APPENDIX K – DISCHARGE ESTIMATION METHODOLOGY

Information regarding vessel transits, including distance and time in the sanctuary was obtained from three different sources of information:

- Cooperative Vessel Traffic Service (CVTS) radar data
- NMFS Vessel Monitoring System (VMS) satellite data
- WDFW Recreational Fishing Data, collected by Port Sampling Staff

This information was used to develop estimates on vessel discharges in the sanctuary in 2009. 2009 was chosen for analysis because it was the most recent period for which complete information existed for each of the three data sources. While each of these data sources collects data for different purposes and contains different information, they have in common information that lends itself to an overall assessment of vessel usage with the sanctuary. In order to develop discharge estimates certain data was estimated.

Table 19 Comparison of vessel data sources

Data Source	Type of Vessel	# of Transits	Spatial Information	Time in Sanctuary	# of Passengers
CVTS	Vessels participating in vessel traffic system - mostly large commercial vessels	YES – each transit has a unique ID	YES	YES– needed to be calculated based on point data	NO – estimated
NMFS	Commercial fishing vessels required by fisheries management plan to carry VMS system	NO– estimated number of transits was calculated	YES	YES– needed to be calculated based on point data	NO – estimated
WDFW	Washington State recreational fishers (includes charter vessels)	YES – summarized by boat trip	PARTIALLY – reported by Marine Areas, estimated % time within OCNMS.	NO – time per trip was estimated	YES – summarized by angler trips

Cooperative Vessel Traffic Service (CVTS) Radar Data

This data is collected by the Canadian Coast Guard Marine Communications and Traffic Services (MCTS) and includes all vessels participating in the Cooperative Vessel Traffic (CVTS). This data is forwarded to OCNMS, which imports the information into a Geographic Information System (GIS) system. For each class of vessel class, the number of "vessel days per year" (the total combined time all vessels within a given class spent within OCMNS waters in 2009) was calculated from CVTS data. The range of the CVTS radar does not cover the whole sanctuary (Figure 15) but it does cover the northern portion of the sanctuary where vessels complying with the ATBA (estimated at >98% of vessels) are transiting sanctuary waters. Vessels in compliance with the ATBA can traverse a small portion of the sanctuary in the south, so the time estimates calculated by this method can provide a small underestimate of time in sanctuary, which in turn could result in an underestimate of total discharge. This is the sanctuary's primary source of vessel traffic data. This data was used for the following Vessel Classes (Table 6 and Table 7):

- Commercial Vessels < 300 GT
- Commercial Vessels 300-1599 GT
- Commercial Vessels > 1600 GT

- Passenger Vessels < 300 GT
- Passenger Vessels 300-1599 GT
- Passenger Vessels > 1600 GT
- Public Vessels < 300 GT
- Public Vessels 300-1599 GT
- Public Vessels > 1600 GT
- Tank Vessels < 1600 GT
- Tank Vessels > 1600 GT
- Tug with Tank Barge

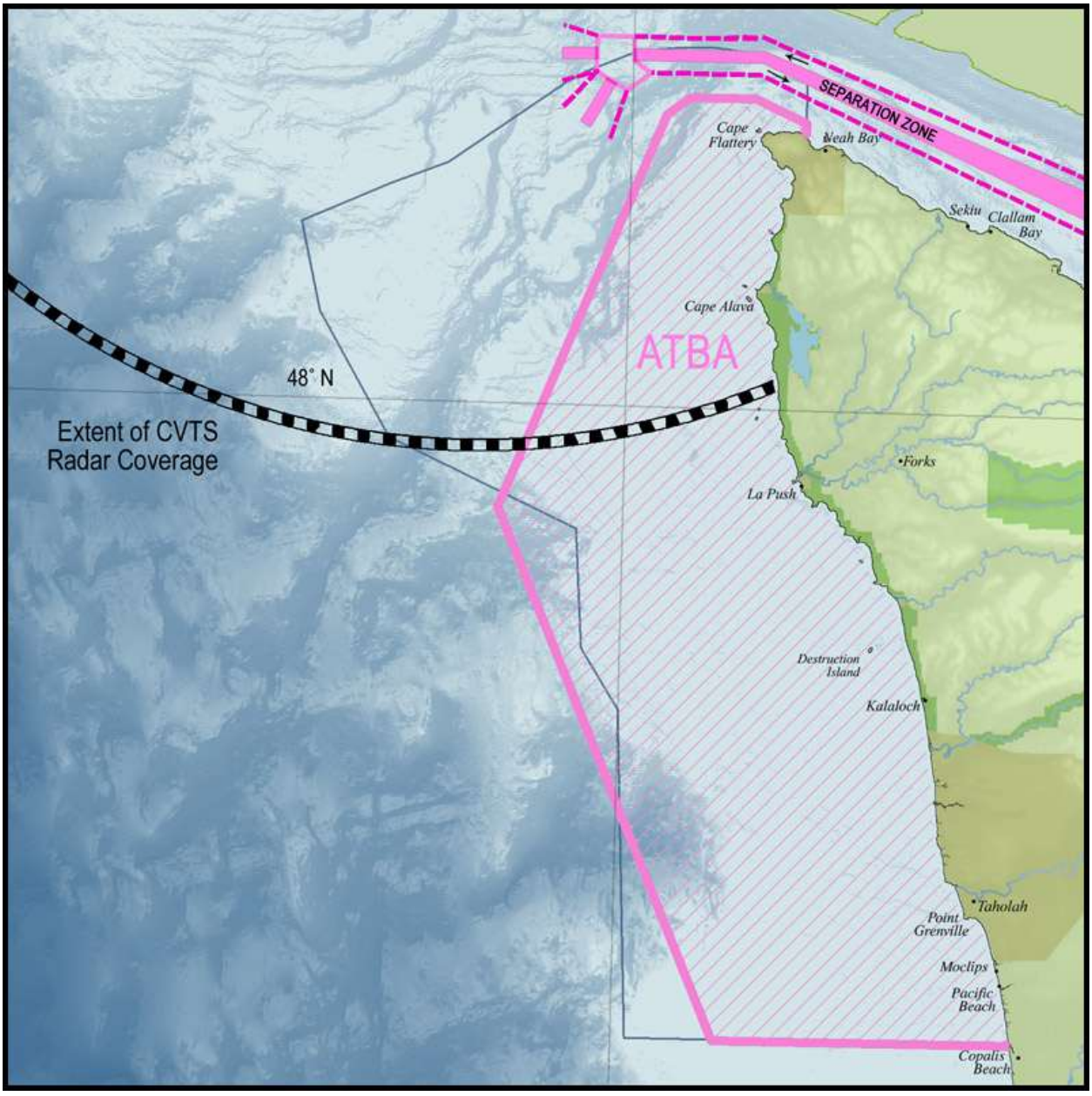

Figure 15 Extent of the Canadian Coast Guard radar coverage within OCNMS

NMFS Vessel Monitoring System (VMS) Satellite Data

National Marine Fisheries Service Northwest Region and the Pacific Fisheries Management Council have a vessel monitoring program to monitor compliance with areas closed to fishing. The program utilizes a satellite based Vessel Monitoring System (VMS) that reports the position of participating vessels. NMFS provided OCNMS with point data for VMS participating vessels within the sanctuary during 2009. There were 52,015 points, representing 171 individual vessels that met these criteria. Not all information from the VMS database was provided for the analysis, e.g., while unique vessel ID's were provided they cannot be used to identify the vessel's name. The data points were sorted by time, then boat ID. Transit ID's were then added, incrementing the transit ID number any time the boat ID changed, or the boat ID was the same but the time jumped by more than 6 hours. Each transit ID contains a continuous set of points for one boat with no more than 6 contiguous hours of missing points. Therefore, for the purposes of this analysis a transit is defined by time in the sanctuary, not the duration of time between port calls. If a fishing vessel is fishing part time in the sanctuary and part time out, then their fishing trip might be broken into multiple transits. This analysis resulted in an estimate of 3,006 fishing transits in the sanctuary for a total of 1,577 vessel days for 2009. This information was used for the Commercial Fishing Vessel Class (Table 6 and Table 7):

WDFW Recreational Fishing Data

As part of their Port Sampling Program, WDFW collects information on recreational fishing activity. This data is reports both boat trips and angler trips, by WDFW Marine Areas (Figure 16). The sanctuary boundaries include all of Marine Areas 3 and 4 and approximately 28% on 4B and 29% of Marine Area 2. For the purpose of this analysis we assumed boat trips and angler trips were equally distributed throughout the reporting area, and each boat trip lasted an estimated six hours. Actual distribution will vary according to the location of preferred fishing areas, distance from port and weather conditions.

After estimating the number of boat trips in OCNMS in 2009 (10,351 private and 1,148 charter) (Table 20), an average was calculated for number of anglers per trip (2.8 private and 10.6 charter) (Table 21). This information was used to for the following Vessel Class (Table 6 and Table 7):

- Charter Fishing Vessel
- Recreational Fishing Vessel

Table 20 Recreational fishing boat trips, within OCNMS, for 2009

2009	Marine Area	Boat Trips in Entire Marine Area			Boat Trips in OCNMS			
		Private	Charter	Total	% of area in OCNMS	Private	Charter	Total
Neah Bay-straits	4B	6,401	34	6,435	28%	1,792	10	1,802
Neah Bay -coast	4	3,607	120	3,727	100%	3,607	120	3,727
La Push	3	2,760	343	3,103	100%	2,760	343	3,103
Westport	2	7,556	2,329	9,885	29%	2,191	675	2,867
Total		**20,324**	**2,826**	**23,150**		**10,351**	**1,148**	**11,498**

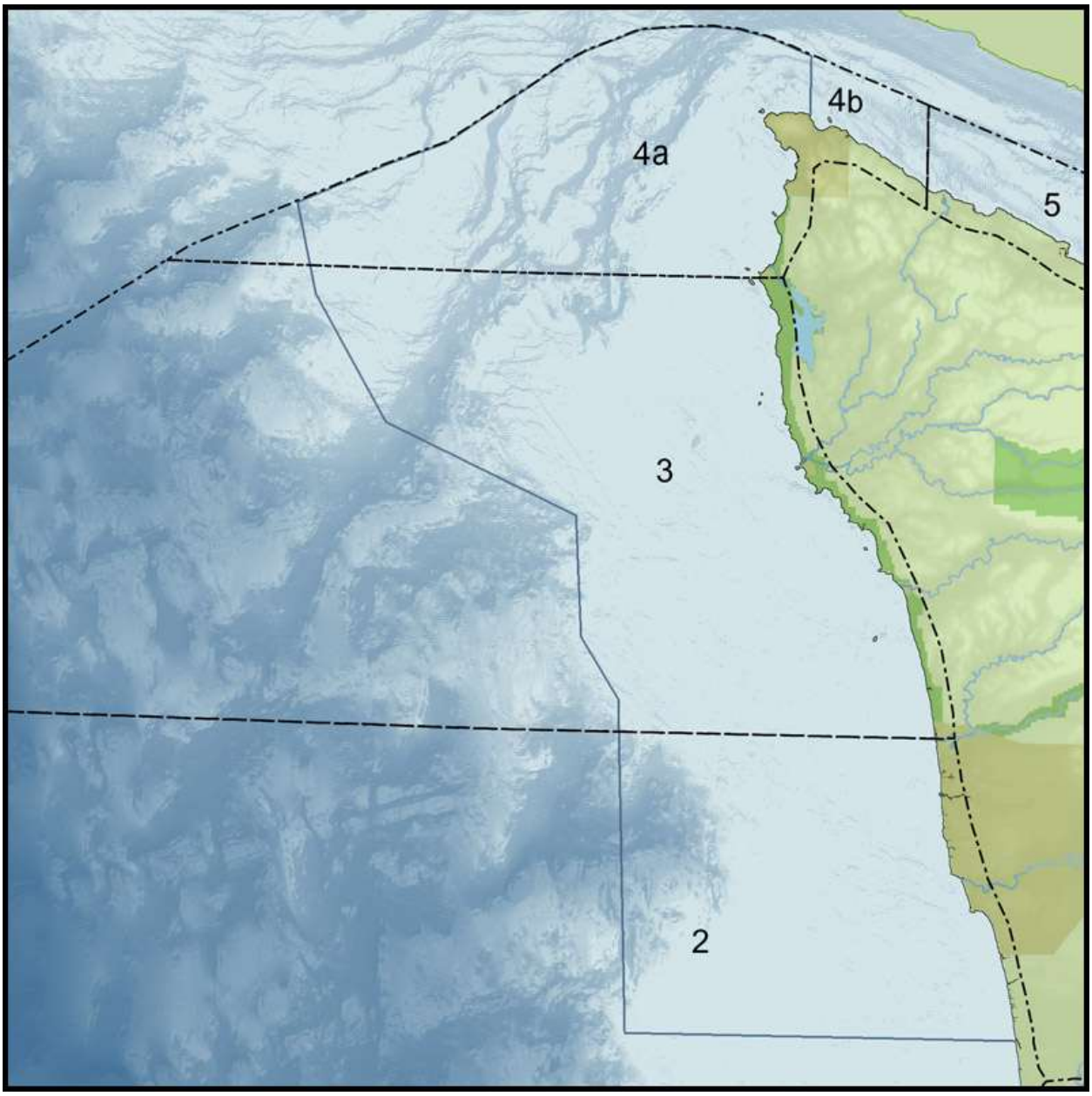

Figure 16 WDFW Marine Areas and OCNMS Boundary

Annual Discharge Volume (ADV) Calculation

Annual discharge volume (ADV) estimates for each vessel class was calculated using **Equation 1** based on the number of vessel days per year in the OCNMS, the number of people aboard (including passengers and crew), and the average wastewater generation rate per person. It is difficult to estimate the exact quantity of sewage generated per person per day because variable volumes of water are used to flush different types of toilets. Product information for three popular type II MSDs (The Tank MSD®, Ahead Tank®, and Orca®) suggest wastewater generation rates of 5.5, 9.2, and 30 gallons of blackwater generated per person per day, respectively. Measured sewage wastewater generation rates of cruise ships in Alaska in 2004 ranged from 1.1 gallons to 27 gallons per person per day (EPA 2008a), indicating the wastewater generation rate estimates provided by MSD manufacturers fall within a reasonable range.

Because of the potential variability in waste generation rate, a minimum, average, and high estimate, based on hypothetical sewage generation rates of 5.5, 15 and 30 gallons of waste per person per day are reported in Table 6. The average waste generation rate was calculated as the mean of the MSD product information rates identified above.

Table 21 Recreational fishing angler trips, within OCNMS, for 2009

Marine Area	Angler Trips in Entire Marine Area			Angler Trips in OCNMS				Average Anglers/Vessel in OCNMS	
	Private	Charter	Total	% of area in OCNMS	Private	Charter	Total	Private	Charter
4B	16,905	127	17,032	28%	4,733	36	4,769	2.6	3.7
4	10,497	742	11,239	100%	10,497	742	11,239	2.9	6.2
3	7,832	2,157	9,989	100%	7,832	2,157	9,989	2.8	6.3
2	20,869	31,814	52,683	29%	6,052	9,226	15,278	2.8	13.7
Total	**56,103**	**34,840**	**90,943**		**29,114**	**12,161**	**41,275**	**2.8**	**10.6**

Some vessels have the ability to hold treated sewage effluent for a period of hours to days, depending holding tank size. However, even with these systems, the overall average discharge rate must equal the waste generation rate. For this reason, the discharge rate used in calculations is assumed to equal the waste generation rate. Because recreational fishing vessels, in general, have minimal kitchen and showering capacity and are day use only, this vessel class was not included in estimates of graywater discharges.

The volume of graywater generated on vessels less than 79 feet varied widely depending on type of vessel, ranging from a few to several hundred gallons/vessel/day. Estimated graywater generation rates of 36, 67, and 119 gallons/person/per day (U.S. EPA 2008a) are reported in Table 7.

Equation 1

$$ADV = VDY \times N \times WGR$$

where:

ADV: Annual Discharge Volume
VDY: Vessel Days per Year
N: Number of passengers aboard vessel
WGR: Waste generated per person per day

Wastewater Treatment System Descriptions

The Federal Water Pollution Control Act, also informally called the Clean Water Act or CWA (33 U.S.C.1251 et seq.), requires any vessel with installed toilet facilities must also have an operable MSD. Three general types of MSDs are available and in use. Type I and II MSDs treat the wastewater before its discharge or transfer. Type III MSDs are storage tanks which retain waste until it can be disposed of at an appropriate pump-out facility or at sea.

- Type I MSDs rely on maceration and chemical disinfection for treatment of the waste prior to its discharge into the water, and are only legal in vessels under 65 feet in length (U.S. EPA 2010a). USCG regulations dictate that effluent from Type I MSDs may not have a fecal coliform count greater than 1,000 per 100 milliliters, nor visible floating solids (USCG 2009).
- Type II MSDs provide an advanced form of the same type of treatment used by Type I MSDs and have a greater capacity to reduce fecal coliform counts and suspended solids. Different from Type I MSDs which rely solely on maceration to break down solid waste, Type II MSDs utilize aeration and aerobic bacteria in addition to maceration for the breakdown of solids. As with Type I MSDs, the waste is chemically disinfected, typically with chlorine, ammonia or formaldehyde, prior to discharge. Type II MSDs are legal in any size class of vessel, and there are a variety of different types (U.S. EPA 2008b). USCG regulations prohibit discharge of effluent from Type II MSDs with fecal coliform counts greater than 200 per 100 milliliters or suspended solids greater than 150 milligrams per liter (USCG 2009).
- Advanced wastewater treatment systems (AWTS) are an advanced form of Type II MSD utilizing techniques such as reverse osmosis and UV sterilization to provide more effective treatment. The performance of these units far surpasses the standards for fecal coliform bacteria, as well as other pollutants, set forth for Type II MSDs. In addition, AWTS typically produce ‘clean’ discharge waste containing substantially lower concentrations of hazardous treatment chemicals (U.S. EPA 2008a).
- Type III MSDs, commonly called holding tanks, flush sewage from the marine head into a tank that may contain deodorizers and other chemicals, predominantly chlorine. The contents of the holding tank are stored until they can be properly disposed of at a shore-side pump-out facility, or discharged off shore. Storing wastewater in holding tanks can increase fecal coliform counts and total suspended solids (ADEC 2000). Type III MSDs can be equipped with a discharge option, usually called a Y-valve, which directs the sewage into either the holding tank or directly overboard.