

Ecosystem Services from Shellfish Harvest for Puget Sound

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The Puget Sound estuary provides one of the most valuable shellfish habitats in the Pacific Northwest. Shellfish are important economically, ecologically and socially to the Puget Sound basin (Dethier 2006). Ecologically, they are affected by the composition of freshwater entering the nearshore marine system and internal marine dynamics. Shellfish bed closures area-wide have decreased (PSP 2010), but in certain locations, persistent closures continue, affecting local growers and restricting commercial and recreational harvest opportunities. Shellfish growing area closures are considered to be a result of several factors that include growing areas exposed to excess nutrient and pathogen concentrations, with their effects complicated by non-point source nitrogen pollution (i.e., failing septic systems, agricultural wastewater, and stormwater) (Valiela et al. 1992, Vitousek et al. 1997). Declining water quality is associated with changes in the composition of watersheds and nearshore habitats from primarily forested to landscapes dominated by agricultural, rural residential and urban land uses (Glasoe et al. 2005). In addition, future changes climate will add another layer of complexity and increase potential threats to ecosystems that support shellfish through impacts on freshwater flows, marine circulation, and water temperature (Snover et al. 2005, CIG 2009). A Puget Sound Partnership priority is to reduce the risks of shellfish growing area closures and adverse effects on human health. Information that can predict pathogen concentrations and biotoxins along transport pathways where they pose a risk to shellfish and human health will help in achieving this goal.

This report briefly presents an overview of the type and quantities of ecosystem services that are associated with Puget Sound shellfish, focusing on harvest services in two study regions (Hood Canal and Samish Bay) covered in the EPA project, Transport and Fate of Nutrient and Pathogen Loadings into Nearshore Puget Sound (EPA Grant DW-13-923276-01). We first discuss the management of shellfish by Washington State agencies that affects the provision of these services and then present estimates of the quantities of different harvest services in the study regions.

Two agencies manage shellfish harvest in Washington State, the Washington Department of Health (WDOH) and the Washington Department of Fish and Wildlife (WDFW). The WDOH classifies shellfish growing areas based on water quality and current and potential pollution sources, as determined by a survey of these sources in the vicinity of the area (a sanitary survey). The classification determines whether or not shellfish in the area can be harvested for human consumption. Commercial harvest is not allowed in areas that are not classified.

Commercial growing area classifications include the following (WDOH, 2012a):

- **Approved:** An area is classified as Approved when the sanitary survey shows that the area is not subject to contamination that presents an actual or potential public health hazard. An Approved classification authorizes commercial shellfish harvest for direct marketing.
- **Conditionally Approved:** An area is classified as Conditionally Approved if it meets Approved criteria some of the time, but does not during predictable periods. During these periods the area is closed.
- **Restricted:** An area is classified as Restricted when water quality meets standards for an Approved classification, but the sanitary survey indicates a limited degree of pollution from non-human sources. Shellfish harvested from these growing areas must be transplanted to Approved growing areas for a specified amount of time, allowing shellfish to naturally cleanse themselves of contaminants before they are harvested for market.
- **Prohibited:** An area is classified as Prohibited when the sanitary survey indicates that fecal material, pathogenic microorganisms, or poisonous or harmful substances may be present in concentrations that pose a health risk to shellfish consumers. Commercial shellfish harvests are not allowed from Prohibited areas.

Recreational growing area classifications are similar and are governed by the commercial area's classification.

Within the two study site areas (Hood Canal, covering the Dosewallips and Hamma Hamm rivers, and the Samish river), there are several commercial growing areas (Table 1; Figures 1A, 1B, and 2). Most of the Hood Canal areas have an Approved classification; exceptions are subareas of the Hood Canal #3 growing area, which are near the mouth of the Dosewallips river (Figure 1A). The Samish Bay growing area shows more variation in classification among its subareas (Figure 2). Over the past 30 years, the growing areas in Hood Canal and Samish Bay have experienced both upgrades and downgrades in their classifications, with the more recent changes dominated by upgrades (Table 2). A notable exception is a 4037 acre subarea of the Samish Bay growing area, which was downgraded from Approved to Conditionally Approved in 2011 (WDOH, 2012a).

Shellfish in both recreational and commercial harvest areas are also routinely tested by the WDOH for biotoxins known to be present in Washington marine waters, such as paralytic shellfish poison, amnesic shellfish poison, and diarrhetic shellfish poison. When toxins are detected at dangerous levels, the area is closed to harvest. Hood Canal has not generally experienced any recent biotoxin closures (Figure 3); an exception is the south portion of Dosewallips State Park at the mouth of the Dosewallips river, which is closed to shellfish harvesting for both pollution and biotoxins (WDOH, 2012b). The Samish Bay growing areas adjacent to the Samish river have not experienced any recent biotoxin closures (Figure 4).

The WDFW manages the harvest of shellfish from beaches and aquaculture sites throughout the state. These harvests are recorded by shellfish management harvest areas or beaches, and aquaculture districts, respectively. Two shellfish commercial management areas, 27A and 27B, cover the Hood Canal study sites (Figure 5); similarly, two areas, 21A and 21B, cover the Samish river study site (Figure 6), although one of these (21B) is effectively closed to wild shellfish harvests because of pollution. For the years 2009-11, wild commercial shellfish harvests have been significantly greater in the Hood Canal areas compared to the Samish river area (Table 3). In Hood Canal, geoducks have generated the greatest amount of revenue over the past three years (\$7.0 million), while Pacific oysters have generated the second greatest amount

(\$3.8 million). In the Samish river area, Manila clams are the only wild species being harvested and have produced a modest amount of revenue (\$250K) over the past three years.

For recreational shellfish harvests, there are numerous beaches within the study site areas that potentially support harvests (Figures 7A, 7B, 7C, 8). These beaches are identified by Beach Identification Number (BIDN). The beaches vary in terms of their management by the WDFW and their classification as determined by the WDOH (Table 4). The WDFW actively manages beaches that are major sources of harvest (both for recreation and tribal commercial harvest) by setting harvest seasons and placing limits on harvest quantities. This management can cover clams and oysters, clams only, or oysters only. For most of these beaches, the WDFW estimates both effort (number of harvester days) and harvested quantities by species (pounds of clams, numbers of oysters). Other beaches fall into the category of passive management, for which no seasons are set by the WDFW. Estimates of harvest quantities are not made for these beaches and effort is estimated only for some. Hood Canal has significant effort and oyster harvests for several beaches (Table 5, Figures 9A-9C, 10A-10C); beaches in the Samish river area are all passively managed. For Samish Bay beaches, estimates of recreational effort and harvest quantities are not available.

Finally, Hood Canal has two aquaculture districts covering the study sites (42C and 42D, Figure 11), while the Samish river area has one district (43F, Figure 12). Both of the study site areas have significant aquaculture harvest revenues from their respective districts (Table 6). In Hood Canal, Manila clams (\$10.3 million) and Pacific oysters (\$8.0 million) have generated the most revenue over the period 2009-11; in the Samish river district, Manila clams (\$3.2 million) and Pacific oysters (\$3.8 million) are the two species that have generated aquaculture revenues during that period.

References

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Table 1 Growing Area Classifications						
Study Site Area	Growing Area	Classification (acres)				
		Approved	Conditional	Prohibited	Restricted	Unclassified
Hood Canal	Hood Canal #3	1,890		56	123	127
	Hood Canal #4	615				18
	Hood Canal #5	1,349				10
	Hood Canal #6	139		66		
	Quilcene Bay	1,214	20	1		352
Hood Canal Total		5,207	20	124	123	507
Samish	Samish Bay	626	4,044	1,282		627
Samish Total		626	4,044	1,282		627
Source: WDOH, unpublished data						

Table 2 Growing Area Classification Changes					
Study Site Area	Growing Area	Year	Action	Change	Acres
Hood Canal	Hood Canal #3	1987	Downgrade	Approved -> Restricted	180
		1988	Downgrade	Approved -> Restricted	630
		1994	Upgrade	Restricted -> Approved	30
		2001	Upgrade	Restricted -> Approved	630
		2010	Upgrade	Restricted -> Approved	70
	Hood Canal #5	1998	Downgrade	Approved -> Prohibited	22
		2007	Upgrade	Prohibited -> Approved	22
	Hood Canal #6	2006	Upgrade	Prohibited -> Approved	70
		2006	Upgrade	Prohibited -> Conditional	40
	Quilcene Bay	1984	Downgrade	Approved -> Prohibited	200
Samish	Samish Bay	1994	Downgrade	Approved -> Restricted	490
		1994	Downgrade	Approved -> Prohibited	2220
		1998	Upgrade	Restricted -> Approved	485
		1998	Upgrade	Prohibited -> Conditional	350
		2002	Upgrade	Conditional -> Approved	350
		2011	Downgrade	Approved -> Conditional	4037
Source: WDOH (2012a)					

Table 3 Wild Commercial Shellfish Harvest Revenues (2009-11)			
Study Site Area	Shellfish management area	Species	Wild commercial shellfish harvest revenues
Hood Canal	27A	Geoduck	\$6,972,883
		Manila clam	\$469,624
		Native littleneck	\$332
		Pacific oyster	\$1,623,876
	27A Total		\$9,066,715
	27B	Manila clam	\$176,998
		Pacific oyster	\$2,167,115
	27B Total		\$11,410,827
Samish	21A	Manila clam	\$249,818
	21A Total		\$249,818
Source: PacFIN, unpublished data			

Table 4 Recreational Shellfish Beach Management Status and Classification									
Study Site Area	Shellfish Growing Area	BIDN	Harvest Management Status	Acres	Growing Area Classification				
					Approved	Conditional	Prohibited	Restricted	Unclassified
Hood Canal	Hood Canal #3	270190	Passive	4.4	100%	0%	0%	0%	0%
		270200	Clams & Oysters	243.5	63%	0%	0%	37%	0%
		270205	Passive	40.6	100%	0%	0%	0%	0%
		270210	Oyster	29.3	100%	0%	0%	0%	0%
		270220	Passive	2.7	0%	0%	100%	0%	0%
		270286	Clams & Oysters	258.3	100%	0%	0%	0%	0%
		270535	Passive	2.4	100%	0%	0%	0%	0%
		270540	Passive	0.1	100%	0%	0%	0%	0%
		270545	Passive	0.7	100%	0%	0%	0%	0%
		270550	Passive	0.2	100%	0%	0%	0%	0%
	Hood Canal #4	270280	Oyster	6.9	100%	0%	0%	0%	0%
		270290	Passive	9.2	100%	0%	0%	0%	0%
		270293	Clams & Oysters	13.9	100%	0%	0%	0%	0%
		270297	Passive	7.6	100%	0%	0%	0%	0%
		270560	Passive	3.7	100%	0%	0%	0%	0%
		270565	Passive	19.3	100%	0%	0%	0%	0%
		270570	Passive	8.6	100%	0%	0%	0%	0%
		270575	Passive	28.8	100%	0%	0%	0%	0%

<p>Table 4 Recreational Shellfish Beach Management Status and Classification</p>									
Study Site Area	Shellfish Growing Area	BIDN	Harvest Management Status	Acres	Growing Area Classification				
					Approved	Conditional	Prohibited	Restricted	Unclassified
Hood Canal	Hood Canal #5	270300	Oyster	22.7	100%	0%	0%	0%	0%
		270310	Oyster	50.8	100%	0%	0%	0%	0%
		270312	Oyster	6.7	100%	0%	0%	0%	0%
		270430	Passive	2	100%	0%	0%	0%	0%
		270580	Passive	7.8	100%	0%	0%	0%	0%
	Hood Canal #6	270420	Passive	24	0%	0%	100%	0%	0%
		270430	Passive	18.4	100%	0%	0%	0%	0%
	Quilcene Bay	270110	Passive	10.9	100%	0%	0%	0%	0%
		270111	Passive	0.3	100%	0%	0%	0%	0%
		270112	Passive	11.7	100%	0%	0%	0%	0%
		270114	Oyster	7.5	100%	0%	0%	0%	0%
		270170	Clams & Oysters	5.9	100%	0%	0%	0%	0%
		270171	Clams & Oysters	3.8	100%	0%	0%	0%	0%
		270172	Clams & Oysters	0.3	100%	0%	0%	0%	0%
		270175	Passive	6.1	100%	0%	0%	0%	0%
		270180	Passive	0.9	100%	0%	0%	0%	0%
		270500	Clams & Oysters	185	94%	0%	0%	0%	6%
		270520	Oyster	94.4	0%	0%	0%	0%	100%
		270521	Passive	9.7	0%	0%	0%	0%	100%
		270522	Passive	64.3	0%	0%	0%	0%	100%

Table 4 Recreational Shellfish Beach Management Status and Classification									
Study Site Area	Shellfish Growing Area	BIDN	Harvest Management Status	Acres	Growing Area Classification				
					Approved	Conditional	Prohibited	Restricted	Unclassified
Samish	Samish Bay	210180	Passive	21.4	0%	0%	100%	0%	0%
		210185	Passive	192.7	0%	0%	100%	0%	0%
		210187	Passive	42.8	0%	0%	100%	0%	0%
		210188	Passive	541.4	0%	23%	0%	0%	77%
		210189	Passive	48.2	0%	0%	0%	0%	100%
		210190	Passive	13.0	0%	0%	0%	0%	100%
		210192	Passive	34.1	0%	0%	0%	0%	100%
		210193	Passive	26.1	0%	100%	0%	0%	0%
		210195	Passive	43.1	0%	100%	0%	0%	0%
		210200	Passive	88.6	0%	45%	55%	0%	0%
		210210	Passive	62.1	0%	0%	0%	0%	100%
Source: WDFW, unpublished data; WDOH, unpublished data									

Table 5 Recreational Shellfish Harvest (2010-12) (Hood Canal Study Sites)			
Growing Area	Beach BIDN	Recreational Effort (days)	Oysters Harvested (numbers)
Hood Canal #3	270200	32,547	376,191
	270286	9,123	65,888
	270540	95	Not estimated
Hood Canal #4	270280	644	Not estimated
	270293	5,253	51,806
	270560	631	Not estimated
Hood Canal #5	270300	2,991	43,728
	270310	11,352	110,927
	270312	235	Not estimated
	270580	94,138	862,415
Quilcene Bay	270111	4,784	Not estimated
	270170	7,831	90,393
	270171	2,450	5,788
	270900	6,855	41,558
Source: WDFW, unpublished data			

Table 6 Aquaculture revenues			
Study Site Area	Aquaculture district	Species	Revenue (2009-11)
Hood Canal	42C	Geoduck	\$276,931
		Manila clam	\$6,372,876
		Native littleneck	\$29,467
		Pacific oyster	\$1,666,807
	42C Total		\$8,346,081
	42D	Geoduck	\$5,496
		Manila clam	\$3,921,549
		Native littleneck	\$10,558
		Pacific oyster	\$6,379,858
	42D Total		\$10,317,461
Samish	43F	Manila clam	\$3,155,605
		Pacific oyster	\$3,791,056
	43F Total		\$6,946,661
Source: PacFIN, unpublished data			

Figure 1A
North Hood Canal Shellfish Growing Area Status, May 2012

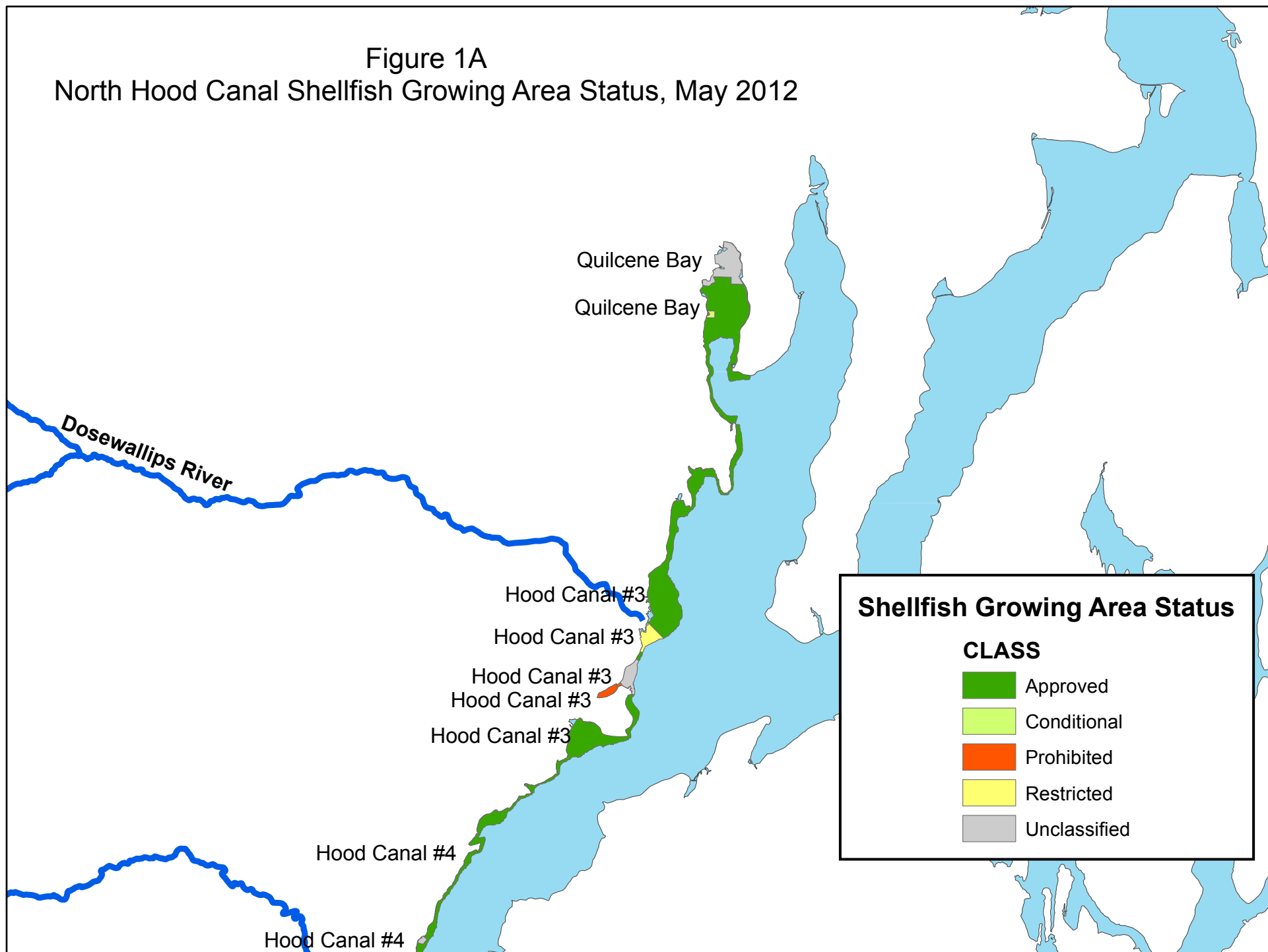


Figure 1B
South Hood Canal Shellfish Growing Area Status, May 2012

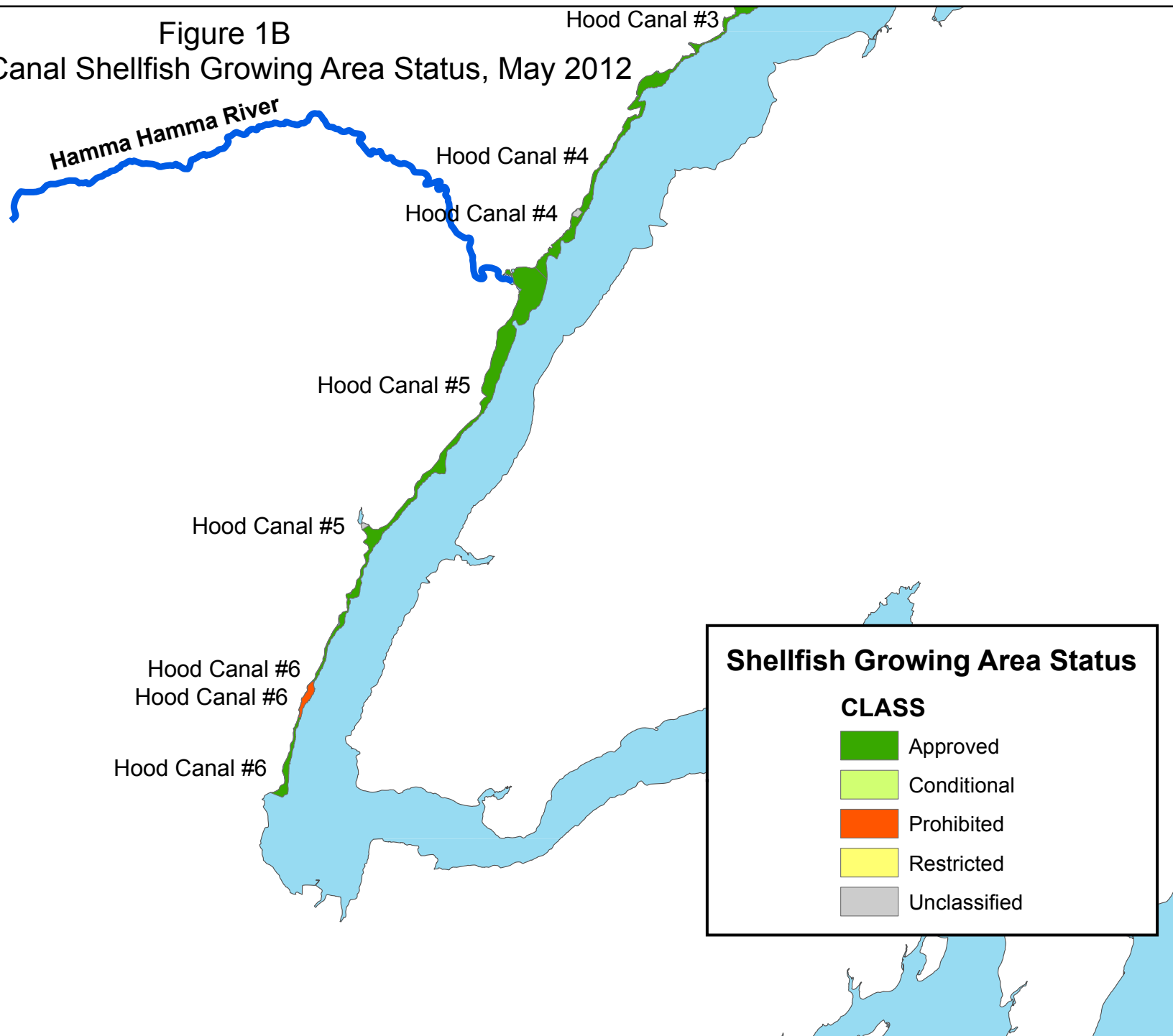


Figure 2
Samish Shellfish Growing Area Status, May 2012

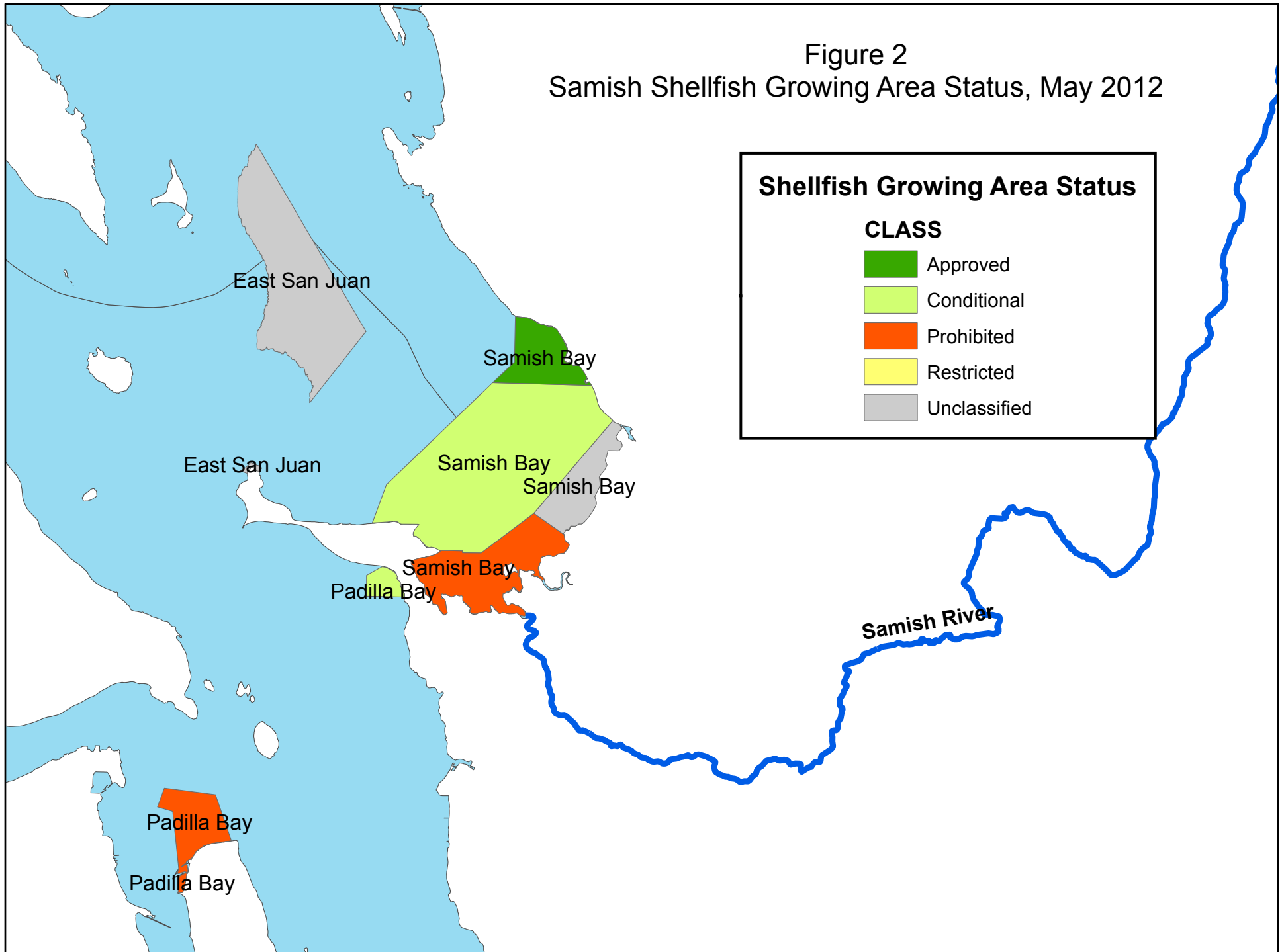


Figure 3
Hood Canal Biotoxin Closures, May 2012

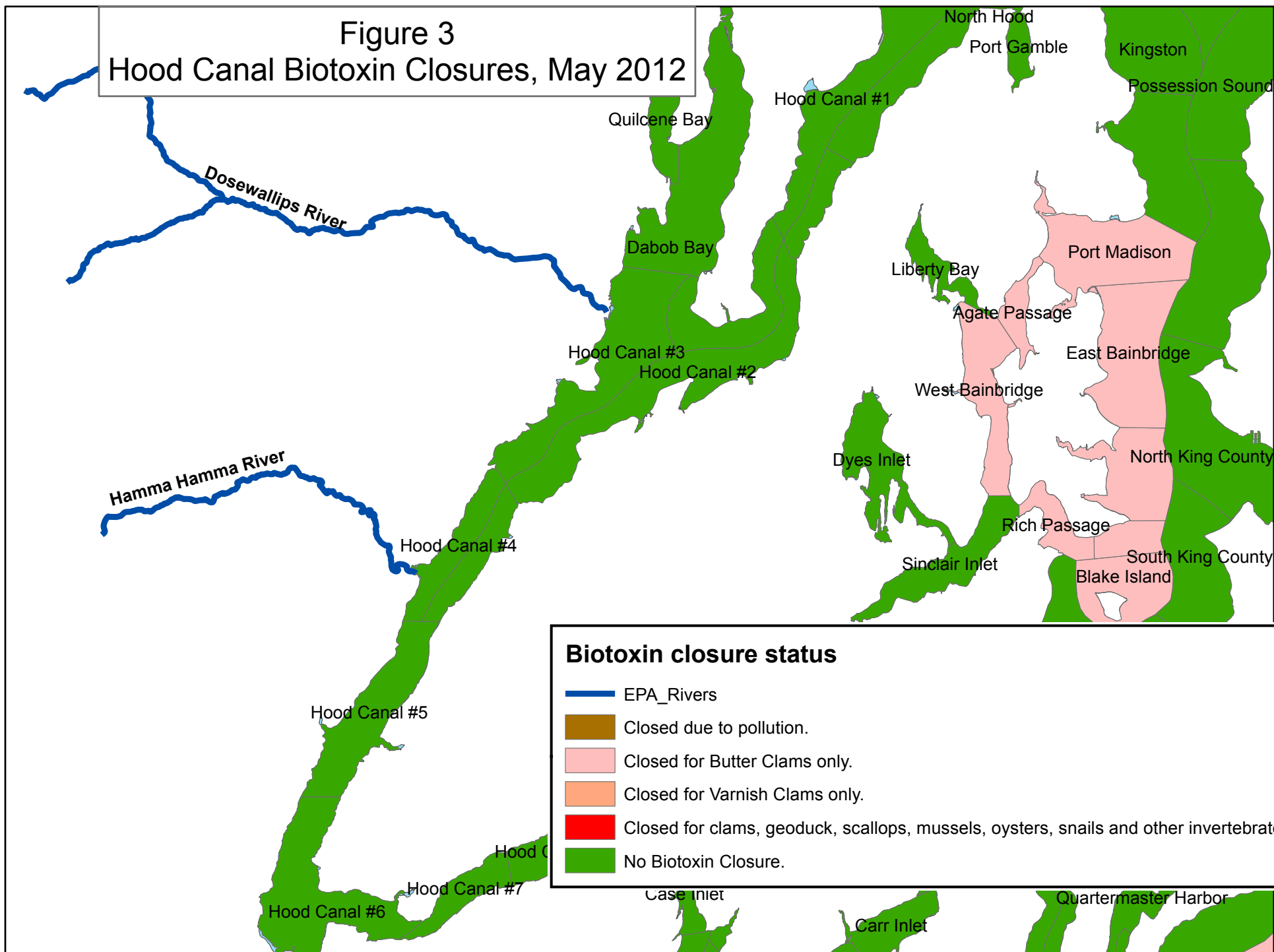


Figure 4
Samish Biotoxin Closures, May 2012

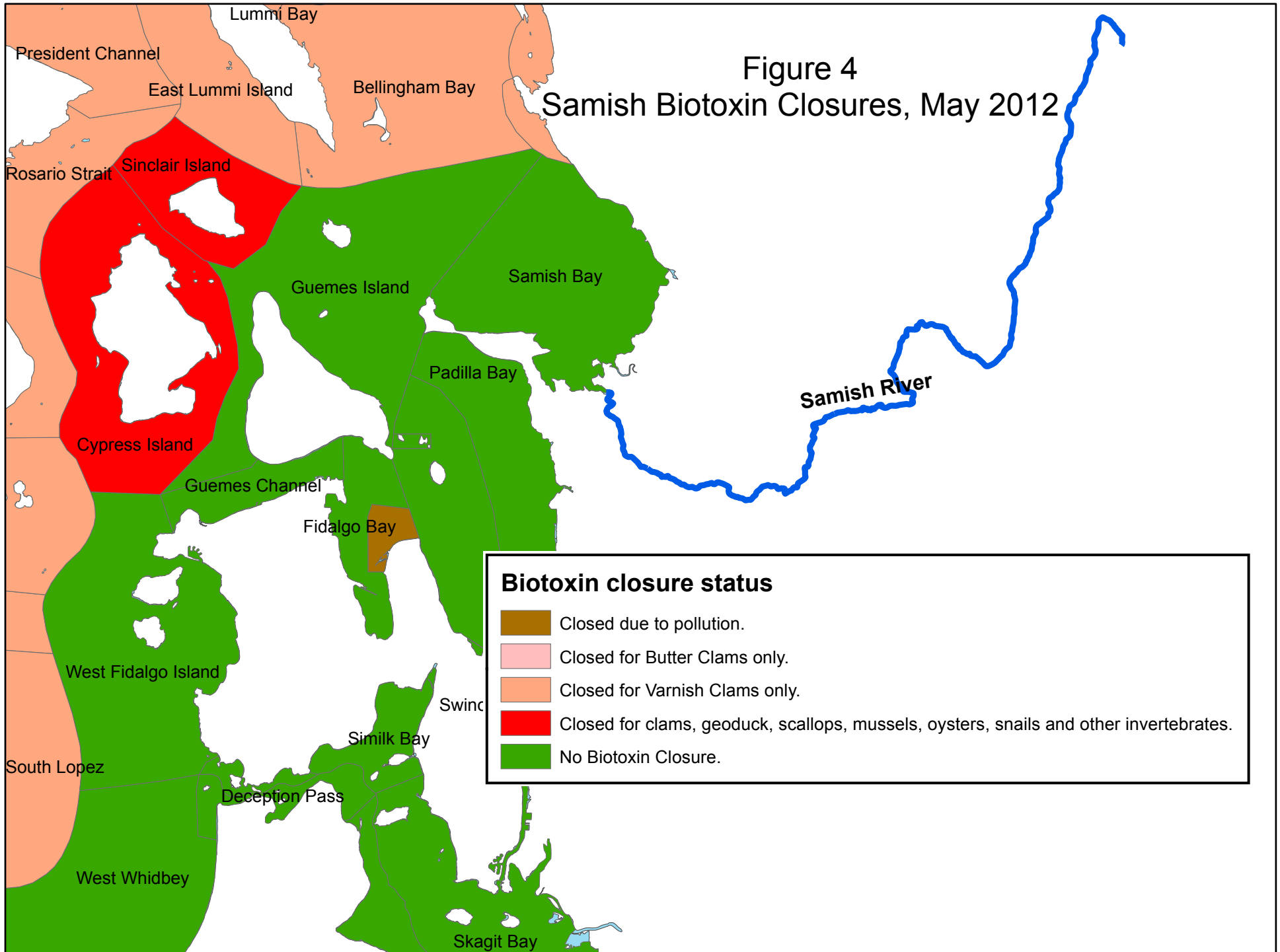


Figure 5
Hood Canal Shellfish Management Zones

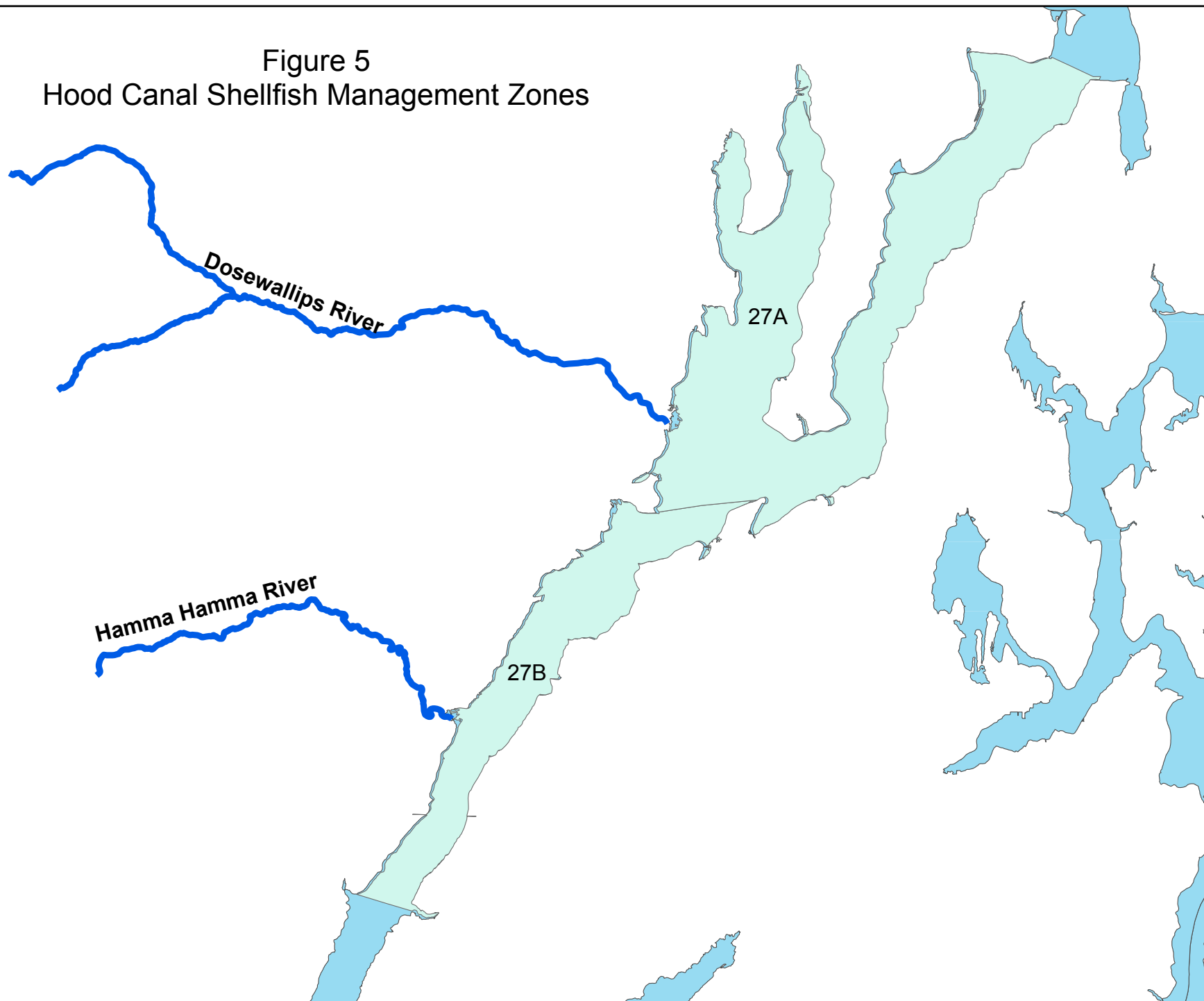


Figure 6
Samish Shellfish Management Zones



Figure 7A
North Hood Canal

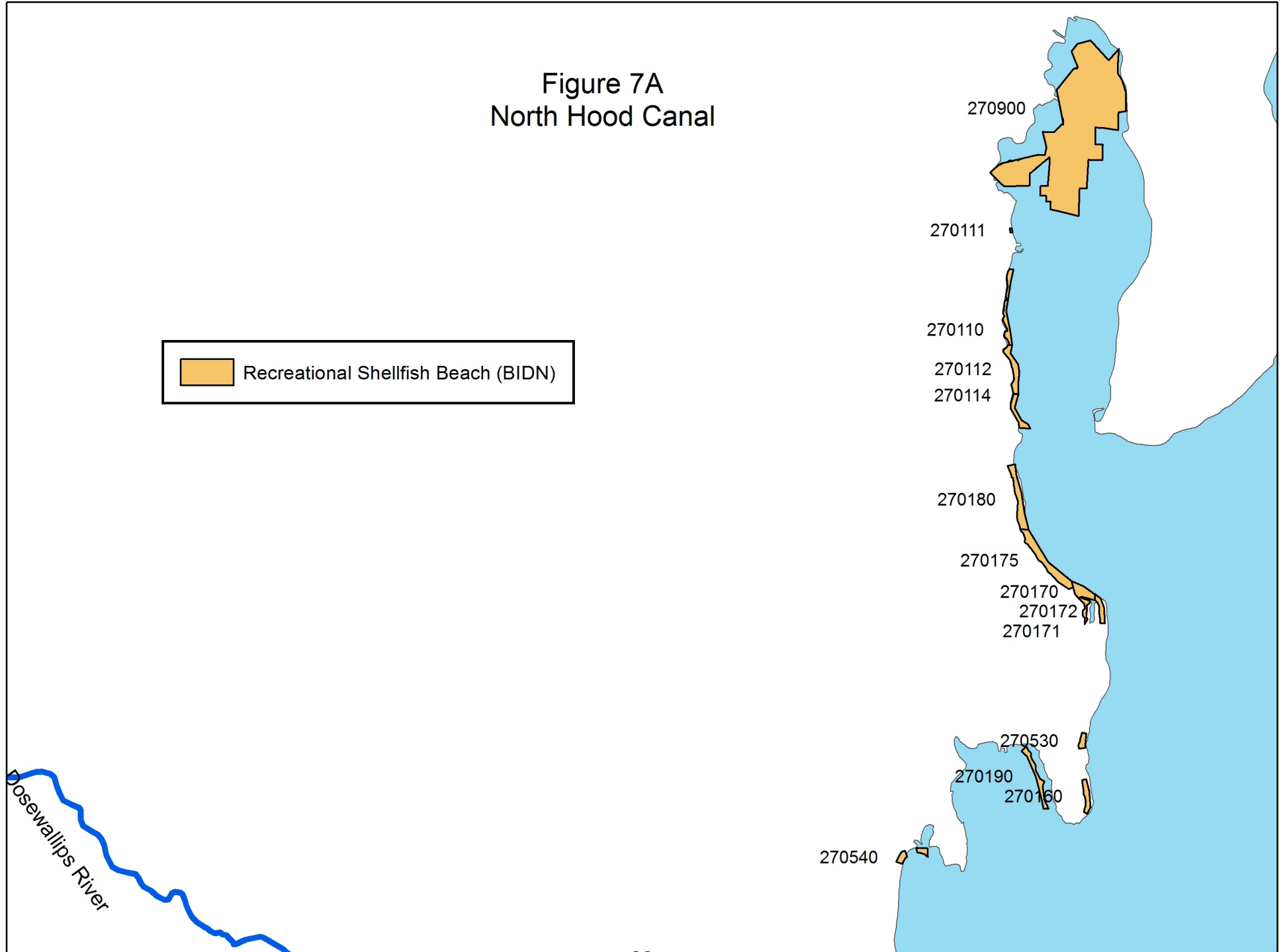
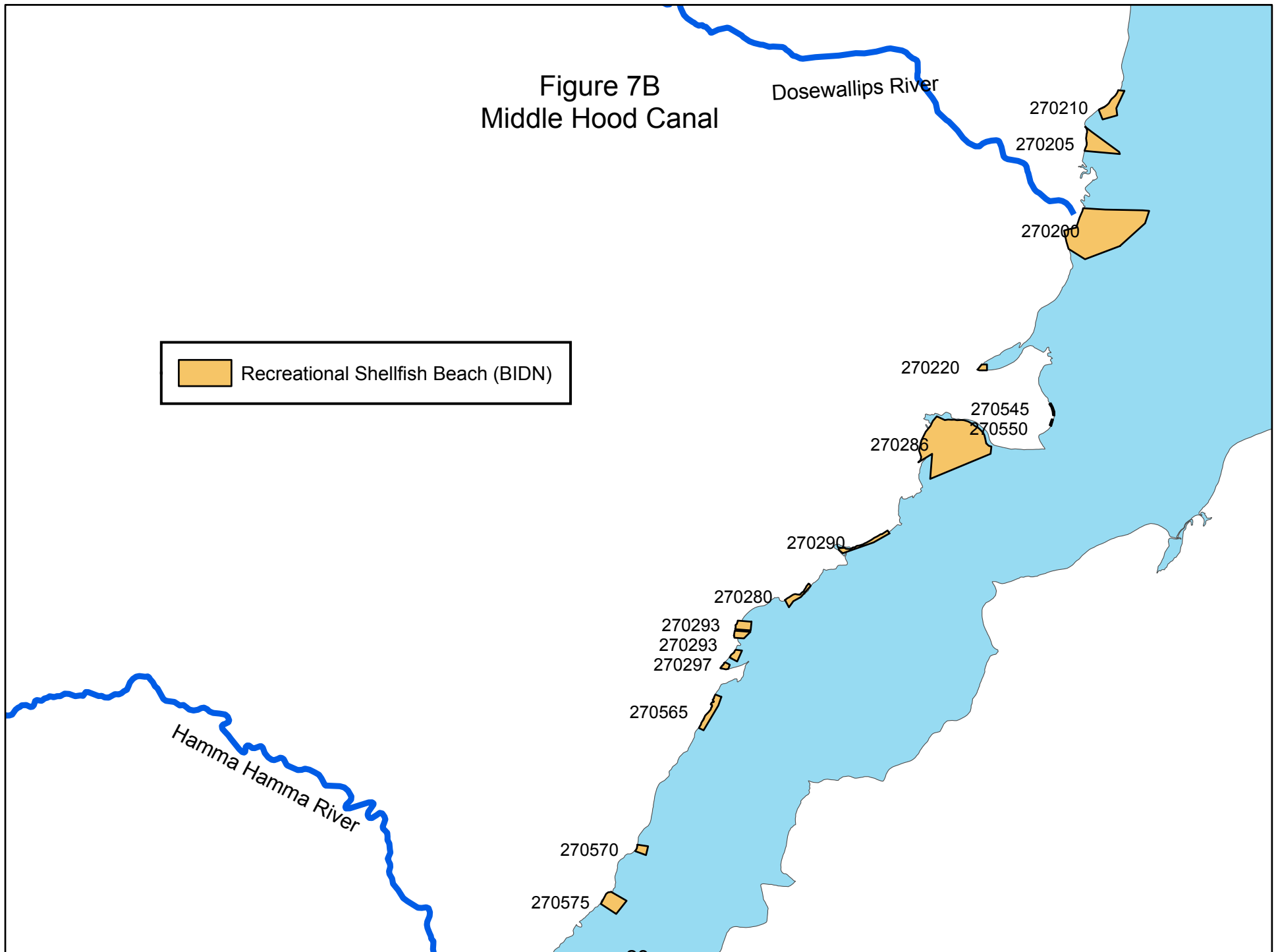



Figure 7B
Middle Hood Canal



Hamma Hamma River

Figure 7C
South Hood Canal

 Recreational Shellfish Beach (BIDN)

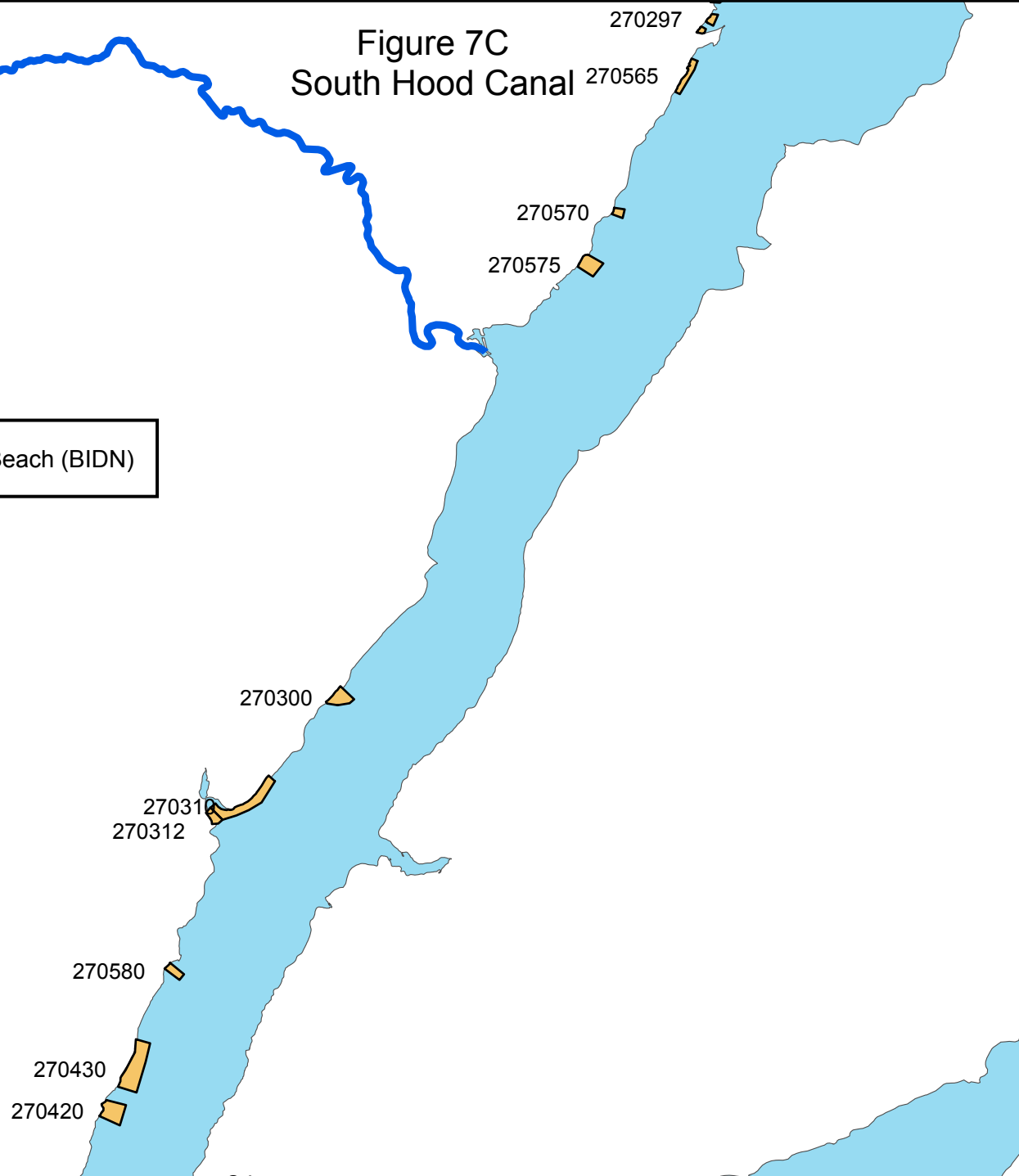


Figure 8
Samish Bay

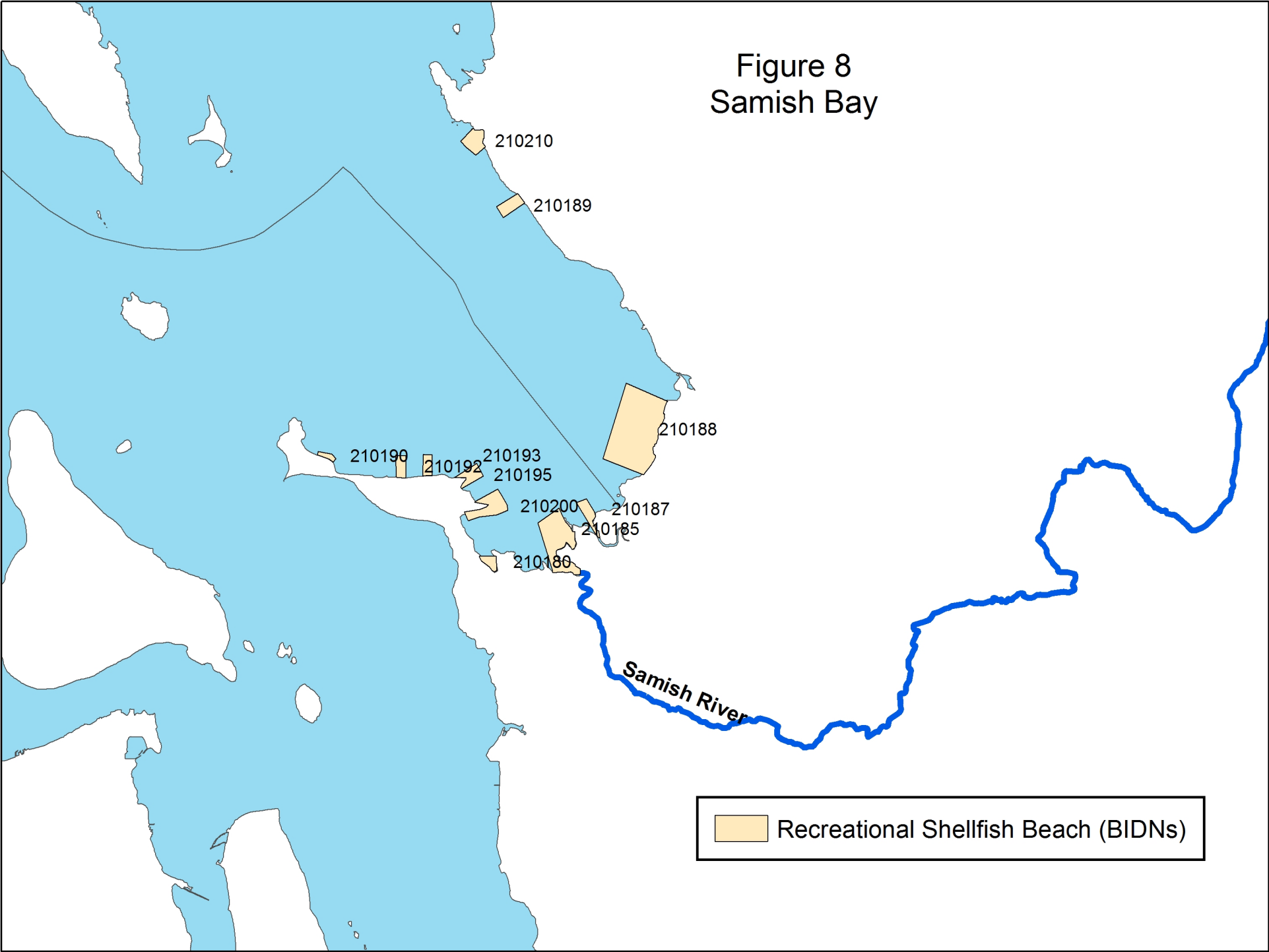


Figure 9A
North Hood Canal

Recreational Shellfish Harvest, 2010-12

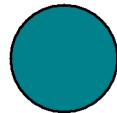
Effort Days



< 1K



1K - 10K



> 10K

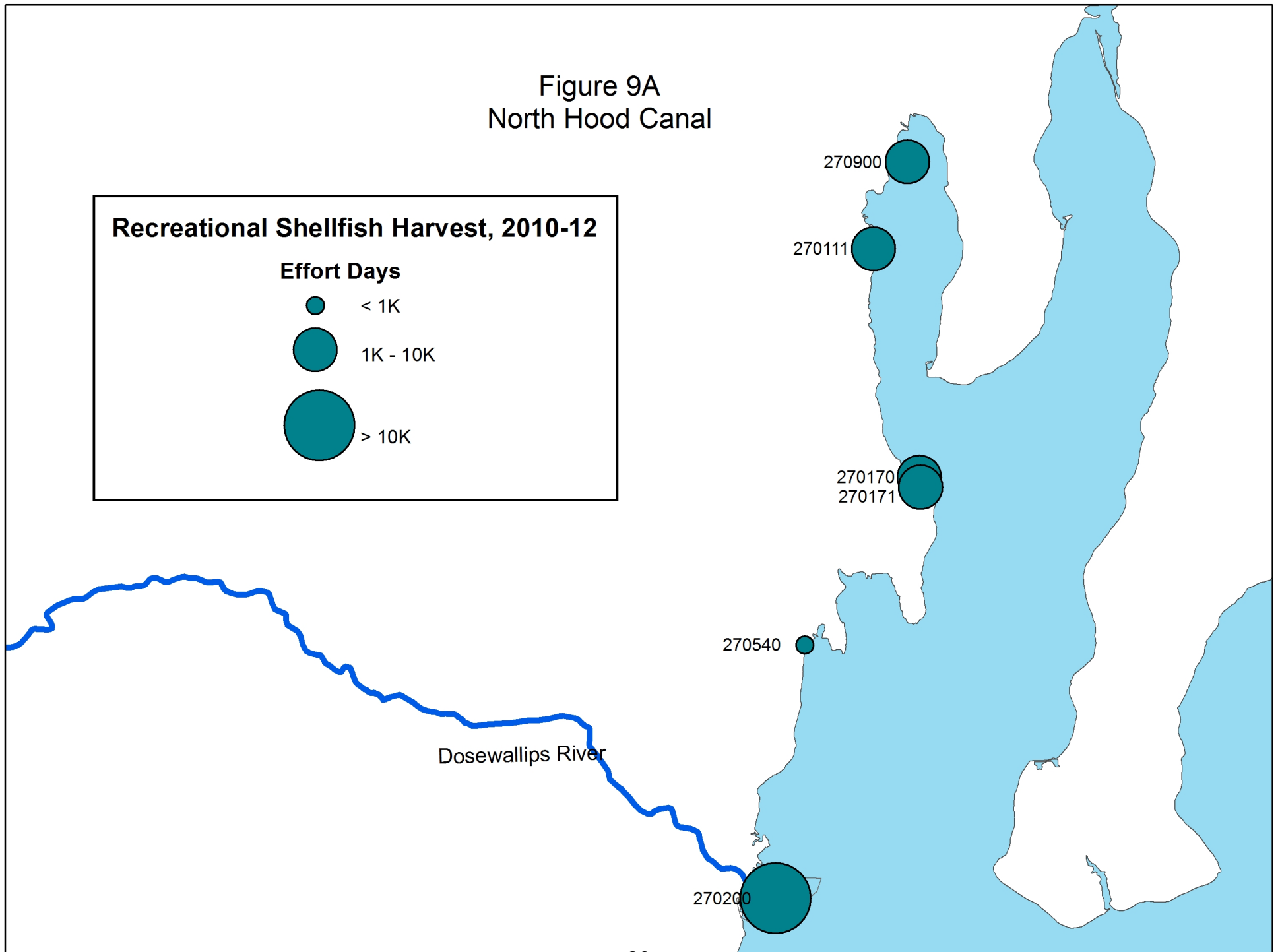



Figure 9B
Middle Hood Canal

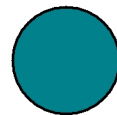
Dosewallips River

Recreational Shellfish Harvest, 2010-12

Effort Days

 < 1K

 1K - 10K

 > 10K

270200

270286

270280

270293

270560

Hamma Hamma River

Figure 9C
South Hood Canal

Recreational Shellfish Harvest, 2010-12

Effort Days

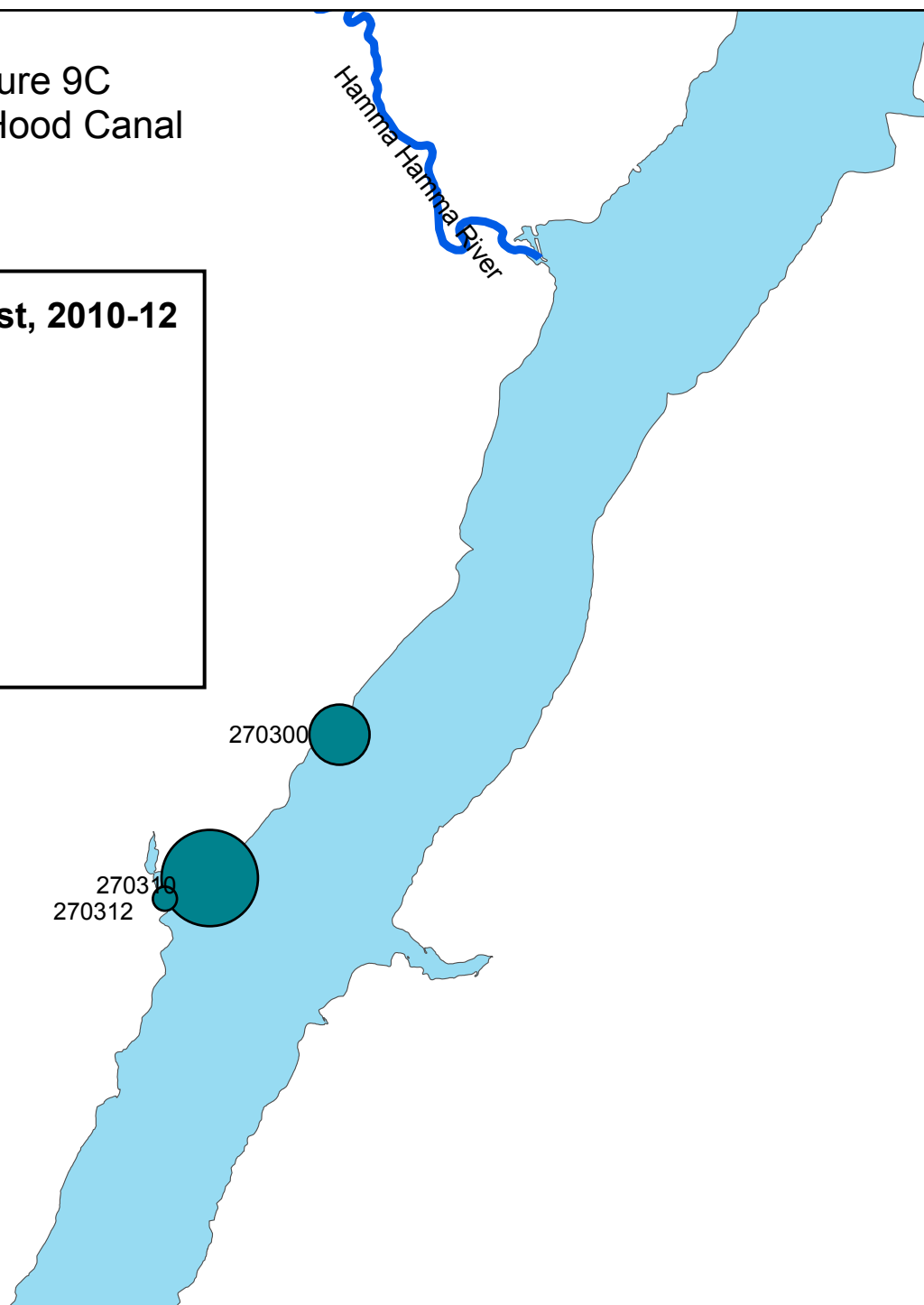
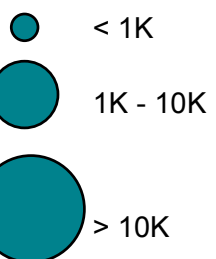
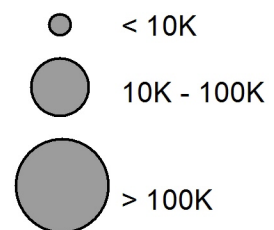


Figure 10A
North Hood Canal

Hood Canal Oyster Harvest, 2010-12

Oysters harvested (#)



270900



270170
270171



Dosewallips River

270200



Figure 10B
Middle Hood Canal

Hood Canal Oyster Harvest, 2010-12

Oysters harvested (#)

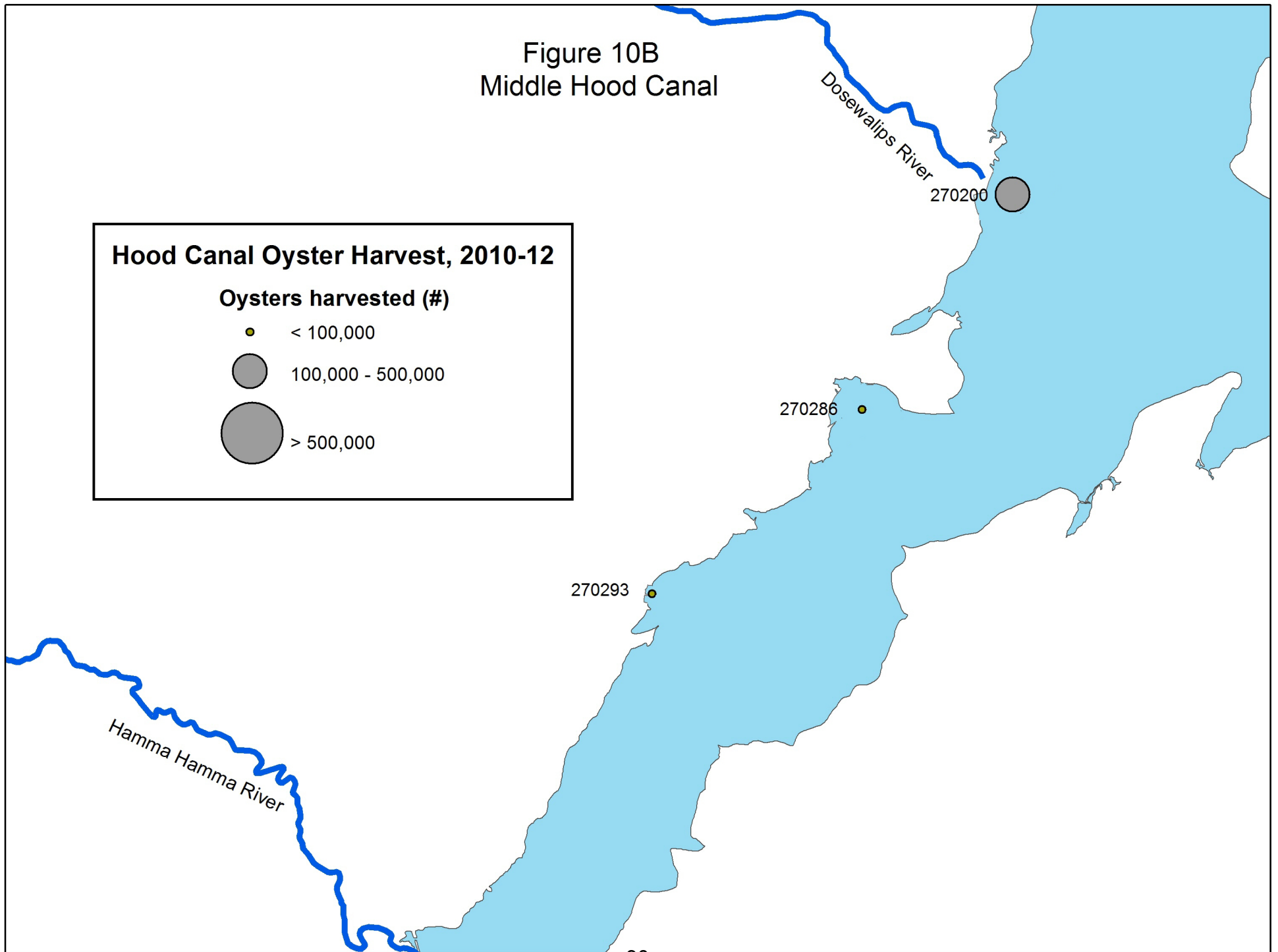
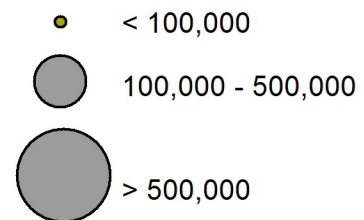


Figure 10C
South Hood Canal

Hood Canal Oyster Harvest, 2010-12

Oysters harvested (#)

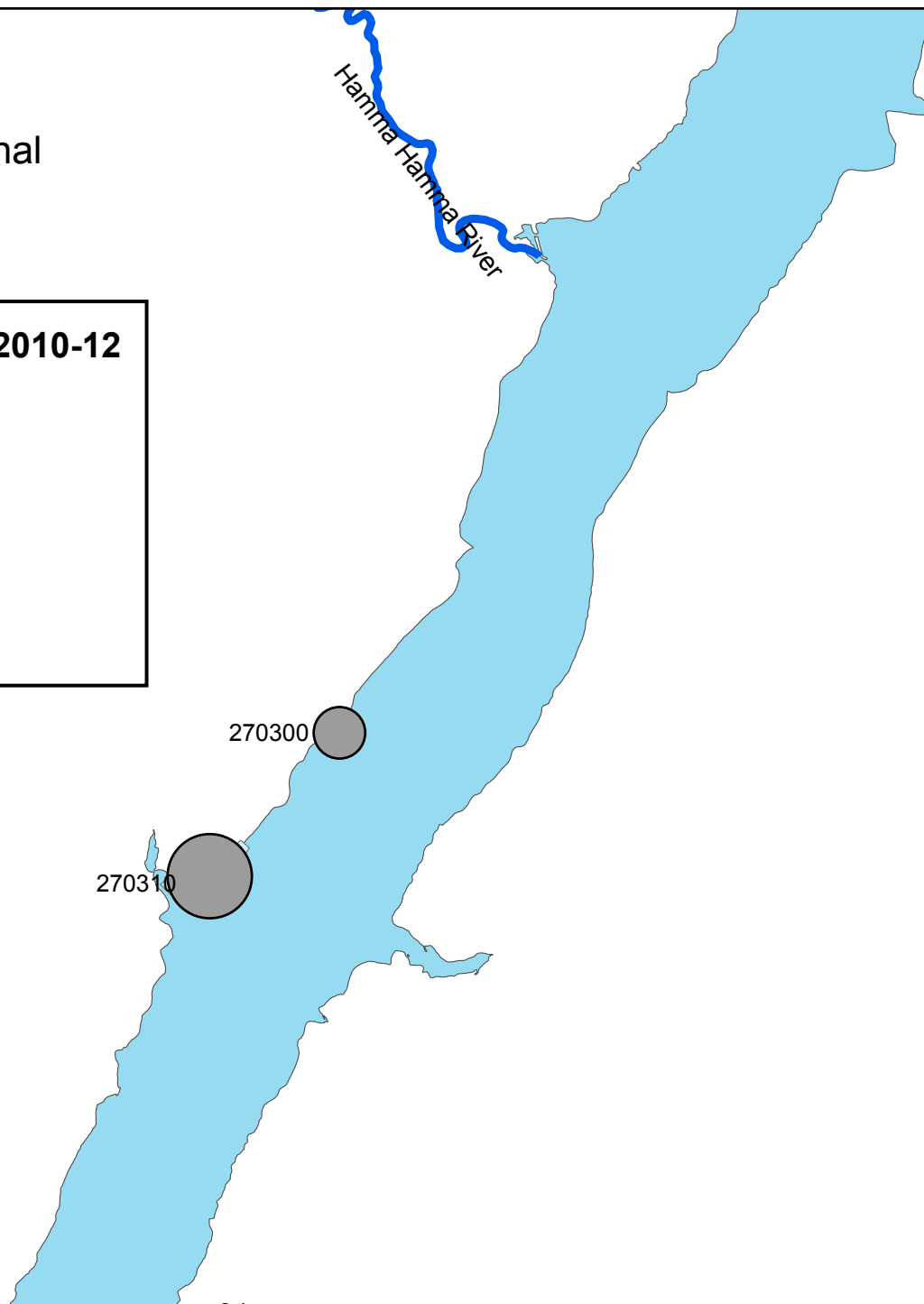
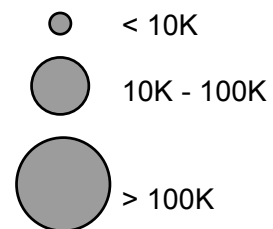


Figure 11
Hood Canal Aquaculture Districts

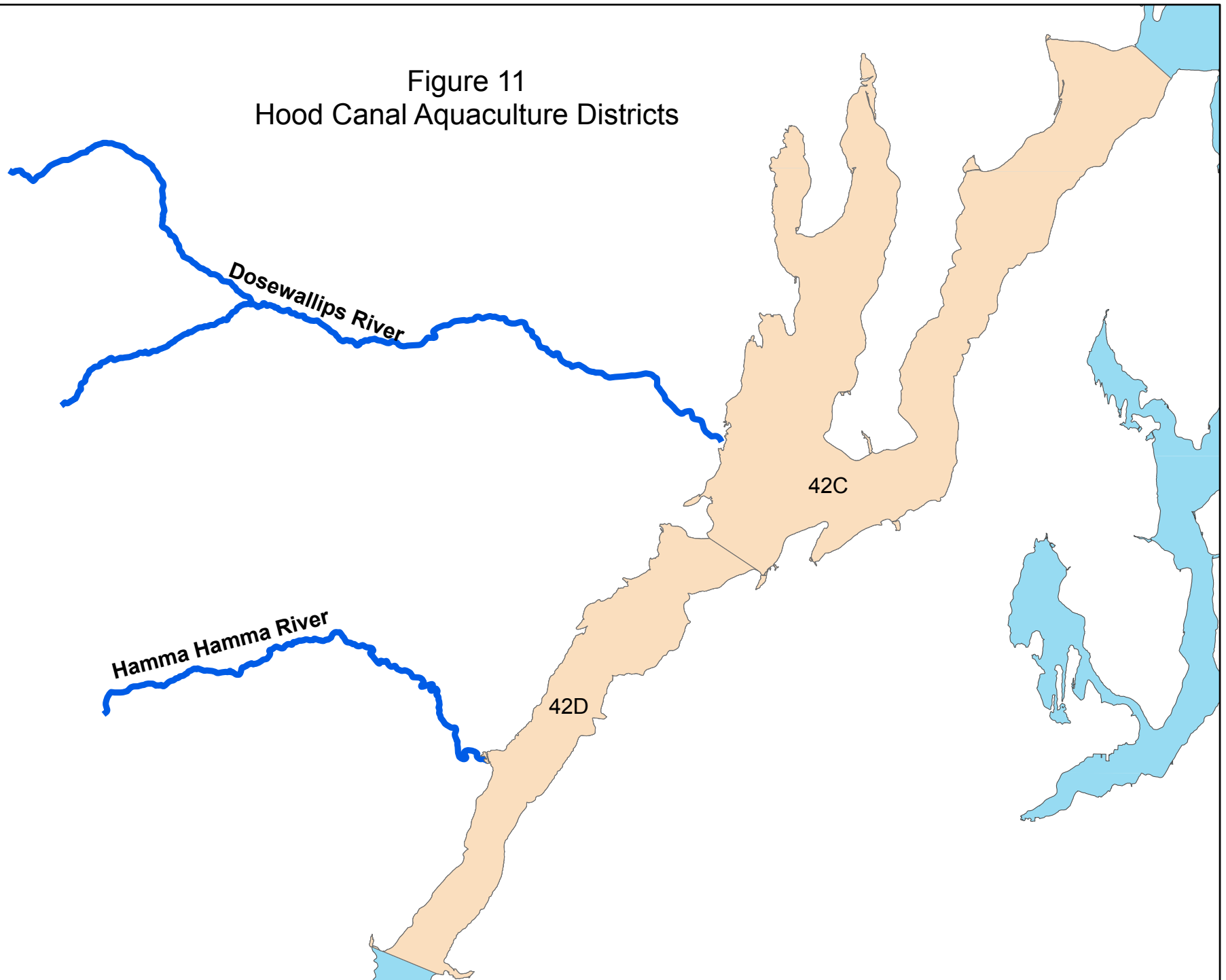


Figure 12
Samish Aquaculture Districts

