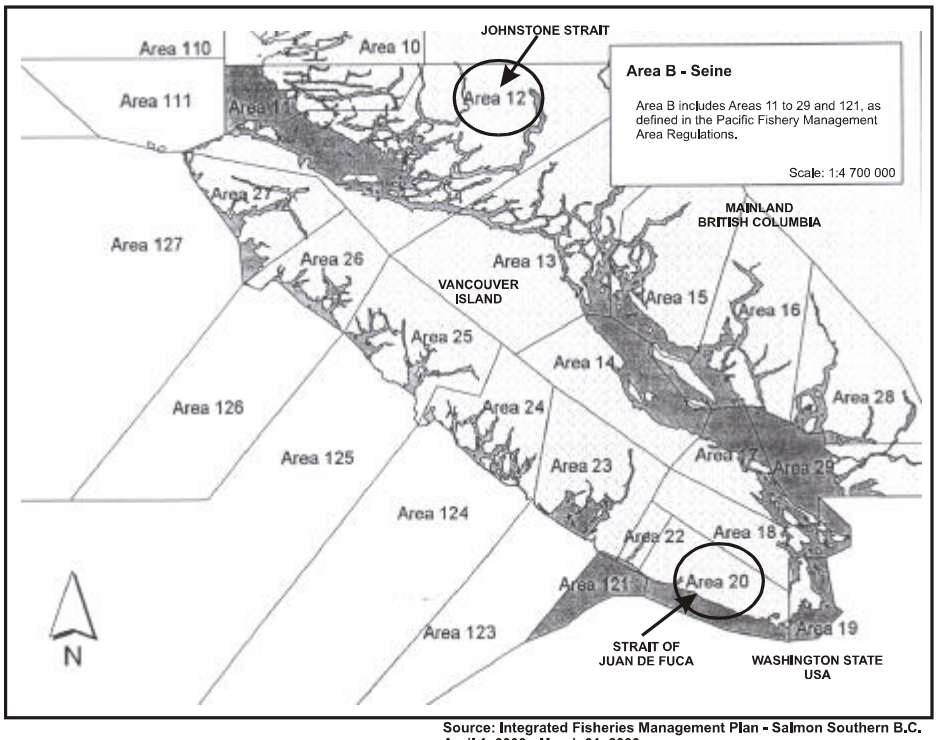
At approximately 1300[2] on Friday 09 August 2002, the Department of Fisheries and Oceans (DFO) announced that it would permit 32 licenced commercial seine fishing vessels to fish for sockeye salmon in a designated portion of the Strait of Juan de Fuca south of Port Renfrew, British Columbia, known as Fisheries Statistical Area 20 (see Figure 2). The fishery would commence at 0600 on Monday, August 12, and end eight hours later at 1400. Under the terms of a joint venture agreement between DFO and private industry, the exact identity of the 32 vessels would be decided by private industry. Regardless of which vessels were chosen, DFO required each of them to be on the fishing grounds no later than 2000 on the evening of August 11.

Vessels scheduled to participate in the Area 20 fishery organized themselves into catch-sharing groups, usually consisting of between six and eight vessels. The total number of fish caught by all the vessels participating in any one group would be divided equally amongst all its members.

Originally, the *Cap Rouge II* was meant to participate in a salmon fishery scheduled to take place at the same time as the Area 20 fishery, but in a more geographically protected waterway known as Johnstone Strait, considered by DFO to be part of Fisheries Statistical Area 12.

When a seiner, originally chosen by the catch-sharing group to participate in the Area 20 fishery, had insufficient time to provision itself and reach Port Renfrew by the DFO-required time on August 11, *Cap Rouge II* was called upon to forego its plans to participate in Area 12 and was re-directed to Area 20. Fishing nets permitted in Area 12 (inside seine nets) were shorter, shallower and usually weighed approximately 2500 kg less than those permitted in Area 20.

[2] All times are Pacific daylight time (Coordinated Universal Time minus seven hours) unless otherwise noted.



Source: Integrated Fisheries Management Plan - Salmon Southern B.C. April 1, 2002 - March 31, 2003

Figure 2. Commercial salmon seine areas

1.3 History of the Voyage

To prepare for its participation, the *Cap Rouge II,* with a total of five crew including the skipper[3], left Sturdies Bay on Galiano Island on the morning of August 10 and made its way across the Strait of Georgia to Steveston, a community within the City of Richmond, located on the shores of the south arm of the Fraser River. In Steveston, the crew acquired groceries, fuel, ice for the fish holds, and fishing gear which included a "west coast" seine net. Later in the day, the *Cap Rouge II* left Steveston for Whaler Bay, on the east side of Galiano Island. There, the *Cap Rouge II* took in tow a diesel-powered aluminum seine skiff and continued its voyage as far as Cadboro Bay near Victoria, where it anchored for the night. The next morning at approximately 0630, the vessel weighed anchor and continued its voyage to Port Renfrew in the Strait of Juan de Fuca, arriving there at approximately 1315.

At 0600 on August 12, the *Cap Rouge II,* along with the other 31 vessels, began fishing. The fishing continued for eight hours until 1400. After the skipper reported to DFO the quantity of his catch, he took on board all the fish caught by another vessel participating in the same group. The *Cap Rouge II* had approximately 22 850 pounds of fish on board when it left the fishing grounds at approximately 1845. This quantity was about half of its cargo capacity.

[3] Skipper is the owner/operator of the vessel.

The fish were stowed in three of four insulated holds (see Figure 1). Each hold was designed to contain a slurry of seawater and ice chips in which the fish were carried to the processing facility. All except approximately 200 pounds of fish were evenly distributed between the two forward holds. The remaining 200 pounds of fish were stowed in the port after hold and none in the starboard after hold. Each of the four holds was partially filled with seawater. The two forward holds were approximately ⅔ to ¾ full and the after holds were approximately ⅛ full.

In preparation for the voyage, a painter was attached to a bridle connected directly to the port and starboard bows of the power skiff and led forward over the stern roller of the fish loading ramp, forward over the top of the seine net wound on the drum and secured to the purse seining winch, located forward of the fish hold hatch. The skiff was initially cinched tight against the roller of the stern ramp of the *Cap Rouge II*. (Subsequently, the bow of the skiff came free of the stern roller as the painter stretched while the vessel was underway.) This work was done while the *Cap Rouge II* was stationary, prior to the commencement of its voyage to the processor.

At approximately 1845, the *Cap Rouge II* departed the Port Renfrew area in clear, calm weather. The lazarette was pumped free of sea water some four to five hours later. The next morning, the vessel arrived back in Sturdies Bay so that two children, whose parents were already on board the vessel, could travel as guests for the remainder of the voyage to Steveston. At approximately 0700 on August 13, the vessel departed Sturdies Bay and made its way into the Strait of Georgia toward the entrance of the north arm of the Fraser River. Environment Canada reports that, at the time, the weather was clear with 22 knot winds blowing from the northwest. Wave height was reported as being between one and two metres.

The vessel was on a northerly course proceeding at approximately six knots and steered by automatic pilot. At 0857, the vessel made a "starboard to starboard" passing with the 33.5 m sailing vessel *Francis Lynn II*, which was under full sail and approximately four miles outbound for Active Pass from Sand Heads at the entrance to the Fraser River. The vessels passed within 180 m of each other. The mate on board the sailing vessel was on watch at the exterior helm near the stern of the sailing vessel. He recalled that, at the time of the vessels' passing, the *Cap Rouge II* was trimmed heavily by the stern and seawater was washing onto its main deck.

On board the *Cap Rouge II,* two crew members were on watch while a third crew member was in the wheelhouse but not officially on watch. The skipper was sleeping in his cabin on the starboard side of the main deck while a fourth crew member was sleeping on a settee located on the port side of the galley. The boy, who had joined the vessel in Sturdies Bay, was in the wheelhouse with the three adults. His sister was resting in one of the bunks, located in the forward crew accommodation area below decks.

One of the crew members woke the skipper to inform him that the seiner had a starboard list which he might want to assess and correct. In response, the skipper left his cabin and made his way aft to the galley door, which was secured in the open position. This door led to the main working deck. He observed seawater on the starboard side of the deck, but due to the obstruction caused by the seine net wrapped on the net drum, he was unable to see the stern of the vessel or the skiff.

The skipper descended a ladder into the engine room and started an auxiliary engine used to power the vessel's bilge pumps. He then proceeded aft along the starboard side of the engine. To correct the list, he adjusted the valves necessary to pump overboard water in the starboard after fish hold. Pumping had just begun when the vessel suddenly heeled heavily to starboard, causing unsecured equipment to fall from the top of the port side main fuel tank. The skipper made his way up the ladder into the interior companionway of the main deck and shouted to those in the wheelhouse to "take the engine out of gear".

The skipper made his way forward to the wheelhouse. By this time, the vessel was listing so severely that the starboard side of its superstructure was touching the surface of the sea. Taking hold of the boy, he made two attempts to lift him through the combined hinged hatch cover and door leading outside to the top of the main deckhouse. However, the boy baulked each time because of his proximity to the heated surface of the main engine's exterior exhaust piping. After these two attempts, the skipper placed the boy in the care of one of the crew members, then made his way up through that opening with the intention of boarding and releasing the seine skiff, so that it might be used as a rescue craft for those on board the vessel. He made his way aft along the side of the vessel toward the skiff, which had floated forward when the vessel's listed condition allowed the skiff's painter to slacken. He boarded the skiff and, while attempting to release it, the *Cap Rouge II* capsized.

The skipper dove underwater at two locations along the hull of the overturned vessel in an attempt to reach those inside. He was unable to do so and, in an exhausted state, managed to re-board the skiff. From this position, he threw a length of rope to one crew member who was in the water and wearing a floater jacket. The skipper hauled the crew member on board the skiff and discovered that, like himself, the crew member had escaped through the wheelhouse top hatch.

Three crew members and two children remained inside the capsized vessel and drowned.

1.4 Events Following the Capsizing

At 0902, the sailing vessel *Francis Lynn II* informed the Marine Communications and Traffic Services Centre in Victoria (Victoria MCTS) that a fishing vessel had capsized off Sand Heads Light, which marks the western edge of the Steveston jetty. The *Francis Lynn II* reported it was approximately two nautical miles south of the position where the *Cap Rouge II* capsized, was

under sail and unable to proceed directly to assist. The mate on board the sailing vessel observed two persons in the seine skiff of the *Cap Rouge II*. No distress call was broadcast by the *Cap Rouge II*. No other information about the accident was provided by the sailing vessel.

The Ro-Ro passenger ferry *Queen of New Westminster* overheard the radio communication between *Francis Lynn II* and Victoria MCTS and informed Victoria MCTS they were off Sand Heads and proceeding to provide assistance. Victoria MCTS issued a MAYDAY RELAY broadcast and the Joint Rescue Co-ordination Centre in Victoria (JRCC Victoria) was advised of the accident. Numerous vessels responded to the broadcast. The JRCC Victoria subsequently tasked dedicated search and rescue (SAR) resources and other vessels to the area.

At 0903, the Canadian Coast Guard (CCG) hovercraft *CCGH 045* departed its base at Sea Island after hearing the *Francis Lynn II* call Victoria MCTS. On board *CCGH 045* was the usual crew of four—a captain, a first officer and two rescue specialists—and another captain, who happened to be on hand when the crew overheard the radio communications about the capsizing. The CCG auxiliary vessel *Auxiliary 07* in Steveston was tasked by JRCC Victoria.

At the same time, 0903, Canadian Forces (CF) 442 Squadron, which is based at Canadian Forces Base (CFB) Comox and on two-hour standby, was informed of the capsizing by JRCC Victoria. A CF CH113 Labrador helicopter was tasked to provide assistance. At approximately the same time, the fishing vessel *Taaska* was in the area, proceeding toward the capsized vessel.

At 0913, the *Seaspan Greg* also observed the skiff and advised Victoria MCTS that the position of the capsized vessel was approximately 49° 04' 39"N, 123° 18' 48"W. The reported position placed the *Cap Rouge II* approximately 1.75 nautical miles south of Sand Heads Light.

As the *Taaska* came alongside the seine skiff, her crew was informed by those on board the skiff that five persons were still within the capsized vessel. The *Taaska* reported this information to Victoria MCTS at 0918.

At the same time, 0918, as it approached the accident site, *CCGH 045* requested of JRCC Victoria that it dispatch a penetration-capable dive team. Within the following minute, *CCGH 045* had arrived on scene and, assuming the role of on-scene co-ordinator (OSC), began to simultaneously co-ordinate rescue activities and dive operations.

At 0920, JRCC Victoria asked Victoria MCTS to inform *CCGH 045* that the CF CH113 Labrador had been tasked and its estimated time for arrival was two hours.

At 0921, *CCGH 045* contacted Victoria MCTS and requested that JRCC Victoria dispatch a floating crane to assist with recovery operations. Rescue specialists on board the *CCGH 045* were also preparing to deploy to survey the situation. By 0922, the *Queen of New Westminster* had

arrived on scene and had lowered her rescue boat into the water. The *Queen of New Westminster* positioned herself upwind from the capsized vessel to provide a lee which would shelter those involved in search and rescue activities.

At approximately 0925, the primary diver and standby diver from *CCGH 045* first entered the water. At 0930, *Auxiliary 07* arrived on scene and two of its crew members clambered onto the capsized vessel and pounded along the hull but there was no response from inside the vessel. Rescue personnel also tried to detach the skiff from the capsized vessel but were unable to cut the skiff's towing bridle.

At 0935, the primary diver began to conduct an underwater external search of the *Cap Rouge II* while the standby diver remained in the water but at the surface. During dive operations, the primary diver communicated to the standby diver that he was entangled. The standby diver dove and freed the primary diver. Before either diver was able to resurface, the standby diver became entangled but was freed by the primary diver.

The two survivors were removed from the skiff and transferred to the *Queen of New Westminster* (later, they would be transferred again to the Royal Canadian Mounted Police (RCMP) vessel *Nadon*). The skipper of the *Cap Rouge II* sketched a layout of the vessel for rescue personnel. He informed them that there was one door in the starboard side of the aluminum plating of the wheelhouse but none in the port side. He also informed them of the possible whereabouts of the persons still within the vessel.

At approximately 0954, the body of an adult was recovered from within the submerged wheelhouse by CCG divers stationed outside the vessel using a boat hook. A crew member from *Auxiliary 07* boarded *CCGH 045* to assist bringing the victim on board. Cardiopulmonary resuscitation (CPR) was then performed. *CCGH 045* called the *Queen of New Westminster* and asked if there was a doctor on board—there was none.

CCG divers were unable to perform another dive because their diving cylinders were out of air and there were no spare cylinders on board *CCGH 045.* No other diving cylinders were available on scene. At 0957, *CCGH 045* issued a MAYDAY RELAY requesting any vessel within the vicinity to provide SCUBA (self-contained underwater breathing apparatus) tanks. Several vessels with charged cylinders on board responded to the call and proceeded to the site. Extra diving equipment, cylinders, and a CAPSAV[4] kit from the base at Sea Island were also being brought to the site. At 1003, the CCG cutter *Osprey 1* informed Victoria MCTS that it had departed its base at Kitsilano and was en route to the site with one diver on board and two spare tanks.

[4] CAPSAV Hull Penetration System is used to penetrate the exposed hull of a capsized vessel and provide air and light into a vessel without loss of existing air trapped within the hull, thereby prolonging the survival time of persons trapped in air pockets.

At 1004, *CCGH 045* departed the scene to transport the recovered body, while the crew performed CPR, to an ambulance standing by in Steveston. The hovercraft retained the role of OSC during the 36 minutes it took to reach Steveston and return to the accident site. *Auxiliary 07* remained on scene and continued efforts to try to release the skiff from the capsized vessel. Other vessels were searching the debris field southwest of the capsized vessel in search of any survivors.

A CF CH113 Labrador helicopter, with four search and rescue technicians (SAR TECHs), departed CFB Comox at 0955. Additional arrangements had also been made by JRCC Victoria to transport four divers from the CF Fleet Diving Unit (FDU) at CFB Esquimalt by CCG helicopter to the Sand Heads jetty. Two RCMP divers were also proceeding to the CCG base at Sea Island.

CCGH 045 was back on scene at 1040, after having transferred the person recovered from *Cap Rouge II* to an ambulance in Steveston. The *Nadon* and *Sea Island 1*, a CCG rigid hull inflatable craft based at Sea Island, had also arrived. *Sea Island 1* had on-board dive cylinders and a CAPSAV kit. After arriving on scene at 1045, the CF CH113 Labrador helicopter lowered the SAR TECHs onto *CCGH 045.* In accordance with CCG operating procedures, *CCGH 045* had shut down her engines to receive the SAR TECHs. The hovercraft had difficulty restarting the engines and experienced on-board systems failures. At approximately 1100, the FDU divers arrived on scene. The SAR TECHs, CCG and FDU divers transferred to *Sea Island 1* to begin their dive operations. *CCGH 045* departed the scene and returned to its base at Sea Island, so that the crew could transfer to the hovercraft *CCGH Siyay*.

The SAR TECHs entered the water at 1110, with CCG, FDU, and RCMP divers providing backup. Within 10 minutes, a child was recovered from within the vessel. The child was then taken by Labrador helicopter to an ambulance at Sea Island. Shortly afterwards, the bodies of two adults were recovered from within the vessel. A further search of the interior of the vessel was conducted. However, the crew's forward, below-decks sleeping area and skipper's cabin could not be searched because of floating debris which prevented divers from reaching those areas.

At approximately 1155, *CCGH Siyay* had arrived on scene and took up the OSC duties.

At 1230, dive operations into the vessel were suspended when it was determined by those on scene that the combined factors of the overturned vessel, its suspended equipment and associated debris constituted an undue risk to the safety of the divers.

At 1303, a barge with a crane arrived on scene. The crane was unable to lift the capsized vessel out of the water but was able to stabilize the vessel which was subsequently towed to shallow water. Shortly after 1900 on August 13, divers were able to search the captain's cabin and recover the body of the second child who had been in the forward accommodation space. None of the persons recovered was located in a pocket of air within the vessel.

1.5 Injuries to Persons

	Crew	Guests	Others	Total
Fatalities	3	2	-	5
Missing Persons	-	-	-	-
Seriously Injured	-	-	-	-
Minor/No Injuries	2	-	-	2
Total	5	2	-	7

1.6 Damage to the Environment

An insignificant amount of diesel was released at the time of the accident. No environmental damage was reported.

1.7 Certification

1.7.1 Vessel Certification

As a small fishing vessel of 47 gross registered tons (GRT) and less than 24 m in length, the *Cap Rouge II* was subject to regulatory inspection on a quadrennial basis. Since being built, the vessel had been inspected in accordance with the *Small Fishing Vessel Inspection Regulations* (SFVIR).

Inspections were routinely carried out at the scheduled four-year intervals and, on 13 June 1994, a Safety Inspection Certificate (SIC) 29 for operation as a Home Trade Class II Vessel was issued, valid until 28 May 1998. Because of operational and/or other logistical reasons, the validity of the SIC 29 was extended until 04 August 1999 when, following an inspection by Transport Canada (TC), the current SIC 29 was issued and made valid until 13 September 2002, effectively restoring the original scheduled quadrennial inspection sequence.

As part of TC's Ship Registration Program, a Certificate of Registry, with a covering letter, is sent to the registered owner/authorized representative. The cover letter states "if your address changes at any time or the vessel is altered, you must notify the nearest Registrar of Ships." The Certificate of Registry has a three-year expiry date from the day the certificate was issued. This new process began in February 2000, as part of the reform of the *Canada Shipping Act*, and the letter was sent to the owner of *Cap Rouge II* on 14 June 2001.

1.7.2 Personnel Certification

The skipper of the *Cap Rouge II* held a Transport Canada Fishing Master Class IV certificate of competency, issued 02 February 2001, which qualified him to command fishing vessels of this size and type. He received training in marine emergency duties (MED A1) as a mandatory component of course work leading to the issuance of his certificate. A mandatory component of his certificate required him to pass an oral examination on the subject of 'General Seamanship' - an "umbrella" category which covered six topics, including 'Stability'.

There is no information to indicate that the four other crew members on board the vessel had received MED training.

There is no information to indicate that regular emergency drills including 'Ship Abandonment' took place on board the vessel.

1.8 Personnel History

The skipper had 31 years' experience in the fishing industry and continues to be the proprietor of a company which routinely operates small boats in sorting logs in preparation for their delivery to various mills.

All four crew members were experienced fishers and had worked on board fishing vessels for a number of years.

1.9 Weather, Tide, and Current Conditions

1.9.1 Weather Recorded

Observations made by the Pacific Weather Centre of Environment Canada at 0900 at the entrance to the south arm of the Fraser River and within two miles of the accident site indicate a wind blowing from the north-northwest (340°) at a speed of 17 knots. The skies were clear.

The waves in the area of the accident were proceeding in a number of directions simultaneously, resulting in what is commonly known as a "confused sea". The height of the waves was estimated by the master of a nearby B.C. ferry to be between 1 and 1.5 m.

1.9.2 Tide and Current

At the time of the accident, the tide was ebbing at a rate of less than two knots after reaching a normal highwater height of 3.8 m. At 0833 at the entrance to the south arm of the Fraser River, the downstream current was flowing at less than one knot.

1.10 Emergency Preparedness

1.10.1 Lifejackets and Immersion Suits

Life-saving equipment on board the vessel consisted of eight adult lifejackets, two children's lifejackets and five immersion suits. The lifejackets and immersion suits were stowed in the companionway connecting the crew's quarters forward with the wheelhouse.

1.10.2 Inflatable Liferaft

The vessel was supplied with a six-person "B" - type liferaft, manufactured by Beaufort in April 1974. It was serviced on 28 February 2001. The liferaft cannister was stowed in a metal, open-topped cradle, located on the command bridge of the vessel. Soon after the vessel capsized, the cannister was observed unopened and floating free of the vessel but still tethered to it by means of the liferaft's painter.

1.10.3 Marine Emergency Duties Training Program

As part of Transport Canada Marine Safety (TCMS) requirements to acquire certification as Fishing Master - Class IV, the skipper successfully completed 19½ hours of instruction on recognizing and responding to hazards in a marine environment. This training program is known as *Marine Emergency Duties Course A1* (MED A1). The syllabus specifies instruction on raising alarms in emergency situations, abandoning a vessel, and the importance of regularly carrying out emergency drills and training.

Four of the crew on board at the time of this occurrence participated in a Workers' Compensation Board of British Columbia (WCB) emergency drills workshop, held on Galiano Island, on 11 May 1998.

1.11 Vessel Stability

1.11.1 Regulatory Stability Requirements

When the *Cap Rouge II* was completed in 1974, there were no regulatory requirements calling for the submission and approval of stability data for small fishing vessels. Subsequent requirements were introduced which called for certain small fishing vessels, built after 06 July 1977, to submit intact stability data for approval by the then CCG Ship Safety Branch (SSB).[5] The SFVIR require that only those small fishing vessels engaged in fishing for herring or capelin submit trim and

[5] The Ship Safety Branch of the Canadian Coast Guard became the Marine Safety Branch of Transport Canada in 1995, now referred to as, for the purpose of this report, Transport Canada (TC).

stability data for approval. Consequently, small fishing vessels, such as the *Cap Rouge II*, which are principally engaged in salmon seining, are not required to submit trim and stability data for approval, nor is there any mandatory requirement for the owners of these vessels to forward this data to TC for safety review or information purposes.

As was the case with the *Cap Rouge II*, there is no regulatory requirement for an owner to assess the stability characteristics of a small fishing vessel. However, such an assessment is occasionally done voluntarily because the result is considered an important indication of a vessel's seaworthiness. Regardless of whether a stability assessment is done on a mandatory or voluntary basis, the criteria used in its determination are included in section STAB 4 of the *Stability, Subdivision and Load Line Standards* (TP 7301).

The WCB *Occupational Health and Safety Regulation* (OHS), Section 24.72(b), requires documentation on board which describes vessel characteristics, including stability. Policy Item R24.72-1, expands upon this requirement stating:

> Under section 24.72(b), the owner must give notice of unique features of the vessel which might not otherwise be known to a new master and crew and which might cause hazards in certain situations if the boat is not properly handled. This includes instructions on how to perform operations on the vessel without impairing its stability and seaworthiness.

However, for vessels such as *Cap Rouge II*, the WCB regulation does not define acceptable stability criteria for the guidance of the owner.

1.11.2 Stability Data Approval History

The builder of the *Cap Rouge II* is no longer in operation; there are no records available of an inclining experiment conducted to verify the vessel's original as-built trim and intact stability characteristics when it was completed as a seiner in 1974. However, a simple rolling period test was carried out at that time, which provided some indication of initial stability, and a transverse metacentric height (GMt) of 19.5 inches (495 mm) was recorded by the SSB. The actual loading condition of the vessel at the time of the rolling period test is not known, however the derived GMt was considered satisfactory as it was comparable to other small fishing vessels of a similar size and service.

In 1987, the vessel was converted for operation as a herring packer by a former owner and, to determine her new stability characteristics, an inclining experiment was conducted on 28 December 1987. At that time, all seine nets, the seine net drum and other fishing gear which were not required for herring packing operations were removed from the main deck of the vessel. The original single fish hold was subdivided by new transverse and centreline bulkheads

to provide four separate fish holds. The centreline bulkhead was installed for the full depth of the fish holds, but did not extend up to the top of the main deck hatch coaming in way of the forward pair of holds.

The trim and stability data derived from the results of the experiment showed the vessel exceeded the minimum stability criteria of STAB 4, which are applicable to small fishing vessels engaged in catching herring or capelin. However, the requirements were not applicable to herring packing operations, and the inclining experiment was not witnessed by a TC inspector. The related trim and stability booklet was not submitted to or approved by TC.

1.11.3 Vessel Modifications History

Since being built in 1974, the vessel has been the subject of several modifications and the installation of additional rigging, fishing, hull, and engine room outfit. Previous and present owners have added to, and modified, the outfit of fishing gear and other equipment to meet the ongoing changes, developments and requirements of the seining fishery. Since 1987, when the vessel was arranged for fish packing operations with fishing gear and the powered seine net drum removed, the *Cap Rouge II* had been re-rigged and updated for current salmon seining operations by the modification of existing equipment and the installation of various items of additional gear, including the following:

- a full-width stern seining ramp, roller, hydraulic package, and controls;
- seine net power drum seating raised some 330 mm to increase under-net clearance;
- a fish pen permanent coaming fitted on main deck in way of hold loading manholes;
- a 2.44 m-diameter seine net power drum, hydraulic drive package, and controls;
- main cargo boom vanging winches, rigging, hydraulic package, and controls;
- main cargo boom topping winches, rigging, hydraulic package, and controls;
- hydraulic seine net power block on main boom;
- Volvo auxiliary engine and electrical generator set in engine room (S);
- bow thruster unit installed in compartment within forward freshwater tank;
- increased hydraulic and lubricating oil tank capacities in engine room;
- seine net ring stripper davit at top of bulwark rails near midships (S);
- heavy-duty domestic deep freezer on deckhouse top;
- additional radar mast, unit, and scanner on wheelhouse top;
- additional fishing lights on main mast;
- permanent trimming ballast on main deck in captain's cabin (430 kg)(S);
- accumulated spares and tools in engine room (570 kg); and
- "West Coast"seine net on power drum at 1.73 m above main deck (7400 kg).

The cumulative effect of the above items increased the vessel's lightship weight, lowered the inherent effective freeboard, raised the centre of gravity and markedly reduced the transverse stability characteristics of the *Cap Rouge II*.

1.11.4 Vessel on Recovery

During and after the salvage and recovery of the *Cap Rouge II*, the vessel was inspected by divers, the Transportation Safety Board of Canada, TC, and WCB personnel. The following items were noted:

- the seine net was on the net drum. (Dry weight was subsequently verified to be 7400 kg);
- the main boom was in the raised position and secured on the centreline of the vessel;
- the roll reduction outrigger booms (stabilizers) were secured in the vertical position;
- four main deck flush-fitting manhole covers, giving access to the fish holds and another in way of the lazarette, were found in place by the divers, but were subsequently removed to facilitate pumping the vessel clear of floodwater during the salvage operations;
- the door on the starboard side of the wheelhouse was found closed by divers;
- the combined hinged hatch cover and door from the after end of the wheelhouse, giving access to the main deckhouse top, was found open by divers;
- the door in the after end of the main deckhouse, giving access to the after end of the main deck, was found secured in the open position;
- the fibreglass covers of the main deck hatch and fish sorting table were missing;
- unsecured spare parts and tools, displaced from the top of the port side oil fuel tank, were found on the starboard side of the engine room;
- autopilot controls in the wheelhouse were found in the engaged position;
- the rudder was found to be turned approximately 20° to starboard;
- the valves in the suction and overboard discharge piping systems of the after starboard side fish hold were open and the fish hold pump set for discharging water from that compartment;
- valves in the suction and return pipes cross connecting the two after oil fuel tanks were open and the oil fuel transfer pumping system set for the tanks to be used simultaneously;
- valves in the suction and return pipes cross connecting the oil fuel tanks in the engine room were all closed, and the port and starboard tanks were isolated from each other;

- the oil fuel pumping and transfer system was set to draw fuel from the after tanks only;
- when the after oil fuel tanks were emptied and their contents measured by a calibrated flow meter, they were each found to contain 2273 L (500 gallons);
- the oil fuel tanks in the engine room were emptied and their contents were also measured by flow meter; the starboard side tank contained 2273 L (500 gallons) of diesel oil, and the port side tank held 1727 L (380 gallons);
- the lazarette was found to contain 1410 L (310 gallons) of seawater;
- the hydraulic oil storage tank was found to contain 1136 L (250 gallons) of oil; and
- the forward freshwater tank contained 1363 L (300 gallons).

Hose testing and inspection of the flush-fitting manholes in the main deck, giving direct access to the four fish holds and the lazarette, showed that their flexible sealing gaskets were ineffective and not watertight. During the hose tests, some water leaked into the forward pair of fish holds, past the gaskets of the secured 610 x 380 mm (24 x 15 inches) manhole covers. A significant amount of water entered the after holds past the gaskets of the 940 x 610 mm (37 x 24 inches) secured manhole covers. A steady stream of water was also found to enter the lazarette past the gasket of the 610 x 455 mm (24 x 15 inches) secured access manhole cover.

Water entered each of the after fish holds in significant quantities, with the port side being somewhat greater. However, the manhole covers were identical in appearance and, because they had been removed during the salvage operations, their correct re-location at the time of the tests could not be verified, and the actual athwartship imbalance of the downflooding rates into the port and starboard after holds at the time of the capsize could not be determined.

As found on recovery, the open or closed condition of the wheelhouse and main deckhouse doors of the vessel were consistent with the sequence of events prior to the capsize, as reported by the survivors. The secured condition of the lazarette and fish holds flush-fitting manhole covers and the configuration of the oil fuel transfer piping and water ballast pump operating arrangements were also as reported.

1.11.5 Occurrence Stability

An inclining experiment was carried out by the TSB on 26 August 2002 to determine the lightship condition of the *Cap Rouge II* at the time of the capsize and to assess the effects due to the weight of additional fishing gear and other equipment primarily installed at or above main deck level. A rolling period test was also carried out at this time, which provided on-site confirmation of the "as inclined" initial stability condition of the vessel. Both of these tests[6] were attended and witnessed by a Minister of Transport observer and a TC inspector.

[6] Inclining Experiment Report & Rolling Period Test Report is available on request.

Preparations for this inclining experiment revealed that the existing after draught markings on the hull were set some 112 mm (4⅜ inches) too high, and that those forward were also approximately 12 mm (½ inch) too high. Consequently, the lightship weight derived from the previous inclining experiment 28 December 1987, was significantly lower than that of the actual vessel at that time, making it and the related stability characteristics unreliable for comparison purposes.

An assessment of the intact transverse stability was carried out to verify the condition of the *Cap Rouge II* prior to and at the time of the capsize, based on the current lightship data, the reported fish catch, the recovered on-board consumables, the "West Coast" seine net and fishing gear, etc.

Calculations show that, shortly before the capsize, the vessel had an after trim of approximately 0.80 m (2.67 ft). The initial transverse stability in the static condition, as indicated by the GMt, exceeded the minimum STAB 4 criteria by some 23 per cent. However, the maximum righting lever (GZ) was 52 per cent of the recommended minimum and the total dynamic stability, as represented by the area under the righting lever curve, was 50 per cent of that required up to an angle of heel of 40°. The maximum righting lever was reached at 20° heel in lieu of the minimum recommended 25° and the range of positive stability was limited to 40° angle of heel.

Due to the wave pattern generated by the speed of the vessel through the water and the rolling and pitching motions in the prevailing confused sea conditions, water was shipped through the freeing ports at main deck level and also through openings in the fixed stern ramp. As the shipped water accumulated at the after end of the main deck, it was constrained within the area bounded by the seine net drum seating and the forward fish pen and hatch coaming. Because the gaskets of the manhole covers of the four fish holds and the lazarette were ineffective, downflooding into all of these compartments commenced (see Figure 3).

The accumulated water on deck, together with the downflooding of the lazarette and lightly loaded after holds, created a marked increase in free surface area and a corresponding reduction in transverse stability.

The additional weight and free surface effects of the shipped water increased the after trim to 1.22 m (4.0 ft), lowered the mean and after freeboards, and markedly lowered the transverse stability characteristics of the vessel. While in this condition, the GMt was reduced to 68 per cent of the minimum requirement and, more significantly, the maximum righting lever and dynamic stability were lowered to 19 per cent and 10 per cent, respectively, of the recommended minimum values. Furthermore, the range of positive transverse stability was limited to an angle of 22° in lieu of the recommended range in excess of 40°.

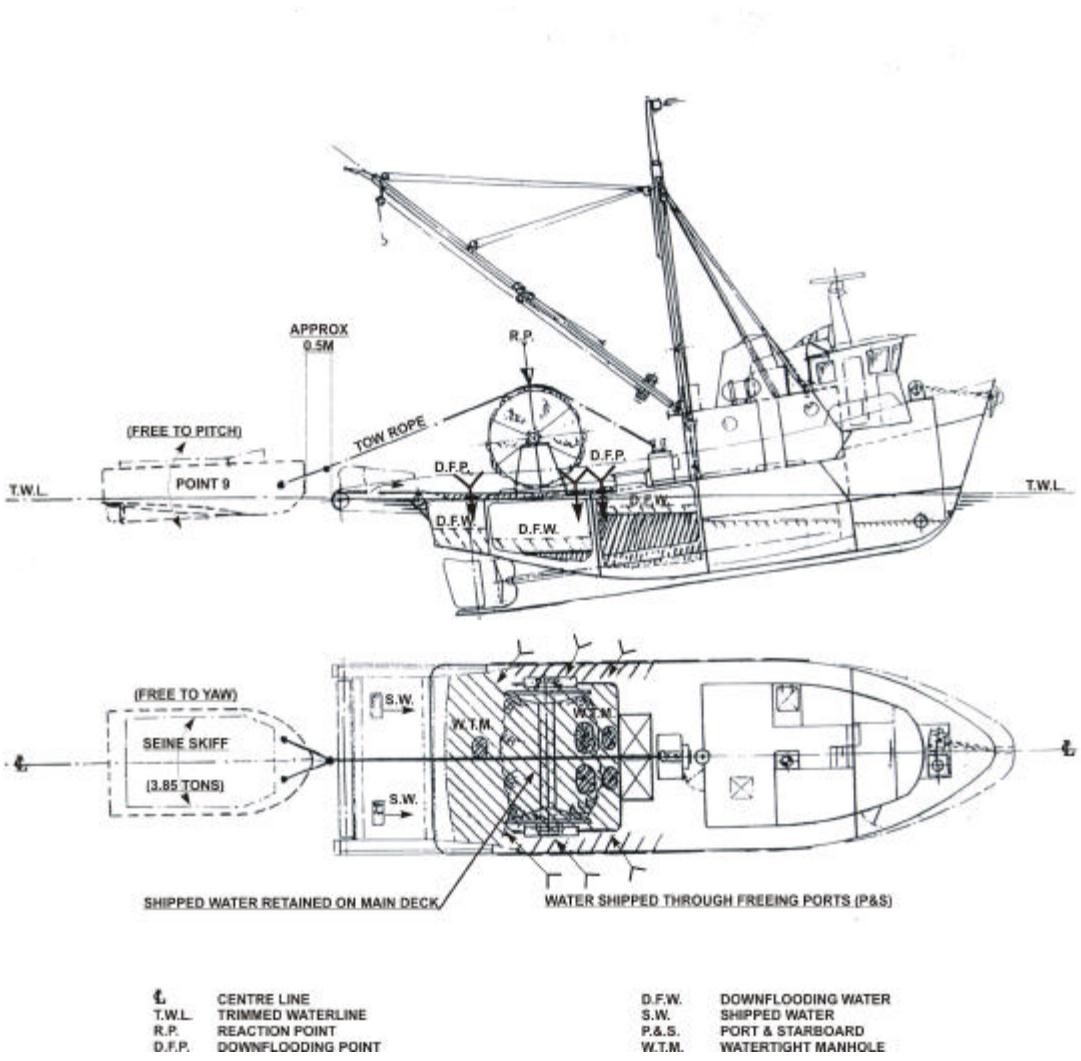


Figure 3. Downflooding prior to capsize

1.11.6 Heeling & Capsize Sequence

Reportedly, the vessel routinely maintained a small angle of heel to starboard and was regarded as a "wet" ship, which regularly shipped water on deck when loaded. This inherent heeled condition is consistent with the recorded imbalance of the diesel in the engine room tanks, the asymmetric volume of the freshwater tank following the installation of the bow thruster, and the location of the solid trimming ballast in the captain's cabin on the starboard side of the vessel. Because of this initial heel, slightly more seawater was shipped and retained on the starboard side of the vessel, and the diesel in the cross-connected after fuel tanks was free to gravitate to starboard. The rate of downflooding into the port and starboard after fish holds differed due to the uneven condition of the manhole cover gaskets. The uneven downflooding

rate is most likely due to water predominantly entering the starboard after hold, which increased the heel to that side, and first alerted the crew to the unusual attitude of the vessel (see Figure 3).

The calculated transverse stability characteristics show the *Cap Rouge II* was in a highly vulnerable condition in the confused sea conditions. With the winds and waves acting primarily on the port side, the dynamic ship motions and free surface effects of the shipped water and below deck liquids caused large fluctuations in transverse stability. In these circumstances, the sudden influence of a single, or combination of relatively small, additional heeling forces would cause the loss of the remaining transverse stability and lead to capsize.

The reported sudden development of the large heel to starboard is a typical reaction to the loss of transverse stability, due to large free surface effects. In this instance, recovery was initially retarded and then prevented by the sudden gravitation of the liquid contents of all under-deck compartments and an unsecured engine room outfit to the lower side of the vessel. Because the centreline bulkhead between the forward pair of fish holds did not extend to the top of their common hatchway, the contents of the partially filled port side fish hold were free to flow to starboard. This large weight transfer prevented the vessel's recovery. The gravitation of diesel from the port to starboard after fuel tanks, by way of their cross-connection piping, also contributed to preventing any recovery.

In the confused seas immediately prior to the capsize, when heavily trimmed by the stern and with a large heel to starboard, the *Cap Rouge II* was in an extremely vulnerable condition. At this time, a combination of relatively small additional heeling forces overcame the vessel's remaining righting ability and completed the capsize sequence. This combination included the yawing action of the downward force of the stretched tow rope of the seine skiff where it was led over the top of the seine net drum (see Figure 3), and the upward force of a wave acting on the port underside of the fixed stern ramp.

1.12 History of CCG Rescue Dive Team

The impetus for the provision of rescue dive services on the west coast dates back to 1992 in Nanaimo, when a vehicle, with passengers on board, fell from a ramp used in loading the *Queen of New Westminster* (TSB Report M92W1057). The accident prompted a provincial commission of inquiry into the resulting deaths. Among other issues, the inquiry, led by Mr. Justice Nemetz, considered the provision of rescue dive services, concluding that the issue was beyond the scope of the inquiry and recommended a provincial task force be set up within six months to consider the provision of rescue dive services. The resulting task force was unable to come to a definitive conclusion with respect to the issue of rescue diving, although it acknowledged that the probability of divers being able to rescue underwater victims was extremely low.

The issue of rescue dive services came into the public eye again in 1993, following a collision between the vessels *Bona Vista* and *Arctic Taglu* (TSB Report M93W1050) which resulted in the capsize of the *Bona Vista*. A number of people survived for several hours in an air pocket within the overturned hull but were not rescued in time. In response, CCG set up a working group in January 1994 to consider the provision of rescue dive services. The working group was unable to reach any definite conclusions and, in June 1995, a Rescue Diving Pilot Project became operational. The project was to run for a period of two years to allow the feasibility and benefits of rescue diving to be assessed.

The pilot project involved training and equipping volunteer divers at CCG Station Sea Island to operate in conjunction with the hovercraft operation. The volunteers were drawn from existing members of the hovercraft crew and duties were carried out in addition to an individual's normal duties as a hovercraft captain, first officer, or rescue specialist. It was attempted, wherever possible, to schedule crews such that the hovercraft was always staffed with two qualified divers and a qualified dive tender.

At the end of the two-year period, in 1997, a review of the pilot project was conducted.[7] The project had not provided sufficient data to allow a definite conclusion to be reached. It recommended the pilot project be extended for an additional two years to allow a full evaluation of the benefits.

During this two-year extension, on 15 September 1998, the *Canadian Occupational Health and Safety Regulations* (COHS) - *Canada Labour Code* (CLC), Part II took effect. The Code, applicable to CCG dive operations, states that:

> 18.48 Where there is a likelihood that a diver may be entrapped, the employer shall ensure that
>
> (a) a two-way voice communication system between the diver and the diver's tender is provided; and
>
> (b) a second dive team, equipped to rescue a diver in the event of an emergency, is present at the dive site.

Although the CCG rescue dive team was already equipped with a two-way voice communication system, the requirement for a second dive team to be present at the site raised questions for the team, whose work involved entering overturned vessels, aircraft, and vehicles. Following the implementation of these regulations, a conference call took place between the Officer-in-Charge (OIC) of the dive team, the Regional Dive Officer and the National Dive Officer, where they agreed that having a second team en route to the dive site prior to commencing a dive where a danger of entrapment would exist would be acceptable.

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[7] Two year report on rescue diving, prepared by Brian Stevens in August 1997.

Subsequently, the four-year review of the pilot program was prepared by the OIC of the CCG dive team in 2000.[8] It concluded that the team should become permanent and be granted an appropriate level of support for a permanent SAR program. Later that same year, the Commissioner of the CCG asked the Regional Director of the Pacific Region to look into the issue of whether CCG should be in the business of rescue diving.

In response to this request, a third review of the rescue diving project was initiated. This report[9] identified a number of problems in the operation of the dive team and concluded that there were two possible scenarios for rectifying the deficiencies: the dive program should either be cancelled or sufficient resources should be devoted to allow it to be conducted safely.

As a follow-up to this report, the dive project was suspended on 29 November 2000 pending further review. This review[10] was conducted by a designated CCG officer and an external consultant. The report, submitted on 25 January 2001, found that there were deficiencies in the operation of the dive team which could be rectified. Most deficiencies concerned documentation surrounding the training of dive personnel and the provisions in place for the availability of a second dive team to comply with the CLC requirements for penetration dives. On Friday, 16 February 2001, the Regional Director of Pacific Region met with members of the dive team at the Sea Island Hovercraft Base to announce that the dive project had been terminated. Diving equipment was immediately removed from the hovercraft.

Later that weekend, in the early morning hours of Sunday, February 18, a car accident occurred in which a vehicle entered the water in close proximity to the Sea Island base. The hovercraft reached the scene quickly and it was anticipated by other emergency response personnel on scene that the Coast Guard would conduct a rescue dive, as they were unaware the dive project had been cancelled 36 hours previously.

The driver of the car did not survive the accident and the Minister of Fisheries and Oceans received significant public attention surrounding the cancellation of the rescue diving project. This attention prompted a review of the decision-making process respecting the project.[11] The review concluded that the decision to suspend and ultimately cancel the dive project: "was correct, even if made within a rather faulty framework." The report further concluded that: "the

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8 Four year review of rescue dive project, prepared by Brian Wooton in October 1998.

9 Additional review of rescue dive project, prepared by J. Nemrava in October 2000.

10 Audit of rescue diving pilot project, prepared by D. Edey and A.D. Skaalrud in January 2001.

11 *Review of the Decision of the Department of Fisheries and Oceans to Terminate the Canadian Coast Guard Rescue Diving Pilot Project*. Prepared for the Minister of Fisheries and Oceans by Peter G. Bernard, Q.C., 17 June 2001.

attitude of senior CCG management towards rescue diving will probably not be changed unless the Minister directs them to establish a policy, create a national program and generally support the rescue diving concept both philosophically and financially."

Following this review, the project was reinstated as an 'Open Water Rescue Dive Team' and the Sea Island base set about training rescue divers. By September 2001, the base was dive capable on approximately 60 per cent of shifts and, by January 2002, this had increased to being dive capable on a continuous basis. During this period, a series of documents defined the 'open water' limitation of the dive team. The *CCG SAR Station Sea Island Diving Manual*, dated 20 August 2001, restricted the team to open water dives but provided for the continued training of divers to enter capsized vessels:

> 1.2 CCG Rescue diving will comply with FSM 7D.16 and the COHS Regulations part XVIII.
>
> Under the restrictions for public safety open water diving PSM (*sic*)[12], penetration into capsized, submerged or partially submerged vessels, aircraft or vehicles is not permitted. It is, however understood that due to the unstable conditions associated with rescue diving, divers should be made aware and prepare for all contingencies they may encounter.

The Pacific Region version of the *CCG Fleet Safety Manual* (FSM), dated 15 July 2002, further clarified the issue of divers conducting penetration dives:

> 3.3. A Public Safety Open Water dive shall be: [...]
> 3.3.6. Limited to dives that avoid entrapment or entanglement situations and allow direct access to the surface. **Penetration** into capsized vessels, aircraft, or submerged vehicles and diving in the vicinity of underwater pressure differentials is **strictly prohibited** (emphasis in original).

In keeping with these directives, CCG divers were prohibited from entering the overturned hull of the *Cap Rouge II* on 13 August 2002.

Following this occurrence, the Minister's office made a statement which indicated the divers could conduct penetration dives, in that provisions in the *Canada Shipping Act* delegate the power of the Minister to the SAR co-ordinator at the Rescue Coordination Centre. As such, a decision to conduct a penetration dive could be made by the SAR co-ordinator in conjunction with the CCG vessel captain, possibly without a backup dive team in place. It was further stated that this provision was in effect at the time of the capsize of the *Cap Rouge II*.

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[12] PSM is a typographical error and the intended acronym is FSM.

Modifications to the FSM, effective 08 November 2002, outlined the conditions: "where the craft captain can request a direction from the SAR Mission Co-ordinator (JRCC/MRSC) to attempt to enter the vessel, aircraft, or vehicle" including: the dive being necessary to save a life, the concurrent dispatch of a backup dive team and the use of surface-supplied breathing apparatus once this equipment was available (in the interim, penetration dives using SCUBA would be permitted).

On 06 February 2003, the Minister of Fisheries and Oceans announced an expansion of CCG rescue dive capabilities at the Sea Island base. Included in this announcement were provisions to expand the team to allow a dive team with full backup to be available 24 hours a day. In addition, it was indicated that the dive team would be equipped to allow the use of surface-supplied air.

1.13 Responsibilities of On-scene Co-ordinator and Dive Operations

The mission of the CCG SAR program is to save and protect lives in the maritime environment. One of the CCG's objectives is to "maintain the highest professional standards". CCG management's goal is to ensure that the SAR program operates at maximum efficiency by adjusting SAR coverage requirements as needs change, and by deploying specialized primary SAR units as required. Additionally, other resources (private and government) may be tasked to provide assistance during a SAR operation. Those resources may include vessels, helicopters, and aircraft, which may happen to be nearby or capable of providing specialized services. It is not uncommon for a number of resources to be involved simultaneously in a SAR operation. The *JRCC Victoria SAR Operations Report* for this accident[13] listed 17 resources which were tasked to respond. Consequently, there is a need for co-ordination of on-scene SAR activities.

In Canada, a JRCC is established within each of Canada's search and rescue regions for the purpose of co-ordinating, controlling, and conducting air and maritime search and rescue operations.[14] In respect of maritime operations, JRCC staff responsibilities include planning and directing the response, tasking and co-ordinating resources, and appointing an OSC when appropriate.

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13 *SAR Operations Report, SAR "Cap Rouge II" - P2002-1803*, Victoria Joint Rescue Co-ordination Centre, page 8.

14 *National SAR Manual*, B-GA-209-001/FP-001, DFO 5449, Chapter 3, May 1998.

An OSC is normally appointed to co-ordinate SAR operations where several resources have been tasked to respond. An OSC is responsible for the following tasks, to the extent they have not been performed by the responsible JRCC or Maritime Rescue Subcentre (MRSC) as listed in the *SAR Seamanship Reference Manual*:[15]

- carry out the plan for the conduct of operations as requested by the responsible [J]RCC/MRSC;
- modify the plan as facilities and on-scene conditions dictate and inform the [J]RCC/MRSC of any such modifications;
- monitor weather and sea conditions and report on these at regular intervals to the [J]RCC/MRSC;
- maintain communications with the [J]RCC/MRSC and the SAR units on scene;
- maintain a detailed record of the operation, including on-scene arrival and departure times of SAR units, areas searched, track spacing used, sightings and leads reported, actions taken and results obtained;
- issue regular situation reports to the [J]RCC/MRSC, which should include, but not be limited to, weather and sea conditions, the results of search to date, any actions taken, and any future plans or recommendations; and
- advise [J]RCC/MRSC to release units when their assistance is no longer required.

CCG Pacific Region SAR services also include rescue dive services, which are provided by the Sea Island Hovercraft Unit located in Georgia Strait. The officers and crew of *CCGH 045* were designated to provide rescue dive services and, in this accident, were engaged in rescue dive operations. Typically, the safety of any non-recreational dive operation requires that the following duties be undertaken in support of a primary diver engaged in underwater operations:

- the operator of the dive platform (i.e., the vessel) remains devoted exclusively to the control of the vessel during live boating;[16]
- a dive supervisor is devoted exclusively to the dive operation;
- a standby diver stands ready.

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15 *DFO/CCG SAR Seamanship Reference Manual*, November 2000, 1st Edition, pages 1-10.

16 "Live boating" means the support of a diving operation from a vessel that is not at anchor, made fast to the shore or a fixed structure, or aground. (*Canada Labour Code*, Part II, Part XVIII, section 18.1)

CCG standard operating procedures for rescue dive operations also require that the rescue unit go through pre-arrival, on-scene and diver preparation procedures prior to diving. There are also procedures to be followed during a dive. *CCGH 045,* with a crew of five, was on scene within 20 minutes of the distress call. Standard operating procedures called for two officers and two rescue dive specialists to crew the hovercraft, but, on this occasion, an additional officer was on board.

2.0 Analysis

2.1 Stability

As a small fishing vessel of closed construction built before July 1977 and not engaged in catching herring or capelin, the *Cap Rouge II* was not required to comply with the stability-related requirements of the *Small Fishing Vessel Inspection Regulations* and meet the minimum intact stability criteria of STAB 4 of the *Stability, Subdivision and Load Line Standards* (TP 7301). However, irrespective of the particular mode of fishing in which a small fishing vessel is engaged, these criteria are generally regarded as the most appropriate "yardstick" against which their transverse intact stability characteristics may be assessed.

When considering the stability of a small fishing vessel, the STAB 4 minimum criteria ensures that these small vessels attain adequate margins of intact transverse stability throughout a range of loading conditions related to the vessel's intended service. The criteria do not ensure immunity against capsize, regardless of the circumstances, and are dependent on the watertight integrity of the hull, weather deck hatches, and other deck openings.

Since its construction in 1974, the stability characteristics of the *Cap Rouge II* have been subject to change due to the installation of various combinations of equipment to suit different fishing modes. From 1987, when it was employed as a herring packer with the seine net and drum removed, until the time of the capsize, her stability characteristics were steadily reduced as more, heavier gear and seine nets were installed. The effects of these increases in weight were not monitored or assessed by a suitably qualified person, nor brought to the attention of Transport Canada (TC) inspectors between or during routine quadrennial inspections.

Section 24.71(2) of the Workers' Compensation Board of British Columbia (WCB) *Occupational Health and Safety Regulation* (OHS) calls on owners to ensure that major modifications to their fishing vessels do not adversely affect stability, but gives no direction with regard to acceptable minimum stability criteria.

In this instance, a larger seine net was being employed, the weight of which was not verified until after the capsize, when it was found to be some 7.4 tonnes. This weight was somewhat heavier than the seine net usually carried, which weighed approximately 4.5 tonnes. The nets were routinely stowed on the power drum, located 1.75 m (5.67 ft) above the main deck, where their weight effectively raised the position of the vessel's centre of gravity.

After the capsize, the quantity of diesel recovered from the vessel was recorded and showed that the tanks in the engine room and lazarette were all partially full. The skipper was under the impression that the engine room tanks were full. Subsequent stability analysis shows that, had

both engine room tanks been full, there would have been a slight improvement in stability, but insufficient to counter the detrimental effects caused by the remaining free surface effects and other weights in the vessel.

At the beginning of the return voyage, the forward fish holds were reportedly about ⅔ to ¾ full and the after holds approximately ⅛ full. The freshwater tank was also in use and about ½ full. Consequently, at the time of the capsize, the relatively lightly loaded vessel was subject to detrimental effects due to free surfaces in five storage tanks, four hold compartments and the lazarette, in addition to water shipped and retained on deck.

In general, few fishers fully understand free surface effect, and fewer appreciate the substantial reduction of initial transverse stability that results when water, even a few centimetres (inches) deep, is shipped and retained on deck. When this occurs on a vessel with inherently low stability characteristics and is coupled with a significant loss of waterplane area when the deck edge becomes immersed, the sudden reduction in transverse stability can be catastrophic.

Upon recovery, the vessel's rudder was found to be positioned approximately 20° to starboard. However, all available information indicates that there was no alteration of course to starboard immediately prior to the capsize. The 20° rudder angle is consistent with an autopilot reaction to a deviation from a preset course brought about by any uneven forces acting on the vessel. The hydrodynamic rudder forces generated by such a rudder reaction, applied below the vertical centre of gravity of the heeled hull, would create a slight heeling moment to starboard in addition to the upsetting effects already acting on the vessel.

In addition to one such voyage in 2001, this was the second voyage made in 2002 with the heavier seine net on board. No untoward concerns were raised during the earlier voyages, however the seine skiff was not towed extensively on these occasions. Fully-loaded voyages with some 30 000 kg (66 000 lbs) of fish onboard and the original lighter weight seine net stowed on the drum were also successfully completed. However, further analysis of this fully-loaded condition shows that, while somewhat less than the minimum criteria of STAB 4, the fully-loaded, intact stability characteristics were significantly greater than when lightly loaded, as at the time of the capsize.

The unexpected and rapid heel to starboard and the inability to recover are typical of behaviour associated with the presence of extensive free surface effects acting in conjunction with inherently low transverse stability. The dynamic impact of any minor heeling moment in the prevailing confused sea conditions would, in the later stages of such heeling action, be sufficient to overcome any residual righting ability retained by the vessel.

Such a scenario is consistent with the sequence of events reported by the survivors on board the *Cap Rouge II*.

2.2 *Ship Inspection and Safety*

The *Cap Rouge II* had undergone modifications since 1987 which adversely affected her stability. Although three quadrennial inspections were carried out following the 1987 modifications, TC reportedly became aware of these modifications only after this occurrence. These inspections are intended to ensure that vessels proceeding to sea are in a seaworthy condition. Therefore, good inspection practice ought to consider all aspects of seaworthiness when visiting a vessel for inspection.

Following the disappearance and presumed sinking of the small fishing vessel *Le Bout de Ligne* in 1990, the Transportation Safety Board of Canada (TSB) issued two recommendations. The Board recommended that TC emphasize, through a safety awareness program for owners, operators, and officers of fishing vessels, the adverse effects of structural modifications and additional items on vessel stability (TSB Recommendation M94-31, issued December 1994). As well, the Board recommended that a means be created to ensure that structural modifications and the addition of weight items are recorded and accounted for in reassessing the stability of small fishing vessels (TSB Recommendation M94-32, issued in December 1994).

In response to TSB Recommendation M94-31, TC issued a Ship Safety Bulletin (16/96) to remind operators of fishing vessels to have their vessels inspected following modifications. However, it did not have wide circulation. Also, the *Small Fishing Vessel Safety Manual* (TP 10038) was re-issued in 1993 and again in March 2003. The manual, which contains information about the many things that can affect the stability of a vessel and cause it to capsize, was distributed to Prairie and Northern Region and in Ontario using the provincial licensing database. For other regions, TC is awaiting a distribution list from the Department of Fisheries and Oceans (DFO) fishing license database. The manual, presented in simplified format, is also available free of charge at TC offices and on the TC website (www.tc.gc.ca).

In response to TSB Recommendation M94-32, TC agreed with the recommendation but reiterated that the onus is upon the owners to report any alteration of the hull, machinery, or equipment affecting compliance with regulations.

While TC noted that it is the responsibility of the owner or master of the vessel to notify them of any alteration, there is a requirement which states: "any alterations made to the vessel since the previous inspection shall be reported in detail by the inspector to the Chairman".[17] Although this requirement is found in paragraph 38 (4)(h) of the *Large Fishing Vessel Inspection Regulations*, it does not apply to small fishing vessels such as the *Cap Rouge II*. The principle, in the interest of safety, should equally apply to all vessels inspected by TC. Consequently, it should be incumbent upon the inspector to be vigilant and to inquire of the master or owner if any alteration has been carried out between inspections.

[17] Chairman of the Board of Steamship Inspection.

The requirements for reporting alterations are being formally addressed by TC in the proposed *Fishing Vessel Safety Regulations*. In the meantime, inspectors are being instructed to seek this information when carrying out inspections.

2.3 *Operational Practices and Awareness of Risks*

The TSB has observed that many crews on fishing vessels do not fully appreciate that some of their day-to-day operating procedures may create unsafe conditions. A number of practices were observed that carried risks which were either not fully recognized or were accepted by the skipper. For example, the skipper considered the *Cap Rouge II* to be a 'wet boat', indicating that it was not unusual to see water on deck or to have to pump out the lazarette. Water accumulating on the main deck and also downflooding contributes to a free surface effect and thus adversely affects the stability of the vessel. Operation of the vessel with the holds partially filled indicates that, like most commercial fishers, the skipper did not fully understand the risks associated with free surface effect.

A vessel's capability to remain safely upright requires its operator to have a sound understanding of the principles of ship stability and to apply them in a manner which takes into account the constantly changing circumstances both on board a vessel and in the surrounding environment. For example, it is necessary to monitor changes in the quantity and location of liquids held in fish hold tanks, fuel tanks, freshwater tanks and oil tanks. It is also necessary to decide on the safest manner of stowing fish product and fishing gear, including nets, to assess the configuration of standing rigging, such as a boom, and to determine the safest manner of transporting a skiff. Knowledge of existing external factors such as sea state, wind characteristics, and under-keel salinity is also extremely important.

TC has recognized the importance for fishing vessels operators to understand the theory and practice of ship stability. Applicants seeking certification for either Class 1, 2, or 3 Fishing Master are examined in this knowledge. However, this requirement is not extended to Class 4 Fishing Master certification, even though knowledge of stability is of equal importance to these operators.[18]

TC requires a Class 4 Fishing Master applicant to pass an oral examination on matters of general seamanship, which includes ship stability. The examiner is required to assess the candidate's "ability to use and interpret stability and trim data supplied to fishing vessels" and to assess other aspects of stability "in general terms and excluding calculations" or by demonstrating a "practical appreciation". Currently, many small fishing vessels are not provided with specific

[18] TC indicates that 5403 Fishing Master Class 4 certificates have been issued between 1975 and 2003. To be eligible for Fishing Master Class 4 certification, an applicant is required to have accumulated 12 months of documented sea service on board fishing vessels equal to or greater than five GRT on voyages beyond "partially smooth waters".

stability information and, if it is provided, it is not presented in a manner that is readily understood by fishers. As only basic knowledge is required, an awareness of what constitutes a dangerous situation is left to personal interpretation based upon the operator's own experience and the experience of others. Considering the number of accidents and incidents involving small fishing vessels, the required knowledge of vessel stability should not be relaxed for this level of certification.

In this accident, the hinged door in the after end of the deckhouse was secured in the open position. The opening permitted the ingress of water into the deckhouse when the vessel heeled sufficiently to starboard. Consequently, significant reserve intact buoyancy, contributing to the vessel's righting ability, was lost (see section 2.1 *Stability*). Closure of weathertight openings, such as deckhouse and accommodation doors, when operating at sea is important to prevent water from entering the vessel and for the safety of all persons on board. The TSB has conducted several investigations into marine accidents involving small fishing vessels in which the failure to maintain weathertight integrity has been identified as a causal factor.[19]

Following the sinking of the small fishing vessel *Pacific Bandit* in 1995, the Board issued a recommendation to TC, in conjunction with other agencies, to undertake a safety promotion program to increase awareness among operators and crews of small fishing vessels of the effect of unsafe operating practices on vessel stability (TSB Recommendation M96-13, issued December 1996). Although the Minister agreed with the recommendation, actions taken since 1996 have been limited to the formation of working groups to study the issue and to issuing a Ship Safety Bulletin (12/2000) to warn operators of how changes in operational loading conditions may adversely affect vessel stability. In May 2001, a standing committee on fishing vessels was formed to review safety issues pertaining to the small fishing vessel industry.

The intent of TSB Recommendation M96-13 was to encourage an immediate safety awareness campaign among those who are in the best position to correct unsafe operational practices. The actions taken have focussed on the review of proposed regulations for dealing with small fishing vessel safety. The effectiveness of ship safety bulletins in raising awareness within the small fishing vessel industry is compromised by their limited distribution. A review of the Ship Safety Bulletin mailing list in 2001 revealed that there were no west coast fishing associations listed. However, in March 2003, TC responded to this safety concern from another occurrence[20], stating that in partnership with DFO, TC, and stakeholders, discussions were underway with respect to the possibility of distributing safety-related material, such as Ship Safety Bulletins, using the DFO database of fishing vessel licence holders. Additional information provided by TC states that registered owners will be added to the Ship Safety Bulletin mailing list. It is noted

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19 *Lady Devine* (TSB Report M94W0026), *Pacific Bandit* (TSB Report M95W0005), *Pacific Charmer* (TSB Report M97W0236).

20 Swamping of the *Alain-Josée* (TSB Report M01M0100).

that TC, the Canadian Marine Advisory Council Standing Committee on Fishing Vessel Safety and its various working groups have undertaken important work toward the development of the new *Fishing Vessel Safety Regulations,* the intent of which is to address many of the recurring safety deficiencies.

The WCB also inspects fishing vessels in accordance with provincial workplace standards for health and safety and consults with vessel owners, operators, and crews to promote health and safety. The WCB recognizes that commercial fishing is one of the most dangerous occupations in British Columbia and has produced, in co-operation with the Joint Fishing Industry Safety and Health Committee, a manual to address common safety and health hazards in the industry. *Gearing Up For Safety—Safe Work Practices for Commercial Fishing in British Columbia* is meant to complement TC's *Small Fishing Vessel Safety Manual*. The WCB has produced other publications as well as safety-related videos.

The WCB also issues hazard alerts to provide important safety messages to workers. One hazard alert, for example, about fish harvesting, was issued in 2002. The alert illustrated the types of fatal accidents which occurred on fish harvesting vessels from 1991 to 2001. It also summarized the correct safety procedures for owners, masters, and crew members of fishing vessels to follow. Although safety-related information is distributed by the WCB directly to fishing associations, processors, and other industry interests, such as insurance companies, unions, and native groups, few are sent directly to fishers. Safety information is available on the WCB's web site (www.worksafebc.com) but it is doubtful that this type of venue is being used by the majority of fishers as a source for safety-related information.

Accidents involving fishing vessels continue to account for approximately half of all shipping accidents in Canadian waters. TSB statistics show that in 1993, 368 Canadian fishing vessels were involved in shipping accidents, while 231 such accidents occurred in 2002. It should be noted that the number of fishing vessels has markedly declined over the years, however, the number involved in accidents remains proportionally the same. Despite current efforts to affect change, unsafe operating practices continue, placing vessels and crews at risk.

2.4 Adequacy of Arrangements for Escape from Small Fishing Vessels

In emergency situations, crews may be required to use alternate escape routes and means of escape to exit wheelhouses and deckhouses. Consequently, alternative escape routes and means of escape should not only be located in a manner which prevents one incident blocking all escapes, but also be adequate in their design to facilitate ease of escape.

There were three means of egress from the combined wheelhouse and deckhouse of the *Cap Rouge II.* A hinged door on the starboard side of the wheelhouse provided egress to one side of the forecastle deck. A combined hinged top hatch and door at the after end of the wheelhouse on the vessel's centreline led to the deckhouse top (see Figure 1). A hinged door in the after end

of the deckhouse to starboard of the vessel centreline provided egress to the open after deck. There was no means for escape from the port side of the superstructure and none of the port side wheelhouse windows was fitted for use as an emergency exit.

Given that the *Cap Rouge II* heeled to starboard as it capsized, the escape would have been increasingly difficult to access as water entered the vessel. With a means of egress on the port side, those inside the vessel would have had an alternative means of escape.

The benefit of having at least two clearly separated means of escape from crew spaces has been recognized by TC.[21] However, when the vessel was built, regulations did not require a second means of escape. Furthermore, small fishing vessels constructed after 1988 are not required to have a second means of escape "where, in the opinion of an inspector, a second means of escape is not practicable due to size limitations or spatial layout of the crew space or area in which the crew may be normally employed".[22] The TSB is not aware of any established procedures or guidelines to assist inspectors in determining whether the fitting of a second means of escape is not practicable nor are there guidelines to help inspectors to determine the most appropriate second means of escape.

Although the TSB database shows that there have been few occurrences in which the limitations of the means of escape were found to be contributing or causal factors, it is difficult to estimate the extent to which a lack of means of escape has impacted survivability of crews of small fishing vessel occurrences. The TC Vessel Registration Query System shows approximately 5500 small fishing vessels currently registered in Canada, of which approximately 4100 were constructed prior to May 1988. Given the high percentage of vessels constructed prior to 1988, which may be operating without a second means of escape, and that 96 of the 100 small fishing vessels reported to have capsized since 1975 were constructed prior to 1988, crews may be unnecessarily put at risk should their vessels capsize or sink.

2.5 Abandonment Drills and Procedures

The situation involving the *Cap Rouge II* demonstrates that crews of small fishing vessels may have little time to assess the severity of an emergency situation and formulate a plan of action. Where a vessel is listing heavily and may be in danger of capsizing, the amount of time available for an orderly abandonment is limited.

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21 Sections 27 (4.1) and (4.2), *Small Fishing Vessel Inspection Regulations*, SOR/89-96.

22 Ibid, Section 27 (4.3).

Emergency situations are inherently stressful. Individuals may selectively focus on information and not accurately assess the probability of adverse events. This could lead to an over-estimation of a positive outcome. Such a bias has the potential to delay a decision to abandon the vessel until it is too late.

Training and practice serve to reduce this potential for error by providing crews with an opportunity to practice their response to emergency situations prior to an actual emergency. In this way, when faced with emergencies, crew response will be more automatic and require less interpretation and decision-making.[23] To have this effect, any training received must be regularly reinforced by using a combination of recurrent training and ongoing practice.

As of 31 July 2002, every member of the complement of a Canadian fishing vessel is required to successfully complete training in marine emergency duties (MED) with respect to basic safety before the member has completed six months on board vessels. This three-day course provides a basic understanding of the hazards which may be encountered at sea and the knowledge necessary to deal with emergencies, including what appropriate assistance should be provided in abandonment situations. The course also covers the purpose and importance of regular drills and training. In this occurrence, one of the two survivors had received this training.

The absence of emergency drills can effectively negate the benefits of emergency training to the detriment of safety. There is currently no requirement for crews of fishing vessels of 150 gross registered tons (GRT) or less to carry out fire and boat drills. In November 1999, TC issued a Ship Safety Bulletin (13/1999) highlighting the importance of regular practice of emergency procedures and encouraging all vessels to do so. Furthermore, TC is considering extending the application of these requirements to fishing vessels below 150 GRT.

Section 24.74(2) of the BC OHS regulation for licenced fishing vessels states "the master must ensure that drills are conducted at the start of each fishing season, when there is a change of crew, and at periodic intervals to ensure that crew members are familiar with emergency procedures". As federal requirements for emergency drills do not extend to vessels such as the *Cap Rouge II*, the provincial requirement is aimed at addressing this shortfall. However, there is no information confirming emergency drills were regularly carried out on board the *Cap Rouge II*.

The capsizing sequence of the *Cap Rouge II* underscores the importance of emergency abandonment drills and procedures. Unless the decision to prepare for abandoning the vessel is made before the problem has become critical, the crew may not have sufficient time to leave the vessel. Emergency training and the reinforcement of such training are critical to making timely decisions with respect to abandoning a vessel.

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[23] Patrick, J. Training: Research and Practice. (San Diego: Academic Press, 1992) 374.

2.6 *Workload Associated with On-scene Co-ordinator and Rescue Dive Operations*

In this occurrence, the crew of Canadian Coast Guard (CCG) hovercraft *CCGH 045* carried out the responsibilities of the on-scene co-ordinator (OSC) while also conducting dive operations. No concern was expressed by the Joint Rescue Co-ordination Centre (JRCC) or the OSC during the rescue operation about the dual role and associated workload that the crew of *CCGH 045* performed. According to the *CCG Rescue Diving Manual,* a vessel conducting a dive operation is not to be involved in coordinator duties until the last diver is out of the water.

Rescue dive operations are demanding, since they involve seeking and processing information and closely monitoring a continuously developing high-risk situation. Taking on the additional workload required of an OSC in certain circumstances, it may be beyond an individual's ability to handle. This could compromise the safety of both rescue dive operations and search and rescue (SAR) activities.

Even with the extra officer on board, the crew on the hovercraft was fully engaged and performing tasks which demanded full attention. In addition to conducting rescue dive operations and ensuring that the hovercraft remained on station, the OSC and crew were engaged in other activities—sometimes simultaneously. In fact, the JRCC's *SAR Operations Report* for this accident concluded that " . . . the crew was involved in dive operations meant that the [On-scene co-ordinator] became over-tasked".[24] Consequently, on board small CCG vessels, the workload associated with being OSC while also engaged in rescue dive operations may jeopardize the safety and effectiveness of rescue operations.

2.7 *CCG Dive Policy*

The CCG open waters dive team was on a scene at the *Cap Rouge II* 17 minutes after receipt of the distress call. A second dive team from Canadian Forces (CF) 442 Squadron, capable of performing penetration dives, was also tasked to respond to the capsizing. Between CCG resources arriving on the scene and the arrival of the CF 442 Squadron divers, the CCG dive team did everything possible within the scope of their procedures to reach the victims of the capsizing, including an external search of the vessel and the recovery of one victim from the wheelhouse with the aid of a boat hook. During these activities, it is reported that both divers became entangled on separate occasions but were able to free each other.

[24] *SAR Operations Report, SAR "Cap Rouge II" - P2002-1803*, Victoria Joint Rescue Co-ordination Centre, page 13.

The provision of rescue diving on the west coast has been the subject of numerous reviews. Few definite conclusions with respect to the need for rescue diving or the provisions of rescue dive services have ever been reached. This created a situation in which a rescue dive team was set up, largely due to the initiative of the personnel at the Sea Island base. The situation was described by Mr. Bernard in his review of the decisions surrounding rescue diving:

> With respect to the Rescue Diving Pilot Project, departmental policy and procedure concerning rescue diving was not created. The pilot project did not have official recognition from the National Directorate of Marine Programs and, to a great degree, it operated on an *ad hoc* basis from Sea Island largely due to the strong desire and dedication of those directly involved. The Rescue Diving Pilot Project was essentially a Coast Guard pilot project in name only.[25]

A rescue dive operation, by its very nature, faces unique challenges and hazards. There is, therefore, a requirement to have a well-trained and highly professional team, capable of calculating and mitigating risk in a continuously changing risk environment, so that the level of safety is not diminished.

In preparing for rescue diving, the CCG Sea Island team worked to achieve these capabilities and developed extensive expertise in the conduct of rescue diving, to the extent that the training practices developed were adopted by other rescue dive operations, including the CF 442 Squadron SAR technicians. However, there were ongoing concerns regarding the training documentation for divers and the requirements of the *Canada Labour Code* (CLC).

The Code requires a backup dive team where there is a possibility that a diver may become "entrapped". In order to comply, CCG issued a blanket prohibition preventing divers from penetrating overturned vessels, aircraft, or vehicles. This policy was put in place with the intention of containing some of the risks. Under these provisions, the dive team was reinstated following the accident of 18 February 2001.

This did not, however, remove potential hazards associated with diving around capsized vessels where there is a very real risk of entanglement from loose lines, netting, and other floating debris. It created a situation under which divers could:

- encounter a demand for dive operations, such as a penetration dive, that could not be carried out safely; and

[25] *Review of the Decision of the Department of Fisheries and Oceans to Terminate the Canadian Coast Guard Rescue Diving Pilot Project*. Prepared for the Minister of Fisheries and Oceans by Peter G. Bernard, Q.C., 17 June 2001.

- make an inaccurate determination of the potential of entrapment which could place them at risk without a backup team in place.

Given the expectation of the public and the marine community to conduct dives without restriction, significant external pressures can be put upon rescue divers to conduct dives where greater risk may be accepted.

Following the occurrence, statements were made which indicated that penetration dives could take place under certain conditions without backup. This created ambiguity and uncertainty within CCG as to what could or should have happened on the day of the occurrence and whether or not the CLC provisions could be suspended in the future.

CCG policy was later modified to permit penetration dives without backup where it was considered necessary to save a life and the decision would be made by the appropriate SAR authorities. This created a situation where divers could be placed at risk.

The issues were resolved when, on 06 February 2003, the Minister for the Department of Fisheries and Oceans made an announcement that clarified this situation in that the dive project is being expanded (see Section 4.1.1).

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. Inherent transverse stability was progressively reduced by structural additions and the installation of more and heavier fishing gear, including the adoption of a "West Coast" seine net of 7.4 tonnes, all of which were located at or above the main deck level.

2. The installation of additional gear and its effects on stability were not monitored or assessed by a suitably qualified person, nor brought to the attention of Transport Canada (TC) inspectors, between or during routine quadrennial inspections.

3. The watertight integrity of the main deck was compromised by the ineffective gaskets of five flush-fitting manhole covers, which resulted in extensive downflooding, a marked increase in after trim, and reduced transverse stability.

4. Because of their limited knowledge of basic principles of trim and stability, the additional weight of the seine net, the inherent heel to starboard, the routine presence of water on deck, and the towing resistance of the seine skiff were not considered by those on board the *Cap Rouge II* to present any undue risk to vessel operation.

5. The vessel lost transverse stability due principally to the cumulative free surface effects of water shipped and retained on the main deck and other liquids in four partially full fish holds, four fuel tanks, a freshwater tank, and the lazarette. While in this extremely vulnerable condition, a combination of relatively small additional external heeling forces overcame the remaining righting ability and completed the capsize sequence.

6. The rapidity of the capsizing precluded orderly abandonment of the vessel.

3.2 Findings as to Risks

1. Current small fishing vessel inspections require only those small vessels over 15 gross tons engaged in fishing for herring or capelin to submit trim and stability data for approval. Other small fishing vessels, such as *Cap Rouge II* principally employed in other fisheries, are not required to submit such data for approval, nor is there any mandatory requirement for owners of these vessels to forward this information to TC for safety review or information purposes.

2. On board small Canadian Coast Guard (CCG) vessels, including hovercraft, the workload associated with being on-scene co-ordinator while also engaged in rescue dive operations may jeopardize the safety and effectiveness of rescue operations.

3. Many small fishing vessels that operate without a second means of escape, or a means of escape that may not be optimally positioned, may unnecessarily put crews at risk.

4. There are no established procedures or guidelines to assist TC inspectors in determining whether a vessel should be fitted with a second means of escape.

5. The absence of emergency practice drills negates the benefits of emergency training.

6. Many fishers are unaware of shipboard practices which adversely affect vessel stability and the profound risks those practices create.

3.3 Other Findings

1. When fully loaded and fitted with an "inside" seine net, the vessel's transverse intact stability characteristics were somewhat lower than the minimum criteria of STAB 4 of the *Stability, Subdivision and Load Line Standards* (TP 7301). When partially loaded and fitted with a "West Coast" seine net, as it was at the time it capsized, the vessel's stability characteristics were substantially lower than the minimum STAB 4 criteria.

2. Between CCG resources arriving on scene and the arrival of the Canadian Forces 442 Squadron divers, the CCG dive team did everything possible within the scope of their procedures to reach the victims of the capsizing.

4.0 Safety Action

4.1 Action Taken

4.1.1 Canadian Coast Guard Dive Policy

On 21 January 2003, the Transportation Safety Board of Canada (TSB) sent Marine Safety Advisory (MSA) 01/03 to the Commissioner of the Canadian Coast Guard (CCG), identifying areas of potential concern arising from the rescue dive operation in this occurrence. Three main issues were addressed: over-tasking of hovercraft crews who were conducting both rescue dive operations and on-scene coordinator duties; safety of rescue divers working around capsized vessels in the absence of a backup dive team; and the ability of CCG divers to provide an adequate backup to Canadian Forces (CF) search and rescue (SAR) divers, given their incompatible communication systems.

Following this MSA, on 06 February 2003, the Minister for the Department of Fisheries and Oceans announced that the capabilities of the rescue dive team at the Sea Island base would be expanded to provide a dive team with a full backup 24 hours a day. This would increase the complement on board the hovercraft and allow the rescue dive team to conduct penetration dives in keeping with the provisions of the *Canada Labour Code*. The provision of surface-supplied air would further mitigate the risks of conducting penetration dives. A specific implementation date was not identified, given the requirements to recruit and train additional rescue specialists for the role.

Following the occurrence, the issues of over-tasking and penetration dives were re-examined by the department and the CCG's Fleet Safety Manual was modified as follows:

> 3.5.2.5 When divers are to be deployed, the Craft Captain must, if previously designated, turn over all responsibilities as On Scene Coordinator to another vessel until such time as the dive operations are completed.
>
> 3.5.2.6 Dives that involve entry into capsized vessels, sunken vessels, downed aircraft, or submerged motor vehicles are dives with a high potential for entrapment or entanglement. The decision to engage in such a high risk activity lies with the craft captain, after consultation with the diving unit members on site. In such circumstances, the Craft Captain will contact the SAR Mission Co-ordinator (JRCC/MRSC) to notify them of the intentions of the diving unit to enter the vessel, aircraft, or vehicle.

These changes came into effect on 06 February 2003.

Regarding concerns over communications systems, the response indicated that it is not possible to provide equipment to allow direct communications between CCG and CF divers. Both CCG divers and CF divers from the Fleet Diving Unit in Colwood use surface-supplied air and their communications are hard-wired to the surface. The CF search and rescue technicians, who use self-contained underwater breathing apparatus, are deployed from aircraft and are equipped with underwater voice communication capability between divers. While they are submerged, they are not equipped to communicate with other personnel on the surface. However, it should be noted that all divers are trained in the use of hand signals and that the Canadian Standards Association[26] requires communication between diver and surface. Additionally, a memorandum of understanding between CCG and the Department of National Defence is being prepared which will include joint training and communications.

4.1.2 Adequacy of Arrangements for Escape On Board Small Fishing Vessels

On 18 March 2003, the TSB sent MSA 05/03 to Transport Canada (TC) to inform them of the potential deficiency associated with the lack of appropriate means of escape in crew spaces which may put the safety of persons on board small fishing vessels at risk.

In response, TC indicated that work is ongoing with regard to the development of revised construction standards that will be incorporated into the proposed new *Fishing Vessel Safety Regulations*. As part of that process, the requirements for a second means of escape from crew spaces of small fishing vessels will be reviewed. Additionally, consideration will be given to re-writing this section such that it can be more readily enforceable. To achieve this, the owner will be required to demonstrate:

a) that either the vessel complies with a stated prescriptive measure, or

b) that alternative design and arrangements are consistent with a stated safety objective.

4.1.3 Near-sister Ship Stability Approval

On 13 May 2003, the TSB forwarded a Marine Safety Information Letter (06/03) to TC to advise that there were two other small fishing vessels, *Western Leader* and *Western Mist*, that could be considered as "near-sister" ships to *Cap Rouge II*.

Stability data generated from an inclining experiment conducted 18 May 1976 had been forwarded to TC for approval and was refused. A request was made for the vessel to be re-inclined. Revised data was submitted 12 May 1977 and approval was given 26 May 1980 for

[26] (CSA) Occupational Safety Code for Diving Operators.

"salmon seining" only. While neither vessel was re-inclined, TC concluded that it was satisfied that the vessels' designers/naval architect had presented the necessary corrections to allow approval of the re-submitted stability data.

The information was forwarded by the TSB to apprise TC of the discrepancies and the possible implications to the vessels involved. It has since been learned that the *Western Leader* is no longer registered in Canada and that the *Western Mist* is operating as a pleasure craft. Consequently, concerns regarding any reduction in transverse stability due to heavy fishing gear have been allayed. However, the TSB has informed the current owners of the stability approval history of their vessels.

4.2 Action Required

4.2.1 Stability Approval for Small Fishing Vessels

There are approximately 20 000 small fishing vessels in service in Canada. Of that number, 4500 are greater than 15 gross registered tons (GRT) and less than 150 GRT and are inspected by TC on a quadrennial basis. Because of the mode of fishing in which they are engaged, some of these vessels are currently required to comply with regulatory stability requirements. The 15 500 vessels of less than 15 GRT are uninspected and are not required to meet any regulatory stability standard nor to have any basic stability data provided for the guidance of their operators.

Since 1990, TSB investigations into the capsize, foundering or sinking of 47 inspected small fishing vessels of more than 15 GRT, and 29 uninspected vessels of less than 15 GRT, have shown that these occurrences were primarily due to inadequate intact stability or stability-related unsafe working practices. The majority of the inspected vessels and all of the uninspected vessels were not required to meet any regulatory stability standard.

Only those small fishing vessels engaged in fishing for herring or capelin are required to submit stability data for approval by TC. Stability data approval, in accordance with the *Small Fishing Vessel Inspection Regulations*, is based on exceeding the minimum criteria in STAB 4 of the *Stability, Subdivision and Load Line Standards* (TP 7301).

In order for the criteria to be verified, an extensive amount of vessel design information is required, including hull hydrostatics and righting lever curves, hold and tank capacities, and centres of gravity at several levels, together with weights and locations of all fishing gear on board. Furthermore, an inclining experiment must be completed in order to determine the vessel lightship weight and centre of gravity from which a comprehensive assessment of the vessel's stability characteristics may be generated.

This design information is generally available for the more recent additions to the fishing fleet, and is readily generated for new or future vessels. Many older vessels have no design data or hull form information from which hydrostatics data may be derived. Furthermore, the adoption of new fish catch storage techniques on board existing small fishing vessels calling for holds to be filled with refrigerated or chilled sea water has, in some cases, led to a significant reduction in effective freeboard, reserve buoyancy and related transverse stability. However, the adverse effects of this development on existing and new small fishing vessels are best addressed by the regulatory stability approval process ensuring that a "worst loading condition" incorporating a maximum load condition meets the minimum stability criteria of STAB 4, and does not result in a loss of all reserve buoyancy. It is recognized that the compilation and approval of the data would enable these older vessels to demonstrate compliance with STAB 4 criteria.

In comparison, conducting a roll period test and a corresponding freeboard verification is a simple procedure and may be completed in port in approximately 15 minutes. While a roll period test only provides an estimate of the initial transverse metacentric height (GMt) related to the loading condition of the vessel at the time of the test, it does give an indication of stability relative to other vessels of similar size and type which have given satisfactory service for some years. Any significant deviation from the normal range of GMt values will give a timely indication that an unsatisfactory transverse stability condition exists.

In May 2003, TC sought to modernize stability requirements with a project based, in part, on input from the Standing Committee on Fishing Vessel Safety of the Canadian Marine Advisory Council (CMAC). Because of the ongoing loss of lives and vessels, the necessity for developing and introducing appropriate stability requirements for all small fishing vessels has been recognized. A comprehensive program has been set in motion to evaluate and assess the impact of new proposed safety standards developed from the results of stability experiments and tests conducted on a representative sampling involving some 30 vessels of the small fishing vessel fleet, many of which are below 15 GRT.

The TC project calls for the participation of vessel operators. A primary goal is to validate more appropriate stability standards for future application to fishing vessels under 24 metres in length. In-the-field data collection is to be carried out in two parts. Part 1 will address small fishing vessels exceeding 15 metres in overall length (such as the *Cap Rouge II*), while Part 2 will focus on vessels of open construction less than 15 metres in overall length. The preliminary results of these studies are expected to be reported at the CMAC meetings scheduled for November 2003 and the spring of 2004. Review and analysis of the collected data, intended to define appropriate minimum stability criteria related to various sizes of vessel and their operational characteristics, are to be completed by September 2004. Timely approval and acceptance of the proposed new criteria by TC and industry stakeholders are scheduled so that the results may be incorporated in the new *Fishing Vessel Safety Regulations* due for implementation in 2006.

The Board is encouraged by the initiation of this project to determine and extend the application of appropriate stability standards for all small fishing vessels and notes that TC is in the process of actively addressing a major safety risk to which crews of small fishing vessels have been and continue to be exposed. Until such time as new small fishing vessel safety regulations are introduced, the Board recommends that:

> The Department of Transport require all new inspected small fishing vessels of closed construction to submit stability data for approval.
>
> M03-05

and:

> The Department of Transport require all existing inspected small fishing vessels currently without any approved stability data be subjected to a roll period test and a corresponding freeboard verification not later than their next scheduled quadrennial inspection.
>
> M03-06

4.2.2 Promoting Safe Practices On Board Fishing Vessels

Since 1993, TSB statistics show that about 50 per cent of all vessels involved in shipping accidents have been fishing vessels. In that period, 493 Canadian fishing vessels have been lost, and 76 fishers lost their lives. In many of these occurrences, unsafe practices, which served to compromise the vessel's watertight integrity and stability, have contributed to the occurrence. These occurrences are typical of situations where the level of risk during fishing operation rises gradually over time.

The capsize of the *Cap Rouge II* was brought about by such an increase in risk involving a reduction of stability due to the weight of additional equipment, deterioration of watertight seals on lazarette and manhole covers, and operation with the deck awash.

Such unsafe practices are not carried out with the intention of jeopardizing the safety of the vessel and crew. Rather, they are carried out by individuals who mean to operate their vessels in a safe manner but who, for a number of reasons, do not fully appreciate the risks associated with such practices.

In general, people tend to underestimate risk. In order to assess the level of risk associated with an activity, there is a need to be aware of the severity and probability of negative outcomes.

Within the Canadian fishing industry for example, while some 49 vessels are lost every year, on average, they represent only a small proportion of the 20 000 small fishing vessels in operation. As such, there is a high probability of a vessel safely completing each voyage. Each successive

voyage safely completed increases the individual's perception that the probability of an accident is low. Consequently, the more comfortable the individual becomes, the more unsafe practices may be carried out, placing vessel and crew at greater risk. Therefore, efforts to eliminate unsafe practices on board small fishing vessels are required, focussing on changing fishers' attitudes toward the risks involved.

Increasing an individual's motivation to adopt safe practices will best be achieved through a concerted effort to change actual behaviour in conjunction with a program to educate fishers with respect to the risks involved in their operation. In this way, the justification for adopting safe practices will change from one which is externally imposed to one stemming from internal acceptance. Previous efforts to change attitudes within other modes of transportation have relied upon such an approach. For example, consider the effectiveness over the last two decades in changing attitudes toward seat belt use and greater passenger safety.

Existing efforts to promote adoption of safe practices within the fishing industry, through education and awareness programs, have shown limited success. As demonstrated in this accident, there continue to be occurrences involving fishers who, although having attended training courses, persisted in the use of unsafe practices. Therefore, formal training for fishers may not always achieve its objective of promoting practical application of classroom theory. Possible reasons for this include a lack of perceived relevance of course content or a method of delivery which does not provide sufficient application of the subject matter.

It is essential that any education and awareness program which aims to promote safety employ educational techniques which are most likely to impart useful knowledge to operators so that they will make use of that knowledge and consequently reduce the risk of accidents. Adult learning principles indicate that adults learn best when learning activities reflect their individual learning style, take advantage of previous experience, relate to their everyday world, and simulate real world situations.[27]

Since 1990, the TSB has issued a number of safety communications[28] addressing deficiencies related to stability awareness, unsafe on-board working practices, structural modifications, and loss of watertight integrity. To address these deficiencies, a number of measures have been instituted which include publications, ship safety bulletins, audio visual aids, and training workshops. In spite of these efforts, accidents associated with those deficiencies continue to occur. The Board, therefore, continues to be concerned with the lack of real progress.

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[27] Knowles, M.S., Modern Practice of Adult Education: From Pedagogy to Adrogogy (New York, Cambridge Adult Press Company, 1980).

[28] M94-32, M96-13, M96-14, M00–06.

In 2003, the Board's report (TSB Report M01L0112) of an occurrence involving the small fishing vessel *Alex B. 1* stated "only through a concerted and overarching effort to change the existing paradigm within the fishing industry, and specifically establish a true safety culture within it, can the risks to fishers be reduced to acceptable levels." The Board recommended that:

> Transport Canada, in coordination with Fisheries and Oceans Canada, fisher associations and training institutions, develop a national strategy for establishing, maintaining and promoting a safety culture within the fishing industry.
>
> (Recommendation M03-02, issued September 2003)

Given that attitudes and beliefs toward risk form the basis of an effective safety culture, the Board recognizes that developing this safety culture will require a long-term effort to promote positive attitudes toward safety within the fishing community. Therefore, given that there is a need to initiate a change in attitude among fishers as demonstrated by this occurrence, and facts supporting Recommendation M03-02, the Board further recommends that:

> The Department of Transport, in collaboration with the fishing community, reduce unsafe practices by means of a code of best practices for small fishing vessels, including loading and stability, and that its adoption be encouraged through effective education and awareness programs.
>
> M03-07

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 02 October 2003.

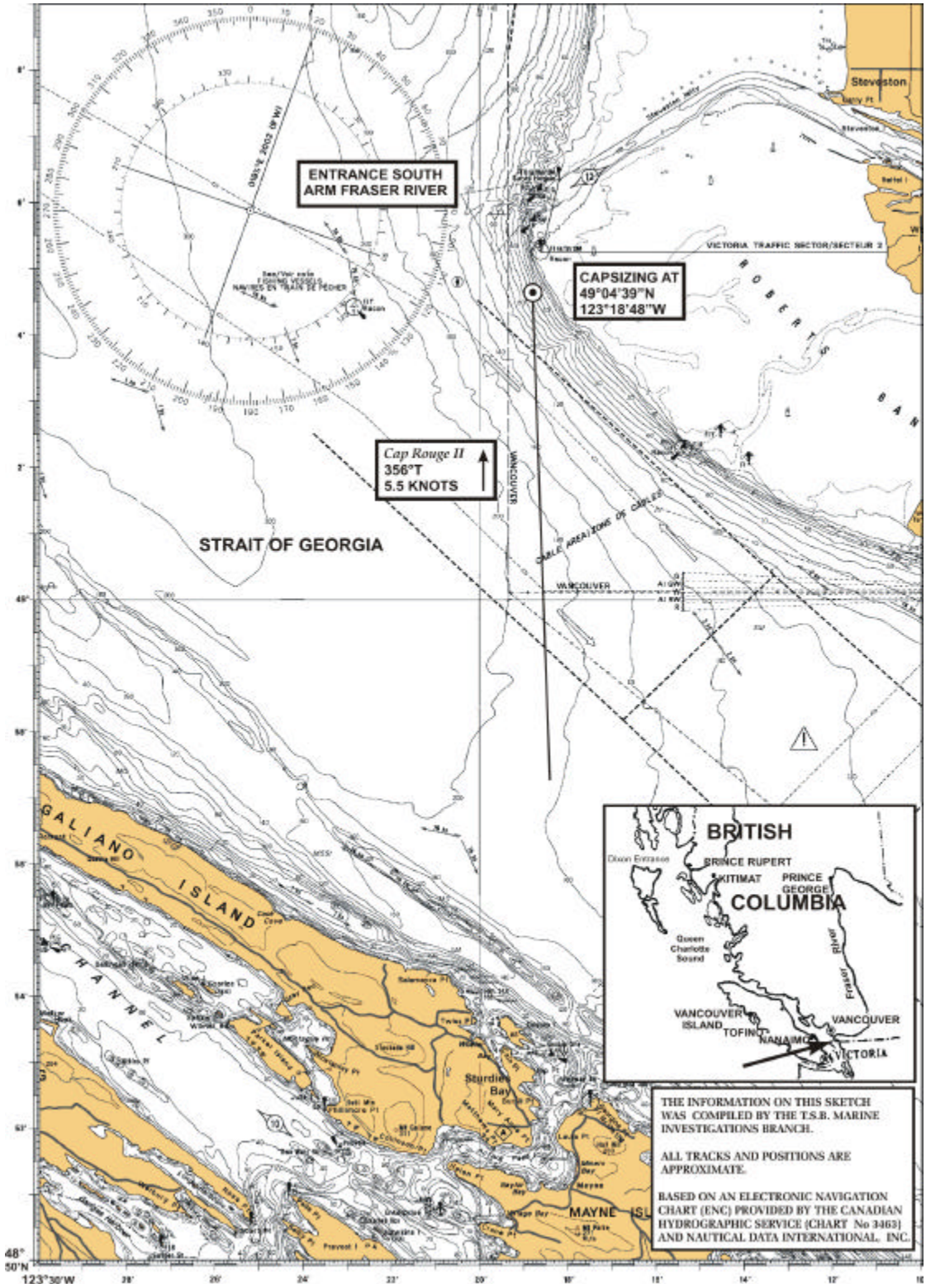
Visit the Transportation Safety Board of Canada web site, www.tsb.gc.ca for information about the TSB and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A - List of Supporting Reports

The following TSB report was completed and is available on request.

S.F.V. *Cap Rouge II* Inclining Experiment Report & Rolling Period Test Report, 26 August 2002.

Appendix B - Chartlet



Appendix C - Photographs of the Cap Rouge II

Photo 1. *Cap Rouge II* in dry-land storage, 10 days after being salvaged. 25 August 2002

Photo 2. Capsized *Cap Rouge II* resting alongside salvage barge. 15 August 2002.

Photo 3. *Cap Rouge II* raised upright at the time of salvage

Photo 4. Working deck of *Cap Rouge II* showing west coast salmon seine net wrapped on net drum. 15 August 2002

Photo 5. Close up view of seine net on the net drum. 15 August 2002

Photo 6. Portion of the forward fish holds being pumped dry by salvors. 15 August 2002

Photo 7. Stern of *Cap Rouge II* showing solidly constructed stern ramp extending beyond the transom. 19 August 2002

Photo 8. A combined hinged hatch cover and door on the centreline at the after end of the wheelhouse

Appendix D - Glossary

CCG	Canadian Coast Guard
CF	Canadian Forces
CFB	Canadian Forces Base
CLC	*Canada Labour Code*
CMAC	Canadian Marine Advisory Council
COHS	Canadian Occupational Health and Safety
CPR	cardiopulmonary resuscitation
DFO	Department of Fisheries and Oceans
FDU	Fleet Diving Unit
FSM	*CCG Fleet Safety Manual*
GMt	transverse metacentric height
GRT	Gross Registered Tons (volume)
"inside" seine net	Salmon seine fishing net used in B.C. coastal waters other than in exposed waters south of Vancouver Island
JRCC	Joint Rescue Co-ordination Centre
MCTS	Marine Communications and Traffic Services
MED	marine emergency duties
MRSC	Maritime Rescue Subcentre
MSA	Marine Safety Advisory
OHS	*Occupational Health & Safety Regulation*, British Columbia
OIC	Officer-in-Charge
OSC	on-scene co-ordinator/commander
(P)	port
RCMP	Royal Canadian Mounted Police
Ro-Ro	Roll on-Roll off
(S)	starboard
SAR	search and rescue
SAR TECH	search and rescue technician
SCUBA	self-contained underwater breathing apparatus
SIC	Safety Inspection Certificate
SFVIR	*Small Fishing Vessel Inspection Regulations*
SSB	Ship Safety Branch
STAB 4	*Stability, Subdivision and Load Line Standards - Section 4*
T	True
TC	Transport Canada
TSB	Transportation Safety Board of Canada
WCB	Workers' Compensation Board of British Columbia
"West Coast" seine net	Salmon seine fishing net used when fishing the exposed waters south of Vancouver Island
°	degree
'	minute
"	second