Olympic Coast National Marine Sanctuary
Area to be Avoided
Education and Monitoring Program

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Ocean and Coastal Resource Management
Marine Sanctuaries Division

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About the Marine Sanctuaries Conservation Series

The National Oceanic and Atmospheric Administration's Marine Sanctuary Division (MSD) administers the National Marine Sanctuary Program. Its mission is to identify, designate, protect and manage the ecological, recreational, research, educational, historical, and aesthetic resources and qualities of nationally significant coastal and marine areas. The existing marine sanctuaries differ widely in their natural and historical resources and include nearshore and open ocean areas ranging in size from less than one to over 5,000 square miles. Protected habitats include rocky coasts, kelp forests, coral reefs, sea grass beds, estuarine habitats, hard and soft bottom habitats, segments of whale migration routes, and shipwrecks.

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Olympic Coast National Marine Sanctuary Area to be Avoided (ATBA) Education and Monitoring Program

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CAPT Larry Simoneaux, NOAA Corps and Lindy Johnson, Office of General Counsel are largely responsible for the current ATBA. The former for developing the ATBA proposal and the latter for seeing it through adoption by the International Maritime Organization.

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Finally, I'd like to recognize the diligence of U.S. and Canadian vessel traffic operators and of the professional mariners who transit the Sanctuary. It is their day-to-day dedication to maritime and environmental safety that offers the greatest protection to Olympic Coast National Marine Sanctuary.

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BACKGROUND

The National Marine Sanctuaries Act (16 U.S.C. 1431, as amended) gives the Secretary of Commerce the authority to designate discrete areas of the marine environment as National Marine Sanctuaries and provides the authority to promulgate regulations to provide for the conservation and management of these marine areas. The waters of the Outer Washington Coast were recognized for their high natural resource and human use values and placed on the National Marine Sanctuary Program Site Evaluation List in 1983. In 1988, Congress directed NOAA to designate the Olympic Coast National Marine Sanctuary (Pub. L. 100-627).

The Sanctuary, designated in May 1994, worked with the U.S. Coast Guard to request the International Maritime Organization designate an Area to be Avoided (ATBA) on the Olympic Coast. The IMO defines an ATBA as *"a routeing measure comprising an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or certain classes of ships"* (IMO, 1991). This ATBA was adopted in December 1994 by the Maritime Safety Committee of the IMO, "*in order to reduce the risk of marine casualty and resulting pollution and damage to the environment of the Olympic Coast National Marine Sanctuary*", (IMO, 1994). The ATBA went into effect in June 1995 and advises operators of vessels carrying petroleum and/or hazardous materials to maintain a 25-mile buffer from the coast. Since that time, Olympic Coast National Marine Sanctuary (OCNMS) has created an education and monitoring program with the goal of ensuring the successful implementation of the ATBA.

The Sanctuary enlisted the aid of the U.S. and Canadian coast guards, and the marine industry to educate mariners about the ATBA and to use existing radar data to monitor compliance. Sanctuary monitoring efforts have targeted education on tank vessels observed transiting the ATBA. OCNMS's monitoring efforts allow quantitative evaluation of this voluntary measure. Finally, the tools developed to monitor the ATBA are also used for the more general purpose of monitoring vessel traffic within the Sanctuary.

While the Olympic Coast National Marine Sanctuary does not currently regulate vessel traffic, such regulations are within the scope of the Sanctuary's Final Environmental Impact Statement/Management Plan. Sanctuary staff participate in ongoing maritime and environmental safety initiatives and continually seek opportunities to mitigate risks from marine shipping.

EXECUTIVE SUMMARY

. . . here there is no place to land on from out of the grey water. For without are sharp crags, and round them the wave roars surging, and sheer the smooth rock rises, and the sea is deep thereby, so that in no wise may I find firm foothold and escape my bane, for as I fain would go ashore, the great wave may haply snatch and dash me on the jagged rock - and a wretched endeavour that would be.

Homer, The Odyssey

In Homer's *Odyssey* Odysseus is cast adrift and finds himself at the mercy of the elements. Over the years many mariners have found the lee shore of the Olympic Coast, with place names such as Destruction Island and Graveyard of the Giants, their bane. The adoption of the Area to be Avoided (ATBA) off the Olympic Coast National Marine Sanctuary was conceived as a buffer to allow help to arrive to adrift vessels along this rocky and environmentally sensitive coast. Despite advances in technology and our best efforts at preventing maritime accidents there will always be a certain amount of risk involved in marine shipping. We must be ever vigilant in improving maritime and environmental safety and seek to avoid that wretched endeavor of a ship breaking up on a lee shore.

A catastrophic discharge of oil or hazardous materials remains one of the greatest threats facing the Olympic Coast National Marine Sanctuary (OCNMS or Sanctuary). Reducing this threat has been one of the National Oceanic and Atmospheric Administration's (NOAA) highest priorities. The Sanctuary, the third largest in the United States, sits at the entrance to the Strait of Juan de Fuca, a major thoroughfare linking the important North American ports of Seattle, Tacoma, and Vancouver with trading partners all around the Pacific Rim. The juxtaposition of such an important international trade route and a national marine sanctuary requires the balancing of political, social, economic, and natural resource issues. Therefore, policies that enhance resource protection need not impede commerce. Vessel and environmental resource management off the Olympic Coast exemplify how industry and government can work together and how a healthy environment and a healthy economy can go hand in hand.

Just as marine transportation forms a vital economic link for Pacific Rim trade, the Sanctuary forms a vital link among resource management agencies, enforcement organizations and the maritime transportation industry. The Sanctuary was designated in May 1994. NOAA worked with the U.S. Coast Guard to propose that the International Maritime Organization approve and adopt an ATBA off the Olympic Coast. This ATBA, which went into effect in June 1995, advises operators of vessels carrying petroleum and hazardous materials[1] to maintain a 25-mile buffer from the coast. This distance narrows as the vessel

[1] The U.S. Coast Guard has interpreted "hazardous materials" for the purposes of this designation, as those cargoes covered under 46 CFR 30.25 Commodities Regulated; 46 CFR 151, Table 151.05 Bulk Liquid

traffic lanes converge at the entrance to the Strait of Juan de Fuca. It is important to note that the boundaries of the ATBA and of the Sanctuary are not contiguous. National Marine Sanctuaries are not exclusionary areas (e.g., commercial fishing and shipping occur within OCNMS).

Since the ATBA was adopted OCNMS has ensured that information on the ATBA was placed on the appropriate nautical charts and publications. In addition, Sanctuary staff worked closely with industry and government agencies to develop an education strategy. This effort resulted in the development of an ATBA flyer distributed in 1996 by the Washington State Office of Marine Safety, the Puget Sound Steamship Operators Association, the Marine Exchange of Puget Sound, the Canadian Coast Guard, 13th Coast Guard District's Marine Safety Office Puget Sound (MSO) and Vessel Traffic Service Puget Sound (VTS). A copy of this flyer is also now part of the Coast Guard's Vessel Traffic Service's Users Manual.

To test a belief that voluntary ATBA provisions were widely accepted by the marine industry, the Sanctuary designed a vessel traffic-monitoring program using Canadian Coast Guard radar data. Since February 1998 OCNMS and MSO Puget Sound have reviewed a total of 267 plots of tank vessels in the ATBA. Where it was believed that additional education was warranted, these plots were forwarded to owner/operators along with correspondence requesting the owner/operator's voluntary support of the ATBA. This correspondence is sent out under the joint signature of the Captain of the Port and the Sanctuary Superintendent. Response from the marine industry to the program has been very favorable. In many cases vessel operators have responded back clarifying that the transits in question were made under ballast, and as such, the recommendations of the ATBA did not apply. In other cases, vessel operators recognized that their vessels had transited the ATBA laden with petroleum or hazardous materials and stated that it was, or would now be, their company's policy to follow the recommendations of the IMO regarding the ATBA. Many of those responding commented on how the correspondence was useful in educating their crews.

To analyze the effectiveness of the ATBA, as well as other vessel traffic patterns in the Sanctuary, data were processed and summarized by quarter from July 1995 through September 1999. The data were analyzed by quarter within three areas: Total (the entire area of radar coverage), OCNMS (the Sanctuary boundary), and the ATBA. The data illustrate differences in where vessels transit, according to vessel type (e.g., fishing vessels, freighters, government/miscellaneous, tank vessels, and tugs/barges). The distribution of vessels in the study area is influenced by vessel routing measures, great circle routes to Asia, coastal shipping routes, military operating areas, and fishing grounds.

Performance indicators have been established and are being tracked. These indicators approximate compliance rates and track the relative effectiveness of the ATBA initiative. An

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Hazardous Materials Carried in Barges; 46 CFR 153, Table 1 Vessels Carrying Bulk Liquids, Liquefied Gas, or Compressed Gas Hazardous Materials.

approximation of compliance is necessary because the data set does not include 100 percent of all transits, and information on cargo is incomplete. Three performance indicators were selected. The first performance indicator monitors all vessels transiting the ATBA, as a percentage of those vessels transiting within the Sanctuary. This indicator (Vessels in OCNMS also in the ATBA) can be used to determine if, over time, the relative number of vessels transiting the ATBA is changing. The second two performance indicators divide all vessels into two general categories, with non-tank vessels being an approximate measure of vessels for which the ATBA does not apply and tank vessels being an approximate measure of vessels that should stay outside the ATBA. Additional performance measures attempted to allow for the fact that inbound petroleum barges rarely carry product (e.g., these barges are included in the non-tank category).

From July 1995 through September 1999, the number of vessels transiting the ATBA decreased, both in absolute numbers and reflected as a percentage of vessels within the boundaries of the Sanctuary, also in the ATBA. In the third quarter of 1995 there were 643 transits in the ATBA; of these 86 were tank vessels. In the same period of 1999 there were 511 transits in the ATBA, of which 18 were tank vessels. Representing total vessel transits in the ATBA, as a percentage of those in OCNMS, the values dropped from 27.1 percent to 20.5 percent within the same period. For tank vessels, the values dropped from 22.6 percent to 4.6 percent in the same period.

Further evaluation of tank vessels within the ATBA illustrates the relative decreases in the different classes of tank vessels in the OCNMS ATBA since it went into effect in 1995. The most dramatic decreases are in the coastal and ocean going tanker, and barge categories. From July 1995 to September 1999, the monthly total of these vessels in the ATBA in these three categories changed dramatically: coastal and ocean going tankers went from 18 to 1 vessel; tugs with oil and gas barges went from 42 to 12 vessels; and tugs with chemical barges went from 19 to 1 vessel.

While this positive trend is very encouraging, the future effectiveness of the ATBA could be negatively impacted by changes in marine trade (e.g., as new vessels/shipping companies enter the market, it is possible that they may not be aware of the ATBA or the sensitive nature of the Sanctuary). Therefore, future improvements in the effectiveness of the ATBA, or at the very least the maintenance of the current effectiveness, will depend upon the continued involvement of vessel traffic managers, industry groups, and the mariners themselves.

In addition to monitoring the effectiveness of the OCNMS ATBA, other uses of these data and methodologies can be applied to other vessel traffic systems and waterways. The utility of displaying vessel traffic data on GIS augments the information provided by experienced operators, vessel masters, and pilots. The ability to analyze spatial and temporal relationships between various classes of vessels in the waterway allows vessel traffic mangers to test and quantify the observations of marine experts. The combination of expert opinion,

with the ability to quantify patterns and trends, can be a powerful tool in the evaluation of a waterway and the identification of solutions to user conflicts. These tools along with others, are currently being employed by policy makers to address maritime and environmental safety in the Sanctuary and adjacent waterways.

Studies of Washington State's waterways have determined that the three highest risks of accidents in the Sanctuary are collision, drift groundings, and powered groundings, in that order. The most likely cause of these accidents are human and organizational error, followed by physical environment and conflicting vessel operations (Volpe, 1997). By routing certain classes of vessels further offshore the ATBA addresses both drift and powered groundings. While the designation of the ATBA has improved maritime and environmental safety within the Sanctuary, it is only one means of reducing risk. The Sanctuary has been participating in other initiatives reviewing additional measures to improve maritime and environmental safety in the region. The implementation of some of these measures may result in improved ATBA effectiveness.

The implementation of the OCNMS ATBA Education and Monitoring Program has been greatly aided by the availability of radar data, and the cooperation of industry and the U.S. and Canadian Coast Guard. The Sanctuary's efforts to view existing radar data on a GIS system have allowed performance measures to be selected and tracked. Radar data has been evaluated and a positive correlation between educational efforts and the effectiveness of the ATBA has been demonstrated.

OCNMS's monitoring program has had additional benefits beyond our outreach efforts and the evaluation of ATBA effectiveness. The Sanctuary has been able to contribute to discussions on maritime and environmental safety in the region by providing a more rigorous evaluation of vessel traffic patterns than would be otherwise possible. This program has also demonstrated the value of this type of analysis to vessel traffic managers and to others interested in improving maritime and environmental safety.

THE NEED FOR AN ATBA OFF OCNMS

Throughout the Sanctuary designation process, marine shipping was identified as a threat to the natural resources of the Olympic Coast, as well as being vital to the economic health of the region. A number of different alternatives were discussed in public scoping meetings, through written comments, and in the Draft and Final Environmental Impact Statements. A proposal developed jointly by NOAA and the U.S. Coast Guard to designate an Area to be Avoided (ATBA) was a direct result of these concerns and discussions. The process of having the ATBA designated by the International Maritime Organization and the designation of the Sanctuary were parallel efforts, with the ATBA becoming effective one year after the Sanctuary.

In July 1991, NOAA released the Draft Environmental Impact Statement/Management Plan (DEIS/MP) for the Sanctuary. The DEIS/MP outlined NOAA's proposal for the OCNMS, including proposed regulations. The DEIS/MP section addressing regulatory alternatives for the operation of commercial vessels included two alternatives: (1) no regulation and (2) regulation of vessel traffic (NOAA, 1991). NOAA's preferred alternative was not to regulate vessel traffic, but to work with the Coast Guard to determine if additional regulations and/or emergency response plans were required.

Staff from NOAA's Sanctuaries and Reserves Division (now the Marine Sanctuaries Division) reviewed the issue of vessel traffic in preparation for the release of the OCNMS's designation document. Comments on the DEIS/MP were reviewed and used to address the issue of vessel traffic within the proposed Sanctuary. In the preparation of NOAA's position on vessel traffic, NOAA consulted with the U.S. Coast Guard, Washington State's Office of Marine Safety, and shipping industry representatives. As a result of these investigations, NOAA and the U.S. Coast Guard developed recommendations to the International Maritime Organization[2] (IMO) to designate an area from the shoreward boundary of the Sanctuary to 25 nautical miles off the outer coast as an Area to be Avoided (Figure 1). An Area to be Avoided is defined by the IMO as "*A routing measure comprising an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or certain classes of ships*" (IMO, 1991).

As a result of this joint NOAA-Coast Guard effort the preferred alternative in the OCNMS Final Environmental Impact Statement/Management Plan (NOAA, 1993) was to not regulate vessel traffic. However, vessel traffic was listed under the scope of regulations, which shows that the issue and alternatives were addressed in the Final Environmental Impact Statement/Management Plan (FEIS/MP), public hearings were held, and public comments were solicited.

[2] The International Maritime Organization is a specialized agency of the United Nations that addresses international shipping issues. It is the only international body that establishes and adopts measures on an international level concerning ship routing and areas to be avoided.

The boundaries and provisions of the ATBA resulted, in part, from a hypothetical scenario developed as part of the FEIS/MP. This scenario illustrated concerns regarding threats from oil spills in the Sanctuary. The scenario was developed after consultation with members of the commercial towing community, local meteorologists and weather forecasters, members of the United States Coast Guard and the United States Navy, and oil spill trajectory experts. It graphically depicted that response time is critical in the event of a maritime emergency.

The scenario narrates the fate of a fictitious tug and petroleum barge on a December transit from a refinery in Anacortes to a port on the Columbia River. Estimates of times for arrival of assistance tugs and meteorological conditions were obtained from veteran mariners and forecasters.

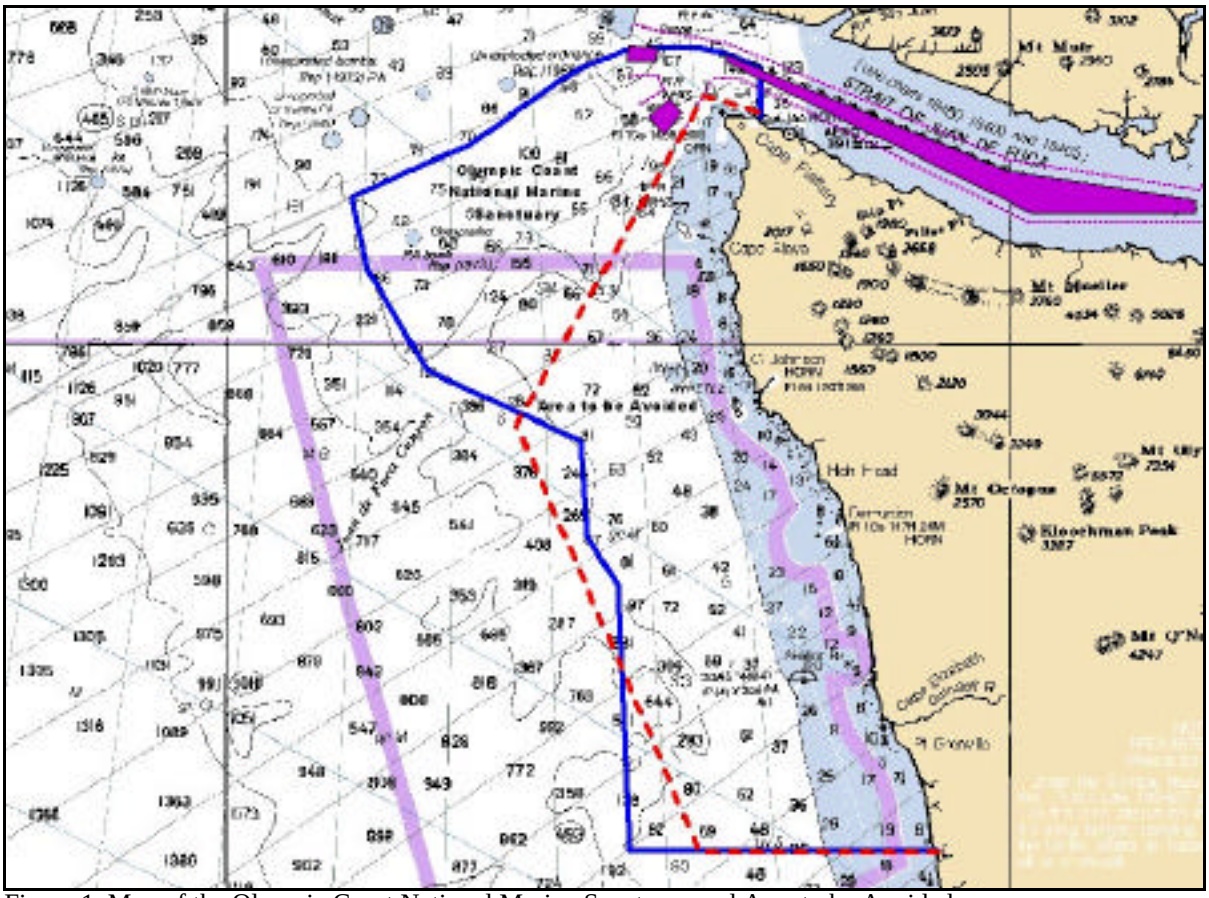


Figure 1. Map of the Olympic Coast National Marine Sanctuary and Area to be Avoided

In the scenario the ocean going, twin-screw tug, *North Wind* (fictitious name) takes in tow a petroleum barge loaded with 30,000 barrels of Marine fuel oil. The tug and tow are bound from Anacortes to a port on the Columbia River. Anticipated speed over ground is eight knots. Estimated time of arrival at the Columbia River bar is approximately 30 hours.

While the current weather is moderate, the forecast is calls for an offshore, deepening low pressure system to move onto northern Vancouver Island during the next 24 to 36 hours. The captain considers all factors and decides he can clear Cape Flattery and be well southbound before the system comes ashore. Further, he concludes that conditions at the mouth of the Columbia River in 30 hours will be moderate enough to safely cross the bar upon arrival.

Twelve hours after departure from Anacortes, *North Wind* and its barge round buoy "J" at the entrance to the Strait of Juan de Fuca. The trip through the Strait has been uneventful. The weather, however, begins to deteriorate. The barometer is falling. Wave height increases rapidly with the increasing wind.

To save time and in an attempt to beat the approaching system, *North Wind* takes up a southbound course using the published "Towboat-Crabber" traffic lane. This lane is a north/south route passing approximately seven nautical miles (nm) west of Cape Alava.

Although the *North Wind's* parent company has established a policy of voluntary adherence to a trackline 10 to 30 nm offshore when towing a loaded petroleum barge, this practice is not followed today due to unfavorable weather conditions offshore.

As the *North Wind's* proceeds southbound the low pressure system is still moving toward Vancouver Island but is rapidly deepening. As the front passes the seas and winds continue to build. During a period of exceptionally high sea and swell combinations, the towline parts. The petroleum barge is now adrift. Recognizing the danger, the captain notifies the Coast Guard of the situation and begins attempts to recover the barge.

The scenario continues in great detail, but the key points are that the *North Wind's* attempts to retrieve the barge are unsuccessful and that help does not arrive in time to prevent the barge from grounding and breaking up.

Since the Sanctuary and the ATBA were designated, several tugs have lost their tows within, or adjacent to the Sanctuary. While none of these incidents resulted in a discharge, they demonstrate the value in having tugs under tow transiting further off the coast:

- March 28, 1999 - Tug *Ralph E Bouchard* with a petroleum barge in tow in very heavy seas, had its tow wire part. The *Ralph E Bouchard* was able to recover the barge without any damage to the tug or barge.
- February 17, 1999 - Tug *Western Navigator* towing a petroleum barge was subject to heavy seas and wind when the tow wire parted. Tow was reestablished with an Orville Hook (emergency retrieval system) after two hours.
- November 25, 1998 - Tug *Robert L* with a petroleum barge in tow was waiting out heavy weather, off the Columbia River Bar, when its tow wire part. No assistance was

available, due to Grays Harbor and Columbia Bar conditions. The *Robert L* successfully deployed an Orville Hook and snagged the barge bridle.

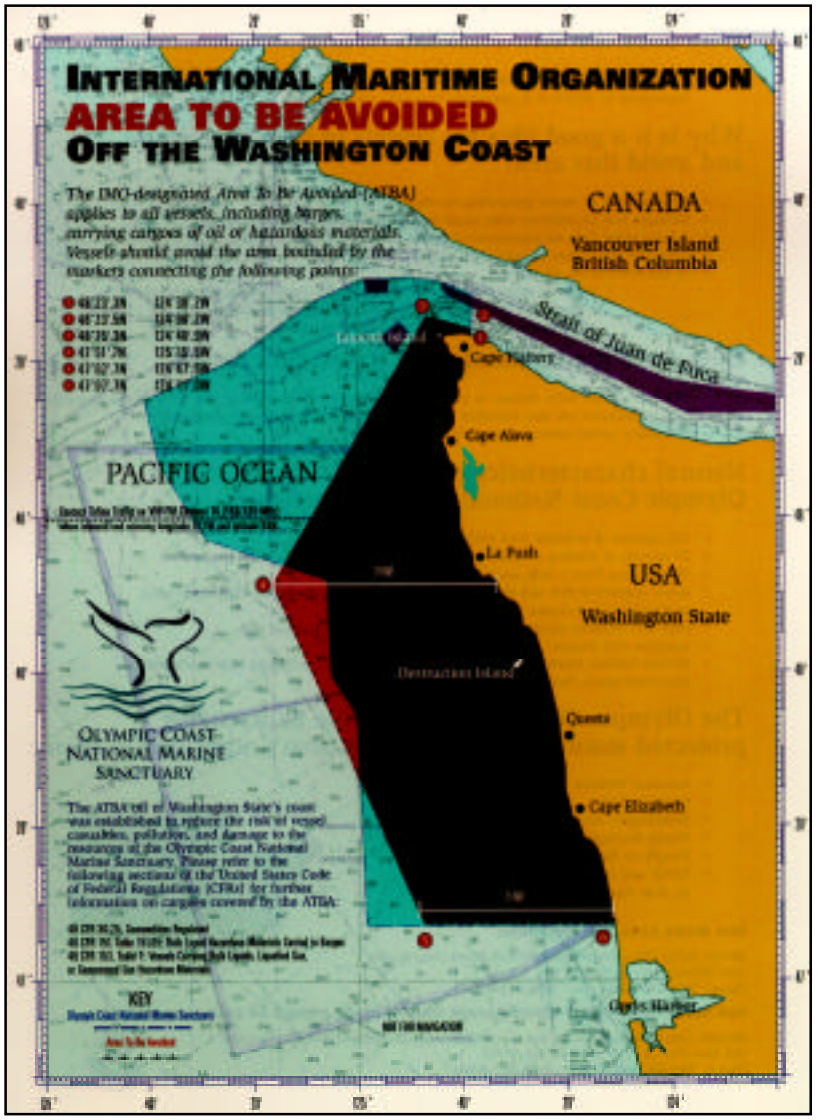
- December 14, 1995 – Tug *Sea Valiant* towing a barge of urea, lost its tow 27 nautical miles west of Point Grenville. A brake failed, stripping all the tow wire off the tow machine. After approximately five hours the *Sea Valiant* was able rig a temporary tow arrangement.

The lack of dedicated emergency response towing vessels in the Strait of Juan de Fuca, along the western Washington coast, or in Puget Sound continues to be a major maritime and environmental safety issue for the region (OMS, 1994; Volpe, 1997; Coast Guard, 1999a; Coast Guard, 1999b). In response to a call for a dedicated emergency towing vessel (OMS, 1994), the maritime industry has sponsored an International Tug of Opportunity System (ITOS). Managed by the Seattle Marine Exchange, ITOS tracks approximately 100 participating tugs in the region. In the event of an emergency the Seattle Marine Exchange would assist the Coast Guard in identifying and dispatching the nearest tug of opportunity to the distressed vessel. The U.S. Coast Guard has recently evaluated the effectiveness of ITOS and found it to provide an incremental improvement to safety and environmental protection in Puget Sound area waters. However, in the waters in the western half of the Strait of Juan de Fuca and offshore approaches (including OCNMS), ITOS is not as effective. In the ITOS evaluation segment 2, which is contiguous with the northern portions of the ATBA and OCNMS, the probability of an ITOS tug being available and willing to assist a given vessel is approximately 13 percent (U.S. Coast Guard, 1999).

EDUCATION PROGRAM

In the time since ATBA designation, Olympic Coast National Marine Sanctuary has worked to ensure that information about the ATBA was placed on the appropriate nautical charts and publications, such as the *Coast Pilot* and the *Local Notice to Mariners*. In addition, Sanctuary staff worked closely with industry to educate them about the Sanctuary and ATBA. In 1996, 28 personal interviews were conducted with representatives from government regulatory bodies, the shipping industry, academia and nonprofit organizations. The purpose of the interviews was to help shape the design of an educational piece to be distributed to the shipping industry and to gather information about available information on vessel traffic monitoring (Ferguson, 1996).

As a result of these consultations, OCNMS staff decided that a one page, double-sided flyer (Figure 2) would be the most effective way to educate mariners about the ATBA. Five thousand color flyers were distributed in 1996 by the Washington State Office of Marine Safety, the Puget Sound Steamship Operators Association, the Marine Exchange of Puget Sound, the Canadian Coast Guard, the Marine Safety Office Puget Sound, and Vessel Traffic Service Puget Sound. A copy of this flyer is also now part of the Coast Guard's *Vessel Traffic Service's Users Manual* (U.S. Coast Guard, 1998). A second phase of the education program, involving targeted outreach efforts, is described later in the paper.



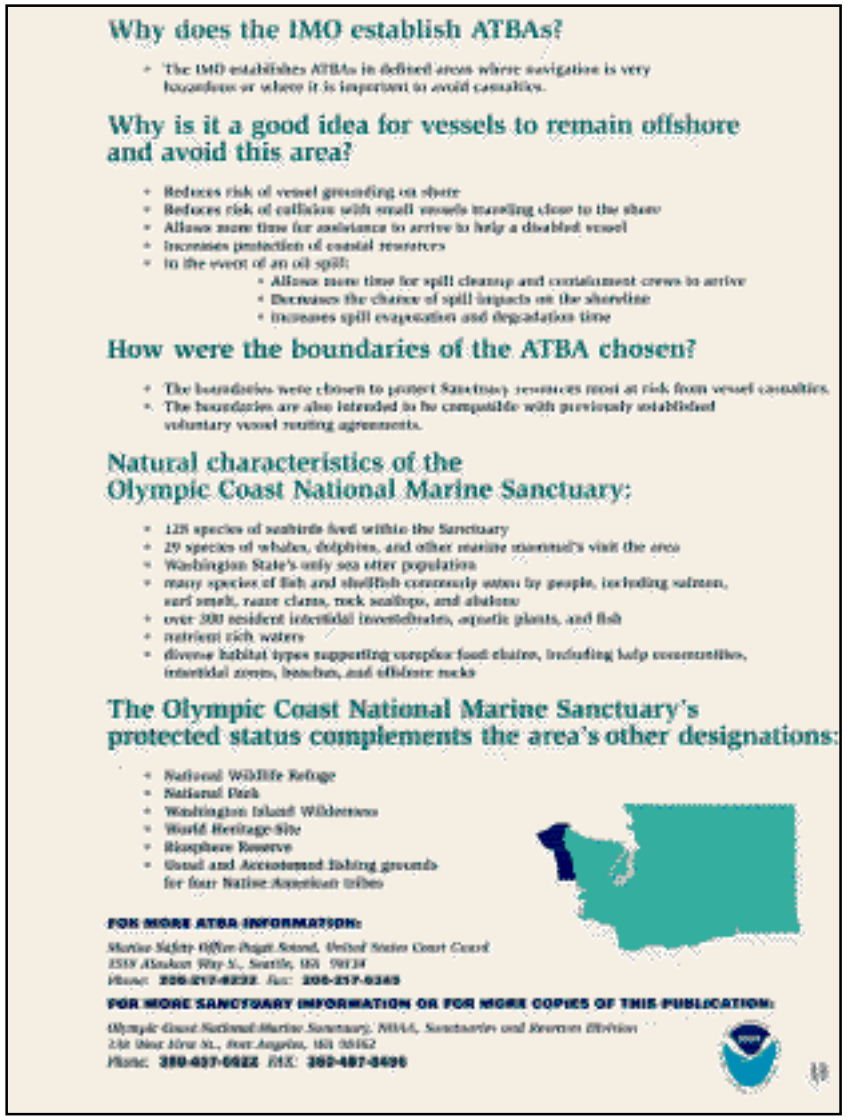


Figure 2. ATBA education flyer

MONITORING PROGRAM

At the time the ATBA was designated, there was generally believed to be a high degree of compliance to IMO adopted ATBAs. However, there was no hard evidence which supported or contradicted this assumption. To test this assumption, the Sanctuary designed a vessel traffic-monitoring program which collected information on shipping in the Sanctuary and the ATBA. The Sanctuary-designed vessel traffic study and monitoring program provides quantitative data on shipping use in the Sanctuary and within the ATBA.

The monitoring program uses Canadian Coast Guard data from the Tofino Marine Communications and Traffic System (MCTS) to monitor the vessel traffic patterns in and adjacent to the Sanctuary and to determine the level of compliance with the ATBA. A radar station located at Mt. Ozzard, British Columbia, with a range of 50-60 nautical miles; this area covers a portion of the northern part of the OCNMS and the ATBA. The MCTS Center in Ucluelet, B.C. has archived vessel information at various intervals (Table 1), noting the vessel name, class of vessel, latitude and longitude, and other information. This information is the best source of data for the area.

Table 1. Tofino MCTS Archived Data (position interval and coverage)

Time Period	Position Interval	Approximate % of days covered
Pre-June 95 (paper copy only)	Hourly interval	unknown
June 95 - April 97	Hourly interval	78
May 97 - October 98	5-minute interval	94
November 98 - September 99	2-minute interval	90

The Sanctuary contracted with Genwest Systems, Inc. to develop a data conversion program (LANPAR™) written in Visual Basic, which converts archived Tofino vessel track data (Table 2) to a database file (Table 3). This dBase III file is then imported into an ArcView™ GIS format, using an extension (Shiptracker) also created by Genwest. This allows the data to be displayed and for spatial analysis to be conducted on the data.

The input file contains ten different record types. LANPAR™ reads only the "A", "F" and "G" records. The "A" record contains the date in a YY-MM-DD format. The "F" record contains a 3-position vessel ID and the vessel's name assigned to each radar contact by Tofino MCTS operators. The "G" record contains the vessel's track ID, time, vessel type and geographic position in DDDMMSS format (Genwest, 1999; McCreery, 1999).

Table 2. Excerpt from raw data file from Tofino MCTS

012450 F C22 SR BATON ROUGE
012640 G C19B 490945 1261119
012640 G C222 483449 1265314
012640 G C14L 490208 1265018
012640 G C21C 484212 1251746
012830 A VTMS LOG TOF TRAFFIC 99-05-01 0020

The output format of LANPAR™ is dBase III format as required by the Shiptracker Extension to ArcView™ developed by Genwest Systems, Inc. for the Sanctuary. LANPAR™ output is in the following format:

VESSELNAME	Vessel Name provided by the Tofino Operator
VESSELTYPE	Vessel Type expanded from TOFINOCODE
CLASSNAME	General Class Name designated by OCNMS
DATE	YY-MM-DD provided by the raw Tofino data
TIME	HHMMSS provided by the raw Tofino data
LATITUDE	Latitude converted to decimal degrees
LONGITIUDE	Longitude converted to decimal degrees
TRACKID	Tracker ID number, in the range A00 - D99
MAJORCLASS	Class of vessel determined by TOFINOCODE
TOFINOCOD	Vessel type provided by Tofino System
IN_OUTBND	I (inbound) or O (outbound) based on vessel track
COURSEGOOD	Course Made Good using first and last points of track

Table 3. Excerpt from data conversion output

VESSEL NAME	VESSEL TYPE	CLASS NAME	DATE	TIME	LATITUDE	LONGITUDE	TRACK ID	MAJOR CLASS	TOFINO CODE	IN_OUT BND	COURSE GOOD
SR BATON ROUGE	Ocean Going Tanker	Tank Vessel	99-05-01	012439	48.58027649	-126.88722229	C22	1	2	I	093
	General Cargo	Freighters	99-05-01	012640	49.03555679	-126.83833313	C14	2	L	O	280
	Tug Misc. Barge	Tugs/Barges	99-05-01	012640	49.16250229	-126.18861389	C19	3	B	I	113
	Tug Chip Barge	Tugs/Barges	99-05-01	012640	48.70333481	-125.29611206	C21	3	C	I	111
	General Cargo	Freighters	99-05-01	012840	49.03749847	-126.84611511	C14	2	L	O	280
	Tug Misc. Barge	Tugs/Barges	99-05-01	012840	49.15972519	-126.18416595	C19	3	B	I	113

Experience has shown inconsistencies with the data related to actions by the operators and in how the Tofino MCTS tracking software logs radar contacts. Vessel tracklines are logged in 24-hour segments. Therefore, if a vessel is within MCTS's radar coverage past midnight, that vessel's transit will be split between two files. MCTS operators occasionally lose radar contact with participating vessels. When this occurs, the vessel's icon remains on the system and its last known position continues to be logged. MCTS operators may also manually move the vessel's icon along its projected route. This may result in an inaccurate trackline represented on the GIS plots of the data. When a vessel enters port and the MCTS operator has reason to believe that the vessel is departing the traffic system for a short interval (e.g., a fishing vessel temporarily entering Barkley Sound), the vessel's icon may be dragged inland. This allows the MCTS operator to quickly reassign the vessel its previous identification code when it reenters the system. This results in some tracklines

appearing to run inland. This also occurs when operators create a vessel record prior to the vessel's radar blip appearing on the screen, such as when a vessel is outbound from the Strait of Juan de Fuca, but still under U. S. Coast Guard control.

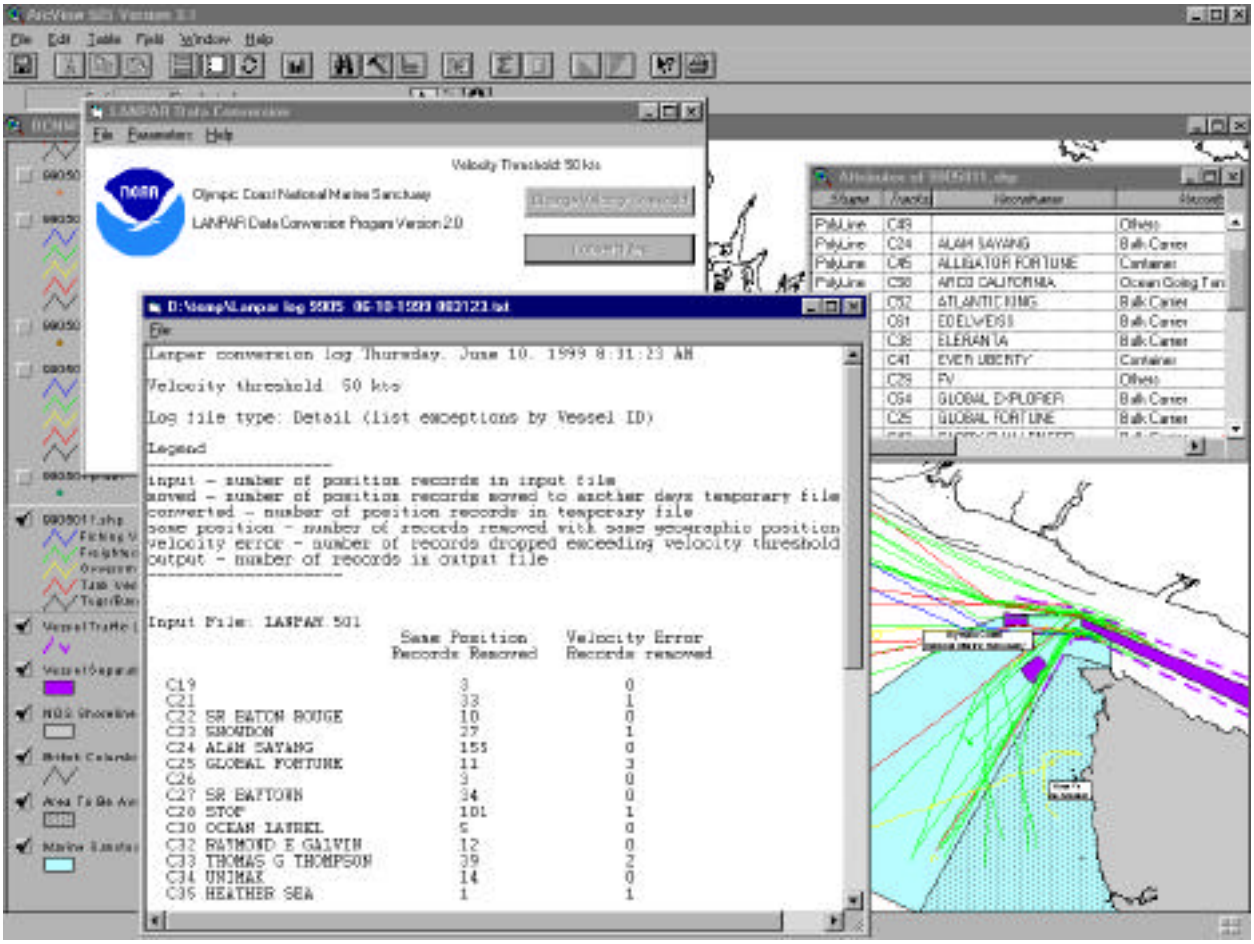


Figure 3. Screen shot of LANPAR™ log file and an example of a shapefile created by the Shiptracker Extension

In order to address some of these inconsistencies, LANPAR™ sorts and filters some data. Since the data files are logged in discrete days, it is common for a vessel to begin its transit through the vessel traffic system on one day and to continue to the next. When data is batch processed, LANPAR™ looks at consecutive files, determines if data extends over more then one input file and moves the data from the subsequent file to the first file. The LANPAR™ software calculates the velocity between each point in the trackline and eliminates the point if the apparent velocity between points exceeds a threshold velocity. This velocity is set by the user, with a 50-knot default. Another function removes consecutive records with the same geographic position. This eliminates data logged to file when the Tofino tracking software loses the radar blip, but continues to log the last known position. LANPAR™ creates a log file (Figure 3), which documents information related to the above edits for each data conversion session. For example, the log file for data batch

processed for May 1999 includes information on removed positions for each individual (daily) file and the following summary data:

	input	moved	converted	same position	velocity error	output
Run Totals:	189,617	45,225	189,617	33,084	1,073	155,460

For May 1999, of the 31 files processed, LANPAR™ read in 189,617 vessel positions. Of those 45,225 were moved so that vessel positions from multiple files (vessel underway for more then a single day) are represented as a single track; 33,084 positions were removed for having identical positions (radar tracking lost); and 1,073 positions were removed for velocity errors. The output 155,460 vessel positions represents 1,211 vessel transits for May 1999.

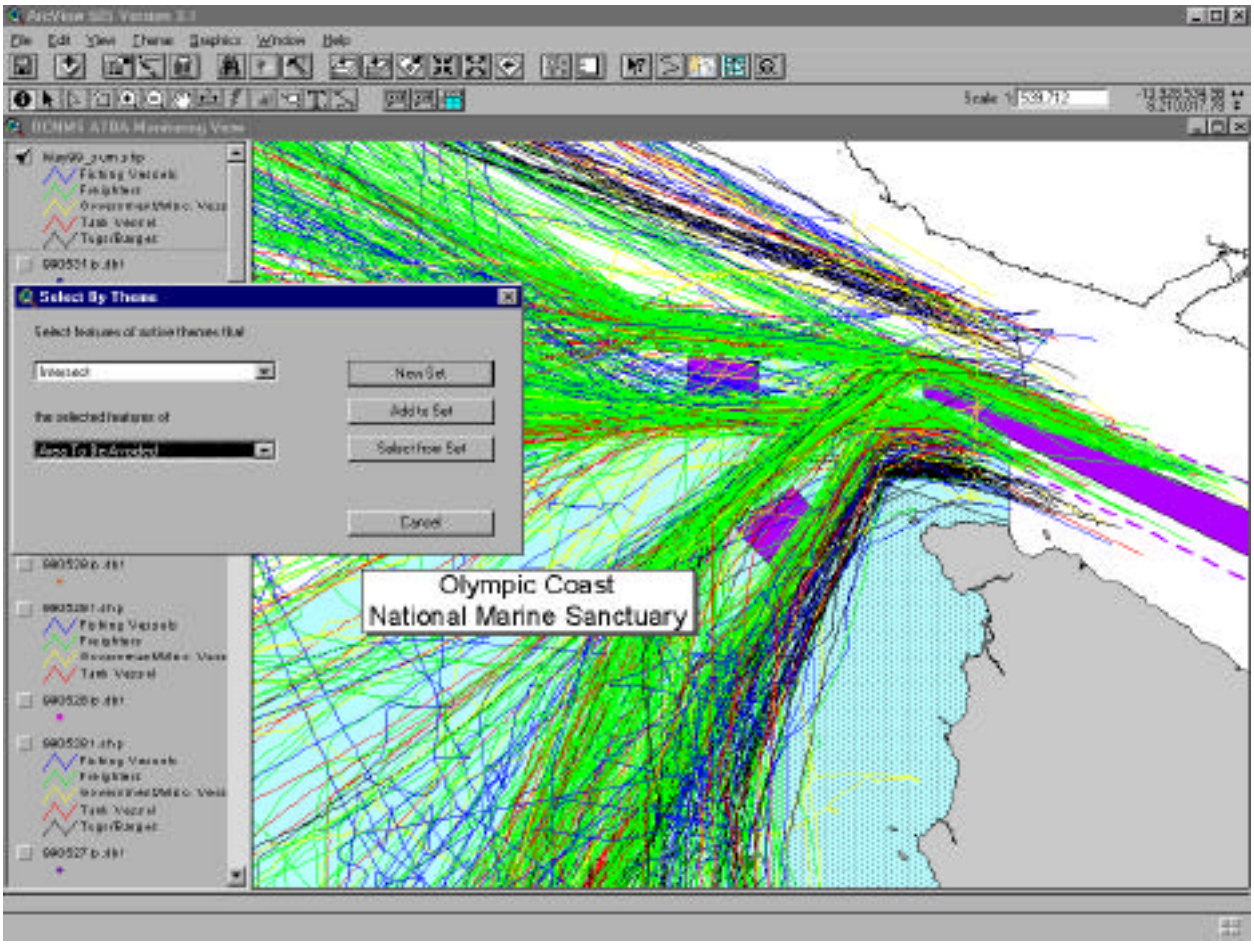


Figure 4. Vessel tracks are summarized monthly and queried to identify vessel distribution by type within the Sanctuary's Area to be Avoided.

The Sanctuary receives monthly radar summaries from the Canadian Coast Guard. Using LANPAR™, these text files are filtered and converted to a dBase III format. Using the NOAA OCNMS Shiptracker extension, these radar data points are displayed as vessel tracks in a shapefile (Figure 4). Some manual editing is necessary to remove obviously erroneous data points (e.g., plots on land). Vessel track data is then summarized monthly and queried

to identify vessel distribution, by type, within the Sanctuary's ATBA. The OCNMS tank vessel classification (Table 4) includes vessels, which by the nature of their classification may be carrying cargoes of petroleum product or hazardous materials. Using these classifications, tank vessels within the ATBA are identified. For example, in May 1999, nine tank vessels were observed within the ATBA (Figure 5).

Table 4. Tofino and OCNMS Vessel Classifications

OCNMS VESSEL CLASSIFICATIONS	TOFINO VESSEL CLASSIFICATIONS	TOFINO CODES
TANK VESSELS	COASTAL TANKER	1
	OCEAN GOING TANKER	2
	VLCC TANKER	3
	ULCC TANKER	4
	LPG/LNG TANKER	5
	CHEMICAL TANKER	6
	VEG OIL/MOLASSES TANKER	7
	O/B/O	8
	TUG OIL/GAS BARGE	D
	TUG CHEMICAL BARGE	J
FREIGHTERS	BULK CARRIER	K
	GENERAL CARGO	L
	CONTAINER	N
	COASTAL	O
	PASSENGER	P
	REEFER	Q
	RO-RO	R
	VEHICLE CARRIER	V
TUGS/BARGES	TUG LIGHT	A
	TUG MISC BARGE	B
	TUG CHIP BARGE	C
	TUG LOG BARGE	E
	RAIL BARGE	F
	LOG TOW	G
	TUG TARGET TOW	X
FISHING VESSELS	COMMERCIAL F/V	Z
	FACTORY F/V	M
GOVERNMENT/MISC	GOVERNMENT	T
	SCIENTIFIC/RESEARCH	S
	WARSHIP	W
	HYDRO/HOVER ETC	H
	PRIVATE YACHT	Y
	OTHERS	I

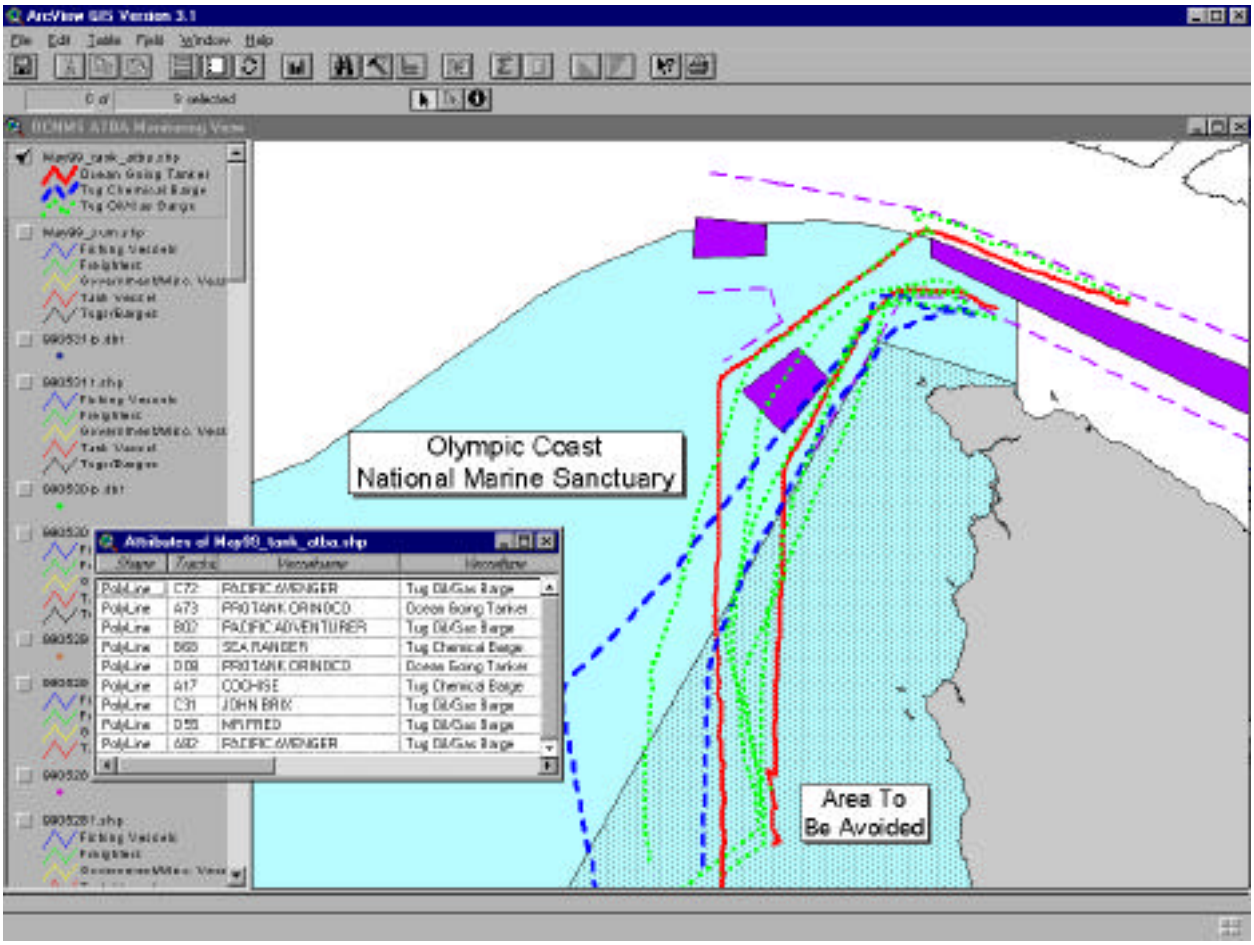


Figure 5. Tank Vessels within the Sanctuary's Area to be Avoided are identified.

TARGETED OUTREACH

As a result of OCNMS's monitoring efforts, a compilation of individual plots of tank vessels in the ATBA is forwarded to the Marine Safety Office Puget Sound (Figure 6). These individual plots are used in the second phase of our education efforts. The Coast Guard sends out correspondence under the joint signature of the Captain of the Port and the Sanctuary Superintendent, which:

- Notifies the vessel owner/operator that their vessel was identified as having transited the ATBA;
- Notes that the monitoring methodology does not distinguish between vessels which are laden or transiting without product, and as such we occasionally send out plots of tank vessels for which the ATBA recommendations do not apply;
- The letter requests feedback on the accuracy of the vessel plots, and;
- Finally, and most significantly, requests the owner/operators' voluntary support of the ATBA.

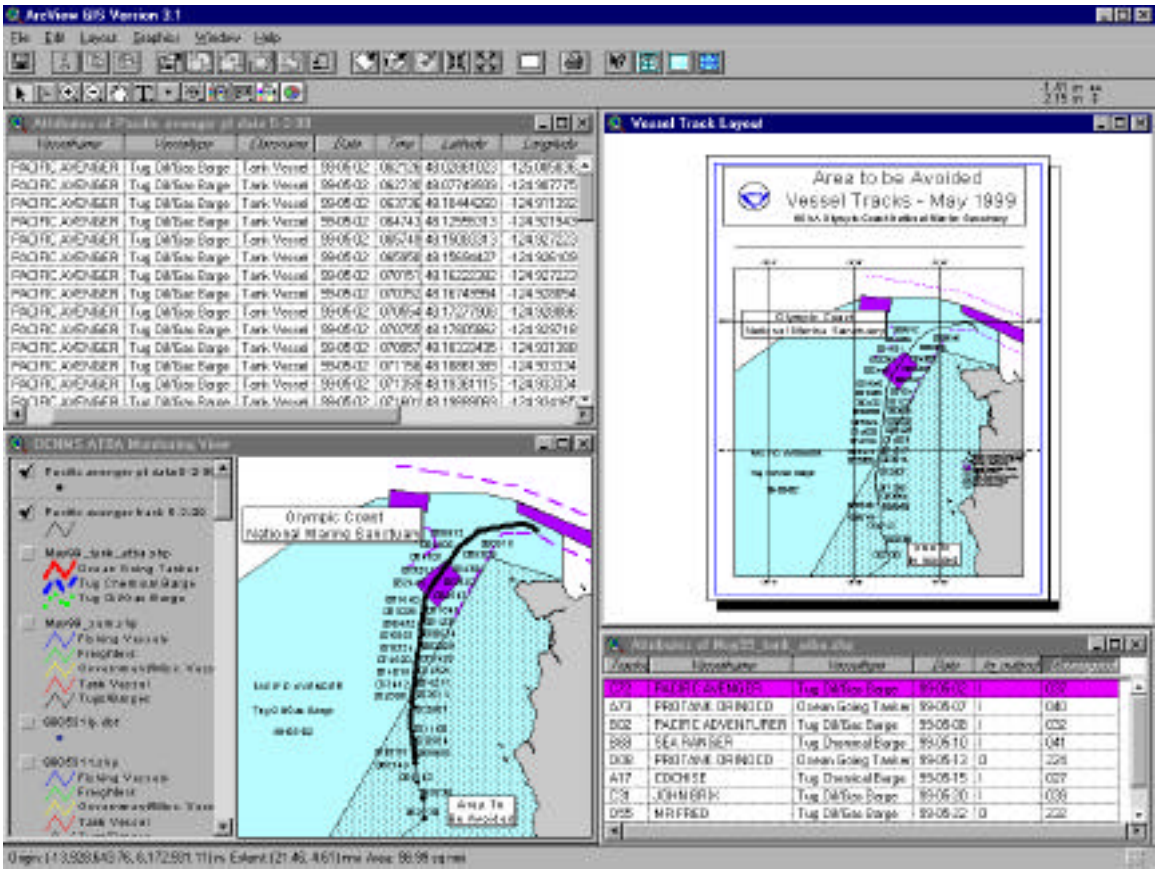


Figure 6. Individual vessel tracks are created and forwarded to the MSO Puget Sound. The Captain of the Port sends out educational information to the identified vessel informing them of the Sanctuary and the ATBA and requesting their cooperation

In February 1998, OCNMS began sending MSO Puget Sound these individual vessel plots. While the Sanctuary has Tofino MCTS data dating back to June 1995 (the effective date of the ATBA), the creation of individual plots started with June 1997. Since that time the Sanctuary and the Coast Guard have reviewed 267 plots of tank vessels in the ATBA and sent out letters where it was believed that further educational efforts would be of value. Response from the marine industry to the program has been very favorable. In many cases, vessel operators have responded back clarifying that the transits in question were made under ballast and, as such, the recommendations of the ATBA did not apply. In other cases vessel operators recognized that their vessels had transited the ATBA laden with petroleum or hazardous materials and stated that it was, or would now be, their company's policy to follow the recommendations of the IMO regarding the ATBA.

ATBA ANALYSIS

When the ATBA was first established in June 1995, it was generally believed that such areas enjoyed a high level of compliance. The monitoring program subsequently developed by the Sanctuary had a dual purpose; first, to test this assumption; and second, to actively improve the ATBA's effectiveness by providing feedback to vessel traffic managers

and industry. Conceptually, the ATBA education and monitoring program could have been organized in such a manner that the effectiveness of different education efforts could have been evaluated by tracking of traffic patterns. Ideally, the monitoring system would have been in place prior to the ATBA effective date, establishing a vessel traffic pattern baseline. The monitoring program would also have benefited from having information on the cargoes of vessels, in addition to the vessel type. For instance, a tank vessel may be light and appear to be subject to the ATBA, while a container ship carrying hazardous cargo would appear not to be subject to the ATBA. Finally, the effectiveness of the OCNMS/Coast Guard outreach efforts would be easier to evaluate if the letters to the industry had been more timely. Due to the lack of personnel resources, and some difficulties with software, some of the plots/letters were sent out up to a year after the transit occurred. The current goal is to send out plots/letters within one month of the observed ATBA transit. More timely feedback will improve the effectiveness of the outreach efforts.

It was OCNMS's original intention to determine and track the rate of compliance to the IMO voluntary ATBA. Because of limits with the data set, an absolute compliance rate cannot be determined; however, rigorous performance indicators can be established and tracked. To analyze the effectiveness of the ATBA, as well as other vessel traffic patterns in the Sanctuary, monthly summaries used in the ATBA education and monitoring program (June 1997 to September 1999) were combined into quarterly summaries. In addition, the preceding two years of data were also processed and summarized by quarter (June 1995 to May 1997). As previously discussed (Table 1), these data vary in their rate of archived position information (60-minute to 2-minute intervals) and in the number of days covered. Because of the variation in the coverage rates of the data set (Table 1 and Table 5), the following analysis is based on relative comparisons between vessel types and vessel classes over time and space. The temporal aspect of the analysis is by quarter and the spatial aspect of the analysis looks at three general areas: Total or CVTS (the entire area of radar coverage), OCNMS (the Sanctuary boundary) and the ATBA (Figure 7).

Table 5. Percentage of days covered by archived vessel traffic data

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1995			95%	98%
1996	56%	45%	76%	81%
1997	100%	92%	99%	99%
1998	99%	100%	99%	92%
1999	79%	98%	95%	

The "Total" area would include all vessels participating in the Cooperative Vessel Traffic System (CVTS). Participating vessels are 20 meters or greater, including tugs and tows. The "OCNMS" area includes the portion of the Sanctuary contiguous with the Tofino MCTS radar coverage. The southern entrance lane and the inbound lanes of the northern approach are within OCNMS. While OCNMS summaries will include greater numbers of

inbound versus outbound vessels, it was selected as an analysis segment for two reasons: (1) it allows the analysis of Sanctuary specific traffic management issues and (2) this area includes the population of vessels which use the southern approach. With the exception of inbound vessels using the northern approach, these are the vessels which could potentially transit the ATBA. Querying the "ATBA" area allows analysis of the success of the ATBA program as well as identifying other vessels transiting closer inshore within the Sanctuary.

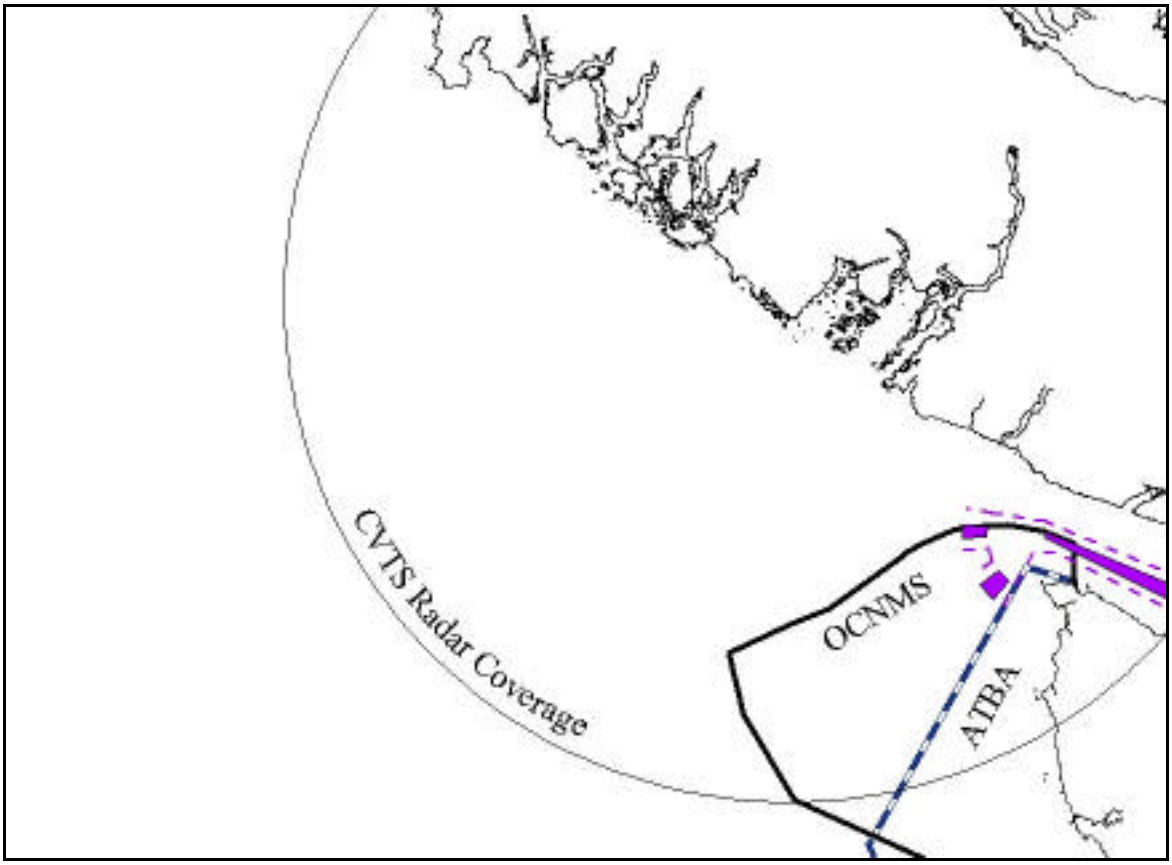


Figure 7. Areal coverage of OCNMS vessel traffic analysis segments

A cursory review of the data illustrates differences in where vessels transit according to vessel type. The distribution of vessels in the study area is influenced by vessel routing measures (the ATBA and the Traffic Separation Scheme), great circle routes to Asia, coastal shipping routes, military operating areas, and fishing grounds. Analysis of various vessel classes can illustrate the relative distribution of vessels. Although not included in this report, differences in the seasonality of vessel traffic patterns have also been observed. A summary for 1998 (Table 6 and Figure 8) illustrates some of the following differences:

- a decrease in the relative percentage of tank vessels transiting the OCNMS compared to those transiting the ATBA
- an increase in the relative percentage of tugs/barges transiting the OCNMS compared to those transiting the ATBA

- a decrease in the relative percentage of freighters transiting the OCNMS compared to those transiting the ATBA
- a decrease in the relative percentage of fishing vessels within the total radar coverage of the MCTS radar, compared to those seen within the OCNMS, with a further decrease within the ATBA

While a thorough spatial and temporal analysis of the CVTS data set could provide additional details on some of these differences, the analysis concentrates on the behavior of tank vessels in the ATBA.

Table 6. 1998 Summary, by class, of total vessels participating in the CVTS and subsets within OCNMS and ATBA

1998 Summary	CVTS Total	OCNMS	ATBA
Fishing Vessel	1905	656	90
Freighters	7553	5534	1075
Govt./Misc.	1730	935	202
Tank Vessel	1967	1515	160
Tugs/Barges	1284	826	669
Total	14439	9466	2196

Performance indicators can approximate the ATBA compliance rate and track the relative effectiveness of the ATBA initiative. An estimate of compliance is necessary because the data set does not include 100 percent of all transits and information on cargo is incomplete. Figure 9 illustrates the following three performance indicators:

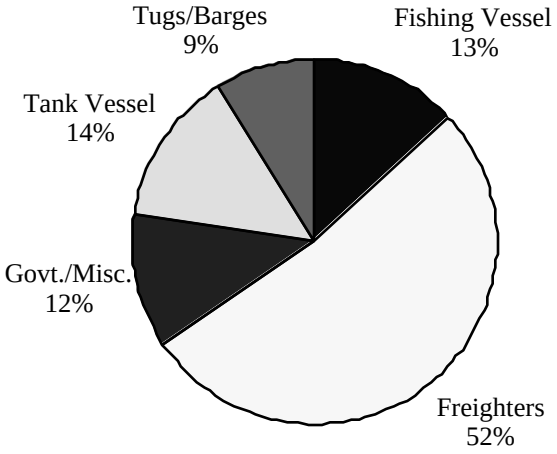
1. ATBA vessels: The percentage of all vessels within the boundary of the Sanctuary (within CVTS radar coverage) which are also within the ATBA
2. ATBA non-tank vessels : A subset of performance indicator “1” which includes freighters, tugs/barges, fishing vessels and government/misc. (Table 4)
3. ATBA tank vessels: A subset of performance indicator “1” which includes tank vessels (Table 4)

The first performance indicator can be used to determine if, over time, fewer vessels are transiting within the ATBA. The second two performance indicators divide all vessels into very general categories, with non-tank vessels being a measure of vessels for which the ATBA does not apply and tank vessels being a measure of vessels that should stay outside the ATBA.

Through correspondence with industry we now have a better understanding of the nature of some parts of the trade (e.g., some tank vessels identified transiting the ATBA were not carrying product). It is our understanding that inbound petroleum barges rarely carry product (McMahon, 1999), and we are no longer sending correspondence to these vessels.

1998 CVTS Summary

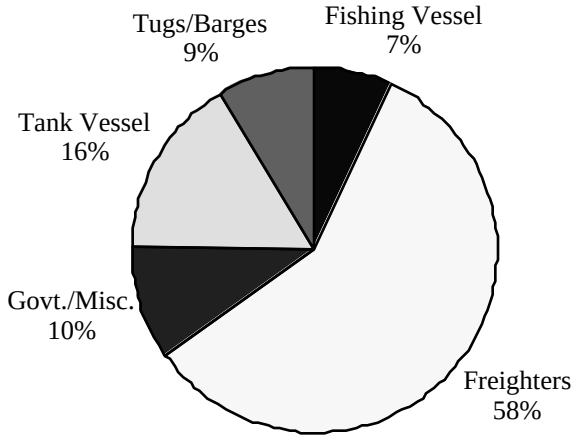
Percentages of vessels by class participating in the CVTS and under the radar coverage of the Tofino MCTS



1998 OCNMS Summary

Percentages of vessels by class within the Sanctuary

Subset of CVTS vessels, includes the southern lanes and the inbound northern lanes



1998 ATBA Summary

Percentages of vessels by class within the ATBA

Subset of OCNMS vessels

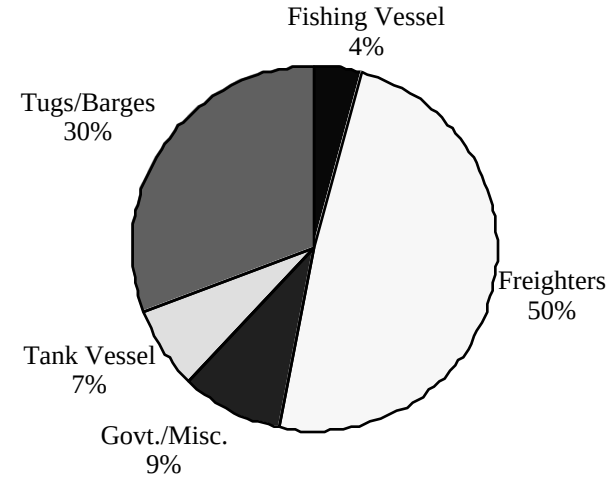


Figure 8. 1998 Summary, by class, and by area: CVTS, OCNMS and ATBA

Figure 10 reflects these findings, by placing inbound oil barges in the non-tank column, resulting in two additional performance indicators:

4. ATBA non-tank vessels in -corrected
5. ATBA tank vessels in -corrected

Figure 9 illustrates changes in vessel traffic patterns in the Sanctuary for the period from July 1995 through September 1999. During this period, the number of vessels transiting the ATBA has decreased; this is true for both absolute numbers and reflected as a percentage of vessels within the boundaries of the Sanctuary, also in the ATBA. In the third quarter of 1995, there were 643 transits in the ATBA, of these 86 were tank vessels. In 1999, for the same period there were 511 transits in the ATBA, of which 18 were tank vessels (Table 7). Representing total vessel transits in the ATBA, as a percentage of those in OCNMS, the values dropped from 27.1 percent to 20.5 percent for the same period. For tank vessels, the values dropped from 22.6 percent to 4.6 percent in the same period.

Table 7. Comparison of third quarter 1995 with third quarter 1999

Vessel Class	3rd Quarter 1995 - # transits			3rd Quarter 1999 - # transits		
	CVTS	OCNMS	ATBA	CVTS	OCNMS	ATBA
Fishing Vessels	491	112	14	461	115	32
Freighters	1974	1406	323	2051	1523	270
Govt./Misc.	452	298	68	585	303	91
Tank Vessel	482	380	**86**	502	395	**18**
Tugs/Barges	279	177	152	300	155	100
Total	3678	2373	**643**	3397	2491	**511**

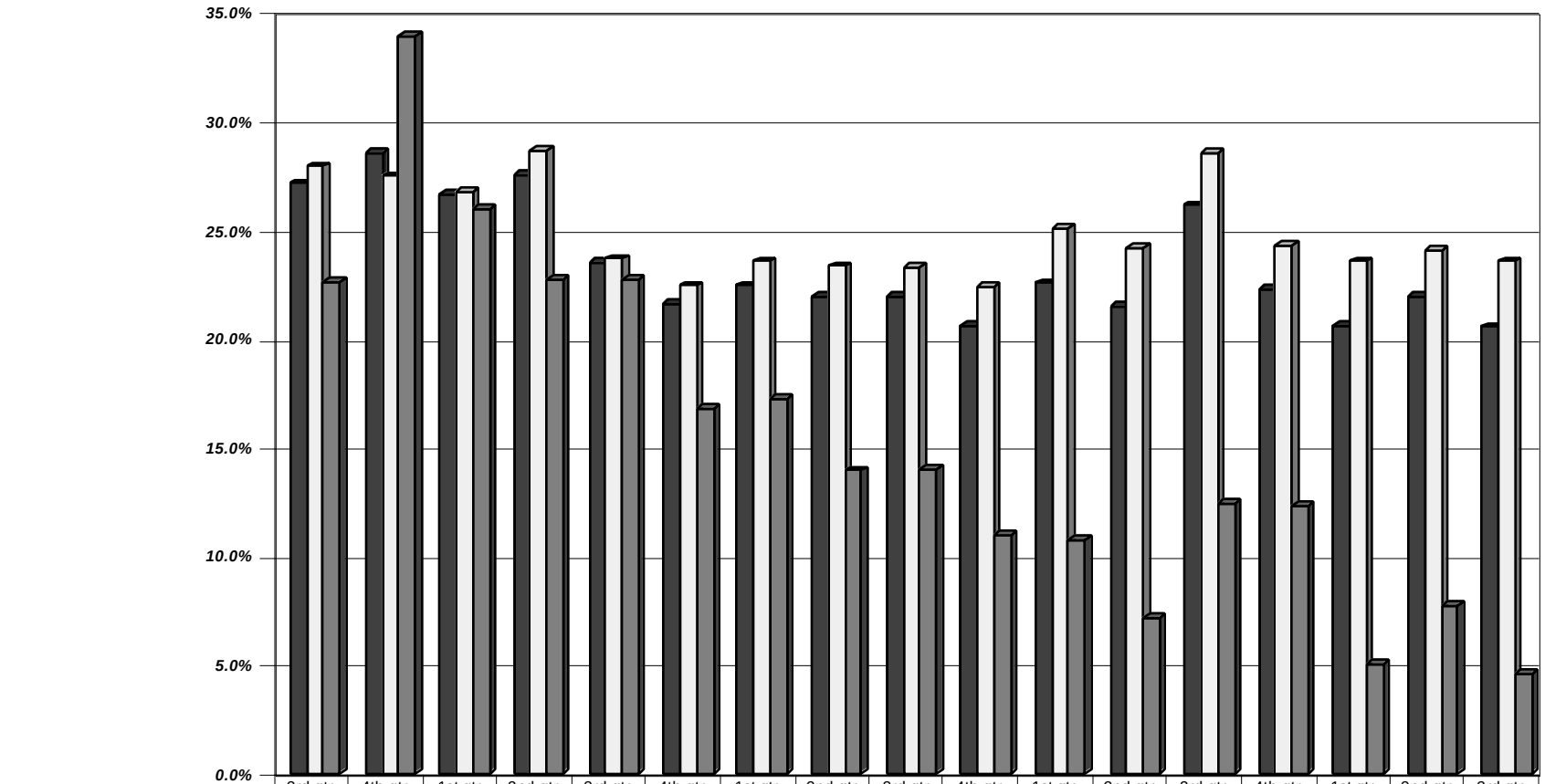
Further evaluation of tank vessels within the ATBA (Figure 11) illustrates the relative decreases in the different classes of tank vessels in the OCNMS ATBA since it went into effect in 1995. The most dramatic decreases are in the coastal and ocean going tanker, and barge categories. From the third quarter in 1995 to the third quarter in 1999 the number of vessels in the ATBA in these three categories changed significantly:

- coastal & ocean going tankers went from 18 to 1 vessel
- tugs with oil/gas barges went from 42 to 12 vessels (includes inbound and outbound transits)
- tugs with chemical barges went from 19 to 1 vessel

The effectiveness of the ATBA could be negatively impacted by changes in marine trade. For example, as the nature of the market changes it is possible to have owners/operators new to the area that may not be aware of the ATBA or the sensitive nature of the Sanctuary. Therefore, future improvements in the effectiveness of the ATBA, or at

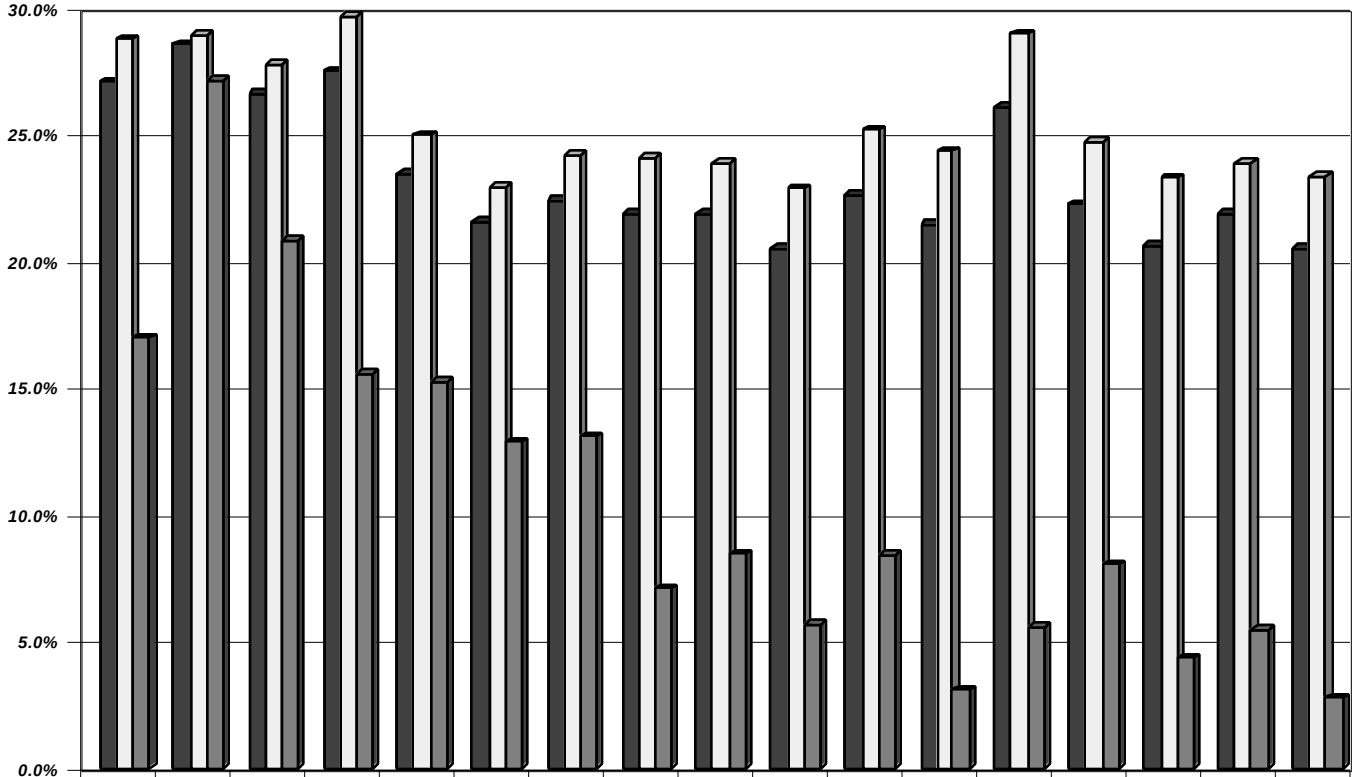
the very least the maintenance of the current effectiveness, will depend upon the continued involvement in vessel traffic managers, industry groups and the mariners themselves.

The ATBA went into effect in June 1995. Since that time information on the ATBA has been published in the *Local Notice to Mariners*, as chart corrections in the *Notice to Mariners*, plotted on new chart editions, in the *Coast Pilot,* and in the *VTS user guide* (Coast Guard, 1998). In addition, OCNMS has developed and distributed informational flyers and has instituted a targeted outreach campaign. While the data displayed in Figure 9 shows a definite trend, it is difficult to evaluate the relative value of each of these educational efforts. However, industry compliance to the IMO voluntary ATBA has steadily improved since its designation. The author believes that the CVTS vessel traffic data, along with industry correspondence, indicate that the OCNMS ATBA education and monitoring program is improving the effectiveness of the ATBA. Being able to track compliance is a vital component of any maritime and environmental safety initiative, either voluntary or regulatory.



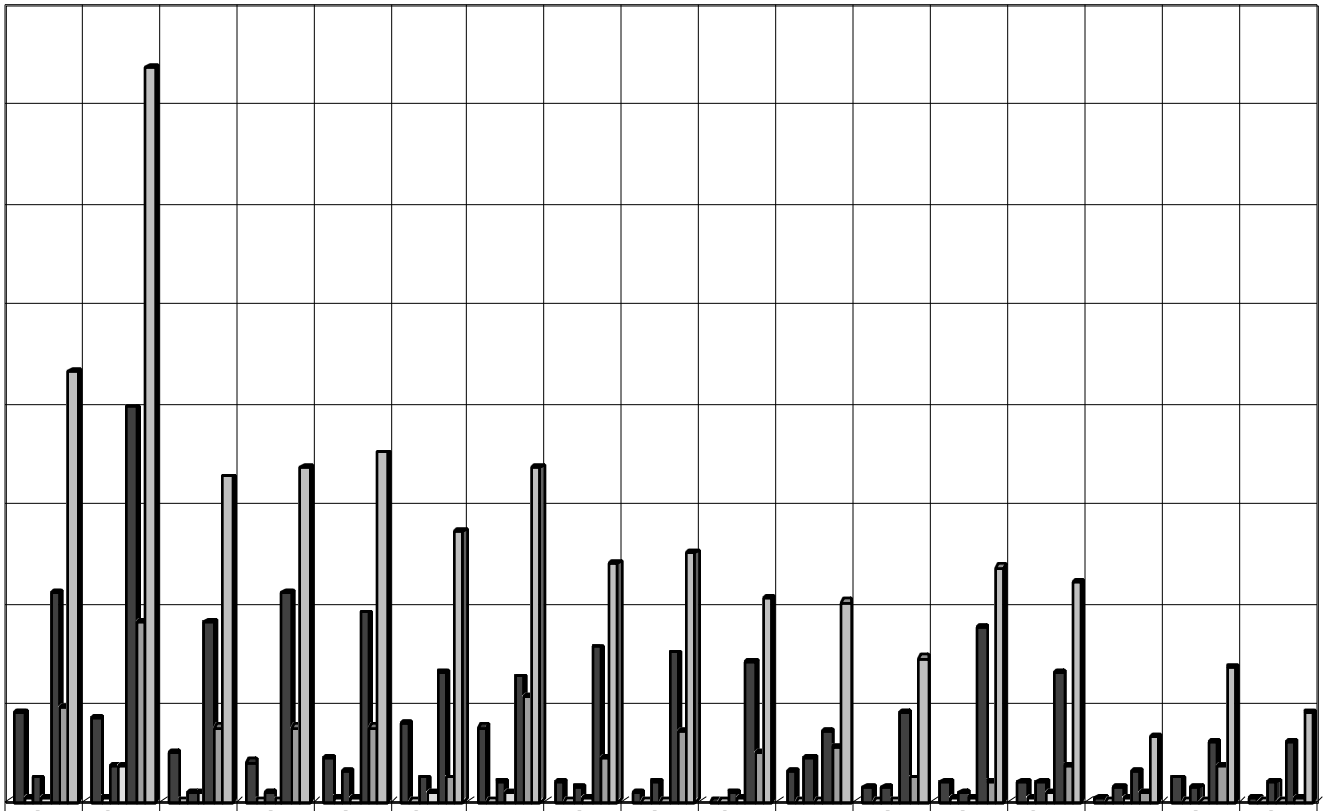
	3rd qtr 95	4th qtr 95	1st qtr 96	2nd qtr 96	3rd qtr 96	4th qtr 96	1st qtr 97	2nd qtr 97	3rd qtr 97	4th qtr 97	1st qtr 98	2nd qtr 98	3rd qtr 98	4th qtr 98	1st qtr 99	2nd qtr 99	3rd qtr 99
OCNMS vessels in ATBA	27.1%	28.6%	26.7%	27.6%	23.5%	21.5%	22.4%	21.9%	21.9%	20.5%	22.6%	21.5%	26.2%	22.3%	20.6%	21.9%	20.5%
OCNMS non-tank vessels in ATBA	27.9%	27.5%	26.8%	28.6%	23.7%	22.4%	23.5%	23.3%	23.3%	22.3%	25.0%	24.2%	28.5%	24.3%	23.6%	24.1%	23.5%
OCNMS tank vessels in ATBA	22.6%	33.9%	26.0%	22.7%	22.7%	16.8%	17.2%	13.9%	14.0%	10.9%	10.7%	7.2%	12.4%	12.3%	5.1%	7.7%	4.6%

Figure 9. ATBA quarterly performance summary, comparison of relative percentages of vessels found within the boundaries of OCNMS which are also within the ATBA



	3rd qtr 95	4th qtr 95	1st qtr 96	2nd qtr 96	3rd qtr 96	4th qtr 96	1st qtr 97	2nd qtr 97	3rd qtr 97	4th qtr 97	1st qtr 98	2nd qtr 98	3rd qtr 98	4th qtr 98	1st qtr 99	2nd qtr 99	3rd qtr 99
OCNMS vessels in ATBA	27.1%	28.6%	26.7%	27.6%	23.5%	21.5%	22.4%	21.9%	21.9%	20.5%	22.6%	21.5%	26.2%	22.3%	20.6%	21.9%	20.5%
OCNMS non-tank vessels in ATBA-corrected	28.8%	28.9%	27.8%	29.7%	25.0%	23.0%	24.2%	24.1%	23.9%	22.9%	25.2%	24.4%	29.0%	24.7%	23.3%	23.9%	23.4%
OCNMS tank vessels in ATBA-corrected	17.0%	27.2%	20.9%	15.6%	15.3%	12.9%	13.1%	7.1%	8.5%	5.7%	8.4%	3.1%	5.6%	8.1%	4.4%	5.5%	2.8%

Figure 10. ATBA quarterly performance summary (inbound oil/gas barges treated as non-tank vessel); comparison of relative percentages of vessels found within the boundaries of OCNMS which are also within the ATBA



	3rd Qtr 95	4th Qtr 95	1st Qtr 96	2nd Qtr 96	3rd Qtr 96	4th Qtr 96	1st Qtr 97	2nd Qtr 97	3rd Qtr 97	4th Qtr 97	1st Qtr 98	2nd Qtr 98	3rd Qtr 98	4th Qtr 98	1st Qtr 99	2nd Qtr 99	3rd Qtr 99
Coastal & Ocean Going Tanker	18	17	10	8	9	16	15	4	2	0	6	3	4	4	1	5	1
LPG/LNG Tanker	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0
Chemical Tanker	5	7	2	2	6	5	4	3	4	2	9	3	2	4	3	3	4
Veg Oil Molasses Tanker	1	7	2	0	1	2	2	1	0	1	0	0	1	2	1	0	0
Tug Oil/Gas Barge	42	79	36	42	38	26	25	31	30	28	14	18	35	26	6	12	12
Tug Chemical Barge	19	36	15	15	15	5	21	9	14	10	11	5	4	7	2	7	1
Total	86	147	65	67	70	54	67	48	50	41	40	29	47	44	13	27	18
Percentage of days covered	95%	98%	56%	45%	76%	81%	100%	92%	99%	99%	99%	100%	99%	92%	79%	98%	95%

Figure 11. Summary of tank vessels (total count for covered days) in the ATBA from July 1995 to September 1999

OTHER APPLICATIONS

In addition to monitoring the effectiveness of the Olympic Coast National Marine Sanctuary ATBA these data have other uses. Lessons from this specific monitoring effort can be applied to other vessel traffic systems and waterways. This section briefly discusses other uses of the specific data set used in the OCNMS ATBA program, as well as a more general discussion on the value of using Geographic Information Systems (GIS) in vessel traffic management.

Vessel traffic operators monitor real-time radar data and advise or, in some cases, direct vessels within the waterway. These operators have been a valuable source of information on the behavior of different classes of vessels in different segments of the waterway. They are familiar with vessel traffic patterns and are able to advise waterway managers on potential difficulties with the existing waterway. Analyzing vessel traffic data on GIS complements the expert opinion of experienced operators, vessel masters, and pilots. The ability to analyze spatial and temporal relationships between various classes of vessels in the evaluation of the waterway allows vessel traffic mangers to test and quantify the observations of marine experts. The combination of expert opinion and the ability to quantify patterns and trends can be a powerful tool in the evaluation of a waterway and the identification of solutions to user conflicts.

While the Sanctuary originally developed the LANPAR and Shiptracker programs to utilize CVTS data to monitor traffic in the ATBA, additional uses of this tool quickly emerged. As an important stakeholder in maritime and environmental safety in the region, NOAA has often commented to Department of Transportation dockets, which have requested comment on the need for additional measures in the waterway. Many of our comments have been based on our analysis of the CVTS data. The ability to graphically display various vessel traffic patterns has also improved the value of our contributions to the Department of Transportation's efforts. The following examples of our use of vessel traffic GIS data are from Sanctuary comments to Dockets[3] OST-1997-3286, USCG-1998-4501, and USCG-1999-4974:

- Graphically displayed vessel traffic patterns and densities in OCNMS;
  - for the entire waterway;
  - for tug/barge traffic in the vicinity of Duntze Rock;
  - illustrated fishing vessels density;
- Provided an independent analysis of tug transits/area estimates in the different ITOS coverage areas, as reported in the U.S. Coast Guard Addendum Report to Congress on the International, Private Sector Tug-of-Opportunity System;
- Demonstrated how the CVTS radar data could be used to evaluate ITOS;

[3] Comments to these, and other dockets, can be downloaded from http://dms.dot.gov/

- Provided analysis of relative usage of north and south vessel traffic lanes, by inbound and outbound for each individual vessel class.

In addition to the above, the Sanctuary has assisted the U. S. Coast Guard in a Port Access Routes Study evaluating a possible traffic separation scheme (TSS) realignment. The OCNMS vessel monitoring system was used to look for high concentrations of commercial fishing activity, analyze the relative usage of the north and south approaches to the Strait of Juan de Fuca, and analyze tug traffic at the entrance to the Strait.

The following capabilities, both those of the Sanctuary system as well as potential enhancements, are offered for consideration as potential improvements to currently existing vessel traffic systems:

- Existing OCNMS capabilities;
  - Determining relative vessel densities by vessel type and class;
  - Determining relative usage of different portions of the waterway (TSS, inshore lanes and environmentally sensitive areas) by vessel type;
  - Tracking seasonality of vessel traffic patterns;
  - Tracking vessel traffic trends;
  - Assisting education and law enforcement activities (e.g., unreported oil slicks).
  - Playback capability to evaluate incidents (e.g., close quarters or collision);
- Additional capabilities recommended for future monitoring systems;
  - Correlating vessel behavior (presence/absence, speed and routing) related to varying conditions (high vessel density, visibility, and severe weather);
  - Developing additional query capabilities by adding fields to the vessel database (e.g., flag of state, cargo status, last port of call, destination, and risk screening information).

Capturing real-time vessel traffic data and making it available for more in-depth analysis can augment day-to-day vessel traffic management capabilities. Similar vessel traffic monitoring capabilities could be considered for implementation in waterways that currently have vessel traffic systems and/or be incorporated into future Automatic Identification Systems (AIS)[4].

RECOMMENDATIONS FOR THE FUTURE

The Volpe Study determined that the three most likely causes of accidents in the Sanctuary were collision, drift groundings, and powered groundings, in that order (Volpe, 1997). By routing certain classes of vessels further offshore, the OCNMS ATBA addresses both drift and powered groundings. While the designation of the ATBA has improved

[4] Automatic Identification System (AIS) technology allows vessels to broadcast their position, name and other information to other vessels and shore stations. AIS systems (e.g., ITOS) are being considered and implemented both regionally and internationally.

maritime and environmental safety within the Sanctuary, addressing two classes of accidents for a limited population of commercial vessels, it is only one means of improving maritime and environmental safety in OCNMS. The Sanctuary has been participating in other initiatives reviewing additional measures, which are evaluating additional measures to improve maritime and environmental safety in the region, including:

- Port Access Routes Study; Strait of Juan de Fuca and Adjacent Waters - F.R. Vol. 64, No. 72, Thursday, April 15, 1999 (PARS);
- Improvements to Marine Safety in Puget Sound-Area Waters - F.R. Vol. 64, No. 79, Monday, April 26, 1999 (Tug Cost-Benefit Analysis);
- Navigational Safety Advisory Panel; North Puget Sound Long-term Risk Management Panel - F.R. Vol. 64, No. 171, Friday, September 3, 1999 (NPSRMP);
- States/British Columbia Oil Spill Task Force West Coast Offshore Vessel Traffic Risk Management Working Group (Offshore routing working group).

The population of potential measures includes both universal measures, which improve maritime and environmental safety throughout the nation or the world, and local measures, which address waterway specific initiatives. While the Sanctuary recognizes the role of universal measures in protecting OCNMS resources, the Sanctuary's efforts have been concentrated on site-specific initiatives. In the previously mentioned Coast Guard dockets, as well as in other forums, the Sanctuary has commented on:

- extending radar coverage on the coast;
- realigning the TSS;
- offshore routing[5];
- extending the applicability and boundaries of the ATBA;
- ITOS;
- the potential need for a dedicated emergency towing vessel;
- tug escort requirements.

The first four of these could potentially improve effectiveness of the OCNMS ATBA education and monitoring program in protecting the resources of the Sanctuary. The last three are currently being evaluated as part of the previously mentioned cost-benefit analysis and are not addressed in this paper.

The Sanctuary is an advocate of extending radar coverage within the Sanctuary; this would allow for better monitoring of vessel traffic within the Sanctuary. Since originally

[5] The Monterey Bay National Marine Sanctuary and the U. S. Coast Guard have been engaged in a multi-year effort addressing maritime and environmental safety in the Sanctuary. The Navigation Subcommittee of the International Maritime Organization has recently approved the resulting offshore routing proposal, consisting of recommended tracks off the coast of California. These tracks will recommend that container ships and bulk product carriers travel in north-south tracks between 13 and 20 nautical miles offshore, and that ships carrying hazardous materials in bulk travel in north-south tracks between 25 and 30 nm from shore. This proposal is expected to be adopted by the Maritime Committee in May 2000.

suggesting such an approach, OCNMS became aware of an U. S. Navy radar installation on Mt. Octopus, which could complement the Canadian Coast Guard's radar site on Mt. Ozzard. The second measure is the realignment of the vessel traffic lanes in the Sanctuary at the entrance to the Strait of Juan de Fuca. The Sanctuary has recommended that such a realignment route traffic further offshore, further away from navigation hazards and when possible, away from concentrations of fishing vessels. The Sanctuary has also recommended, along with many others, that offshore routing measures should be evaluated. Offshore routes would consist of recommended tracks where certain classes of vessels should transit. This differs from an ATBA in that it directs where traffic should transit versus identifying areas that should be avoided. Comments on the fourth measure, extending the applicability and boundaries of the ATBA, actually date back to before the ATBA went into effect.

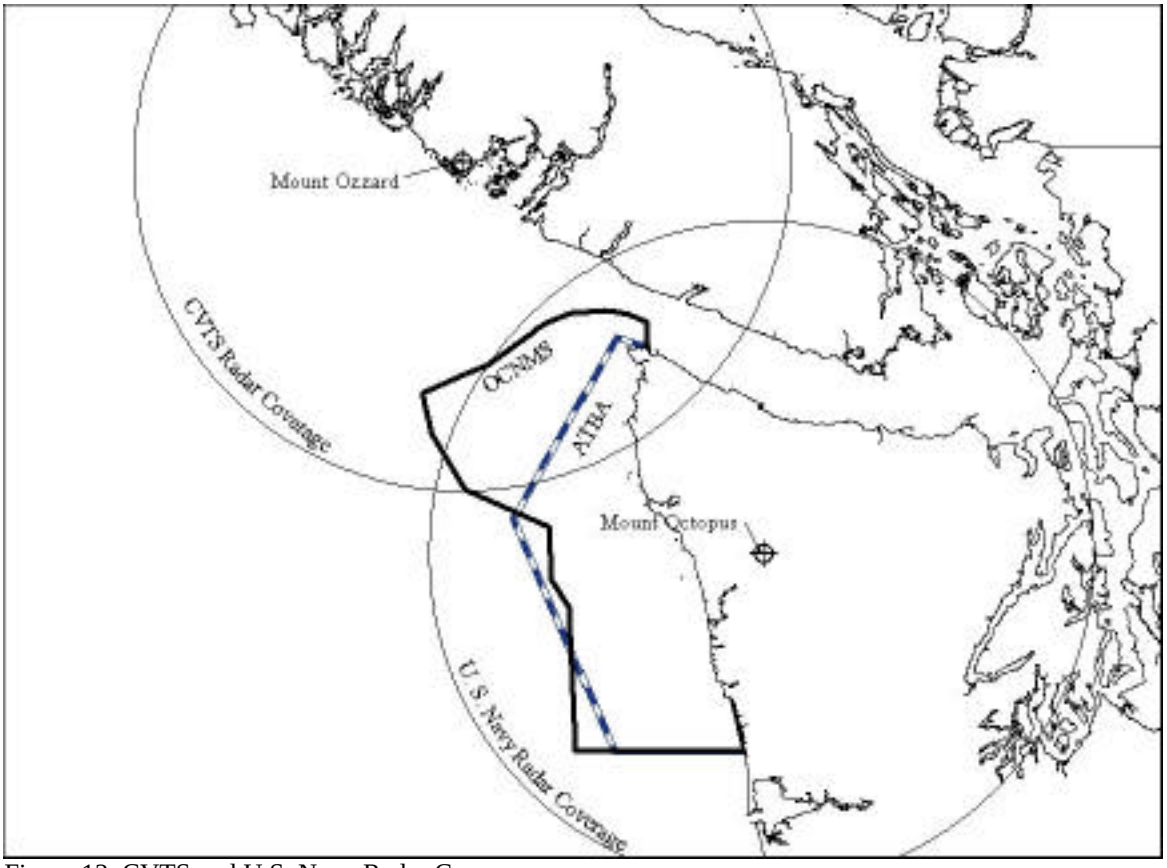


Figure 12 CVTS and U.S. Navy Radar Coverage

In early 1995, the U. S. Coast Guard held a public meeting to discuss if the applicability of the newly designated ATBA should be expanded to include vessels and barges other then those carrying cargoes of oil or hazardous materials. This meeting was in response to concerns raised shortly before the Subcommittee on Safety of Navigation considered the OCNMS ATBA proposal. The U. S. delegation informed the subcommittee that the issue of expanding this ATBA to include other categories of commercial vessels would be considered further at the national level and, if appropriate, an amendment would be submitted for IMO consideration (F. R. Vol. 60, No. 18, Friday, January 27, 1995).

The Coast Guard received extensive public comment, which addressed a number of safety and economic concerns. Recommendations for change included a call to expand the ATBA to all vessels over 500 gross tons, with some calling to exempt non-hazardous barges, fishing, military, and tour vessels. Those advocating a change to the ATBA were concerned with the consequences of a spill of large amounts of bunker fuel noting that vessels, for which the ATBA does not apply, carry large amounts of bunker fuel. Those opposed to changing the ATBA generally agreed with the provisions of the ATBA as originally designated. Comments opposing changes to the ATBA included concerns of the economic impact on vessels transiting between Grays Harbor and Puget Sound and on the fishing industry. A number of safety concerns were also raised, including the increased probability of meeting situation, and collisions, along the offshore boundary of the ATBA (F. R. Vol. 60, No. 184, Friday, September 22, 1995).

NOAA recognized that threats existed from other types of shipping. However, at the time the ATBA proposal was submitted insufficient data existed for including other types of vessels. OCNMS supported the ATBA as designated and recommended that no change be made without further study. Through our vessel monitoring efforts, we now have a better understanding of which vessels would be impacted by a change to the ATBA. The third pie chart in Figure 8 illustrates a relative mix of five different vessel classes. The vessels for which the ATBA does not apply, which have previously been identified as being of the greatest concern, are large commercial vessels. The vessel class, which most closely represents this group, is the freighter class (Table 4). In 1998 this class of vessels represented 50 percent of the vessels transiting through the ATBA. Figure 13 illustrates the relative mix of the vessels in this Freighter Class, with a few minor exceptions. Of these vessels bulk carriers are the most prevalent at 47 percent, followed by container ships at 29 percent (Figure 13). The vessels reflected in Figure 13 represent 1,068 transits. Because some data gaps exist the actual number of transits will be somewhat higher (Table 5).

Future changes to the ATBA are dependent upon the outcomes of the four previously mentioned initiatives (PARS, tug cost-benefit analysis, NPSRMP, offshore routing working group). The Port Access Routes Study may realign the current traffic lanes adjacent to the ATBA. If this occurs the boundaries of the ATBA should be reevaluated. In the current ATBA configuration (Figure 1) the seaward boundary is contiguous with the inshore boundary of the southern traffic lanes. If these lanes are moved offshore it will be possible to modify the ATBA boundaries to increase the distance from navigational hazards, while allowing room for inshore traffic.[6] While the cost-benefit analysis on various tug options (rescue tug, ITOS, and tug escorts) is not directly related to the ATBA, the outcome of the study should be evaluated in considering future changes to the ATBA. If the States/British Columbia Oil Spill Task Force offshore vessel traffic risk management working group can

[6] OCNMS has observed some tugs with oil barges transiting southbound in the northbound lanes, along the seaward boundary of the ATBA.

address the issue of offshore routing in, or adjacent to, the Sanctuary, then it may be possible to readdress the issue of applicability of the ATBA. Finally, the work of the North Puget Sound Risk Management Panel could result in specific recommendations, which may address any, or all, of the above issues. The Volpe Study, the recent ITOS analysis, the recently released cost-benefit analysis, the recommendations of the Port Access Routes Study, the work of the States/British Columbia offshore routing work group, and this report will all provide information for the North Puget Sound Risk Management Panel.

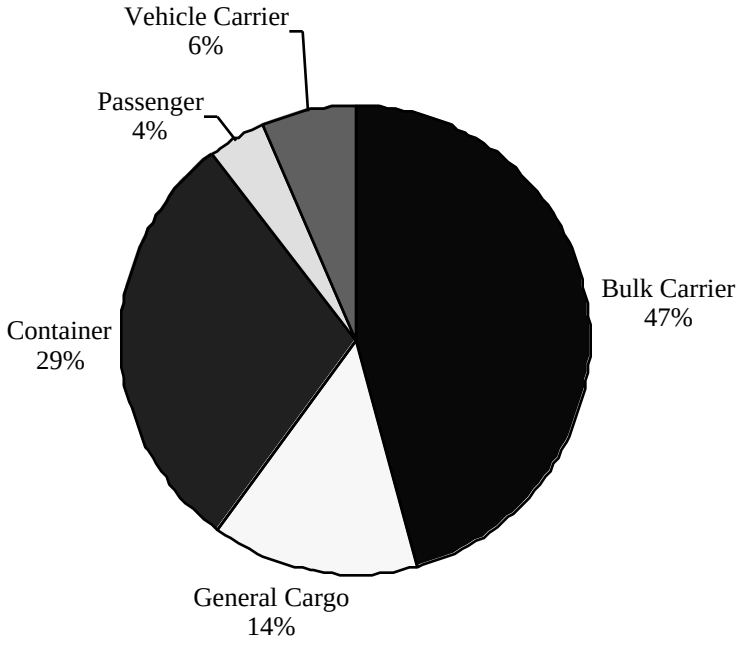


Figure 13. 1998 Summary of Freighter Class Vessels in the ATBA[7]

The following recommendations for the ATBA are sequential[8], with each recommendation predicated upon a specific outcome:

- If the TSS is realigned, then ➡ reevaluate the boundaries of the ATBA;
- If offshore routes are recommended, then ➡ reevaluate the applicability of the ATBA;

[7] To better illustrate the relative mix of vessels, RO-RO vessels were combined with vehicle carriers, coastal vessels were combined with general cargo and 7 reefer vessels (often associated with commercial fishing) were excluded.

[8] These recommendations are the author's and have not been approved as an official NOAA position on the OCNMS ATBA.

Figure 14 shows the current Coast Guard Port Access Route Study (PARS) recommendation for the entrance to the Strait of Juan de Fuca. This recommendation, if implemented, would:

- Extend the TSS approximately 10 miles further offshore;
- Center the separation zone on the International boundary;
- Retain multiple approach lanes;
- Configure lanes, where possible, to avoid customary fishing grounds;
- Create a new exit lane for Northerly coastwise traffic;
- Expand the ATBA to the north and west to provide a greater buffer around Duntze Rock and offshore, while providing a protected route for slower moving vessels;
- Establish IMO "recommended routes" north and south of the TSS to formally recognize and accommodate the existing traffic patterns (excerpt from CG presentation to the North Puget Sound Risk Management Panel).

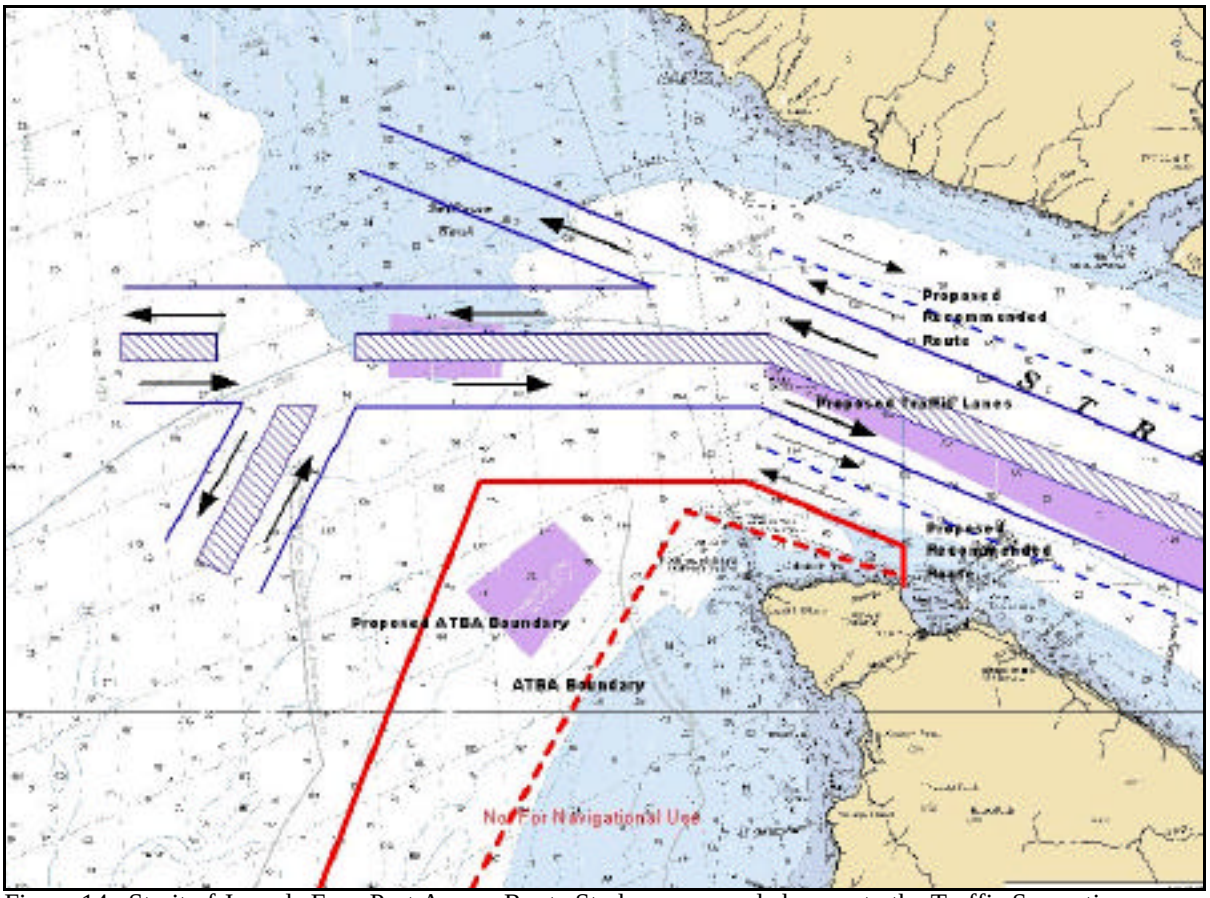


Figure 14. Strait of Juan de Fuca Port Access Route Study – proposed changes to the Traffic Separation Scheme and ATBA

A similar proposal was included in OCNMS's May 1999, comments to the Port Access Routes Study Docket. This Sanctuary scenario differed in that it eliminated the southern approach and included offshore routes. The Coast Guard has been consulting with

different groups while developing this proposal and determined that it was desirable to retain multiple approach lanes to maintain order and predictability for vessels entering or exiting the Strait. While the Coast Guard recommendations do not address offshore routing, they could easily be compatible with recommendations from the States/British Columbia Offshore Routing work group. If offshore routes were proposed, then it would be worthwhile to consider extending the applicability of the ATBA to large commercial vessels. Industry would need to be consulted and certain exceptions would need to be allowed for including government, fishing, and tug/barge vessels. The routing of large commercial vessels, in a controlled manner, further off the coast will significantly improve maritime and environmental safety in the Sanctuary. Given the success shown by the current voluntary ATBA, the author believes that the voluntary nature of any future ATBA should continue.

The TSS realignment, offshore routes, and modifications to the ATBA must all be approved and adopted by the IMO. These initiatives could be sequential or they could be submitted as a comprehensive package.

SUMMARY

The implementation of the OCNMS ATBA education and monitoring program has been greatly aided by the availability of radar data and the cooperation of industry and the U.S. and Canadian Coast Guards. The Sanctuary's efforts to view existing radar data on a GIS system have allowed performance measures to be selected and tracked and provides a means to plot individual vessel tracklines. Plots of tank vessels observed within the ATBA are forwarded to the Coast Guard Captain of the Port. Correspondence, under the joint signature of the Captain of the Port and the Sanctuary Superintendent, is then sent to the vessel owner requesting cooperation with the ATBA initiative. Feedback from our ATBA education and monitoring program has been very favorable. Radar data has been evaluated to determine if a measurable change in behavior has occurred since the beginning of our efforts. A positive correlation has been found between educational efforts and the effectiveness of the ATBA.

OCNMS's monitoring program has had additional benefits beyond our outreach efforts and the evaluation of ATBA effectiveness. The Sanctuary has been able to contribute to discussions on maritime and environmental safety in the region by providing a more rigorous evaluation of vessel traffic patterns than would be otherwise possible. This program has also demonstrated the value of this type of analysis to vessel traffic managers and to others interested in improving maritime and environmental safety.

While the ATBA has improved maritime and environmental safety in the Sanctuary, more can be done. Some of the measures currently being evaluated, if implemented, could complement the ATBA initiative. OCNMS will continue its education and monitoring efforts to maintain this successful initiative while continually seeking additional opportunities for improvements to the waterway.

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