



2020 STOCK STATUS UPDATE OF BRITISH COLUMBIA WILD GEODUCK

Context

Pacific Geoduck (*Panopea generosa*) populations occur in discrete beds of soft substrate, distributed throughout the coast of British Columbia (BC). Geoducks are clams, live buried up to 1 m below the sediment surface, and are therefore sedentary. Individual Geoduck beds are connected by means of planktonic larvae, thereby forming meta-populations. Based on current knowledge, Geoduck populations form a single genetic stock along the BC coast (Miller et al. 2006).

A commercial dive fishery for wild Geoducks began in BC in 1976. The BC Geoduck fishery is managed with a total allowable catch (TAC), individual vessel quotas, scheduled openings and area quotas. The fishery operates on a three year spatial rotation in the North Coast and Inside Waters quota areas (Figure 1), while the West Coast of Vancouver Island (WCVI) area is fished annually.

Stock assessment and management of the fishery are conducted on the spatial scale of individual Geoduck sub-beds. In 2020, there were 2,915 documented Geoduck beds on the BC coast made up of 5,232 sub-beds ranging in size from 0.03 hectares (ha) to 450.44 ha. Sub-beds are discrete patches of Geoduck habitat on the sea floor that were initially assigned a common bed code (Bureau 2017).

The stock is assessed following methods described in the stock assessment framework (Bureau et al. 2012). The framework was updated (DFO 2014, Bureau 2017, DFO 2017) as requested by Fisheries and Oceans Canada's (DFO's) Fisheries Management branch. Biomass estimates are updated annually with new data on population densities, mean Geoduck weights and bed areas.

The provisional Limit Reference Point (LRP) for the BC Geoduck stock is defined as current biomass (B_c) being equal to 40% of the estimated unfished documented biomass (B') (Bureau 2017, DFO 2017). The stock index is defined as the ratio of total coastwide current biomass to total coastwide unfished biomass (B_c/B'). It is recommended that the LRP be applied on a coastwide basis for the purpose of determining Geoduck stock status. It is recommended that a provisional Upper Stock Reference (USR), defined as total coastwide current biomass being equal to 50% of total coastwide estimated unfished documented biomass, be applied to the Geoduck stock.

This report provides estimates of BC Geoduck stock biomass and stock index, updated in 2020, and summarizes the Science Advice provided to fishery managers for setting quotas for the 2021-2022 Geoduck fishing season.

This Science Response Report results from the Regional Science Response Process of March 1, 2021 on the 2020 Stock Status update of British Columbia wild Geoducks.

Background

Description of the fishery

The BC commercial Geoduck fishery began in 1976 and has since grown to be one of the highest valued fisheries in BC at CAD \$58.1 million for 2019-2020 fishing season. Geoducks are hand-picked by divers using surface-supply gear. Individual Geoducks are extracted from the sea bed using a hand held water jet, pumped from the surface. Divers typically harvest Geoducks between 3 m and 20 m in depth.

The management and stock assessment history for the BC Geoduck fishery were described in detail in Hand and Bureau (2012) and Bureau et al. (2012). Details of current management measures are provided in the Geoduck and Horse Clam Integrated Fisheries Management Plan (DFO 2021b). The fishery originally developed in the Inside Waters, followed by the WCVI in 1978 and expansion to the North Coast in 1980 (Figures 1 and 2). The majority of landings have come from the North Coast since 1995.

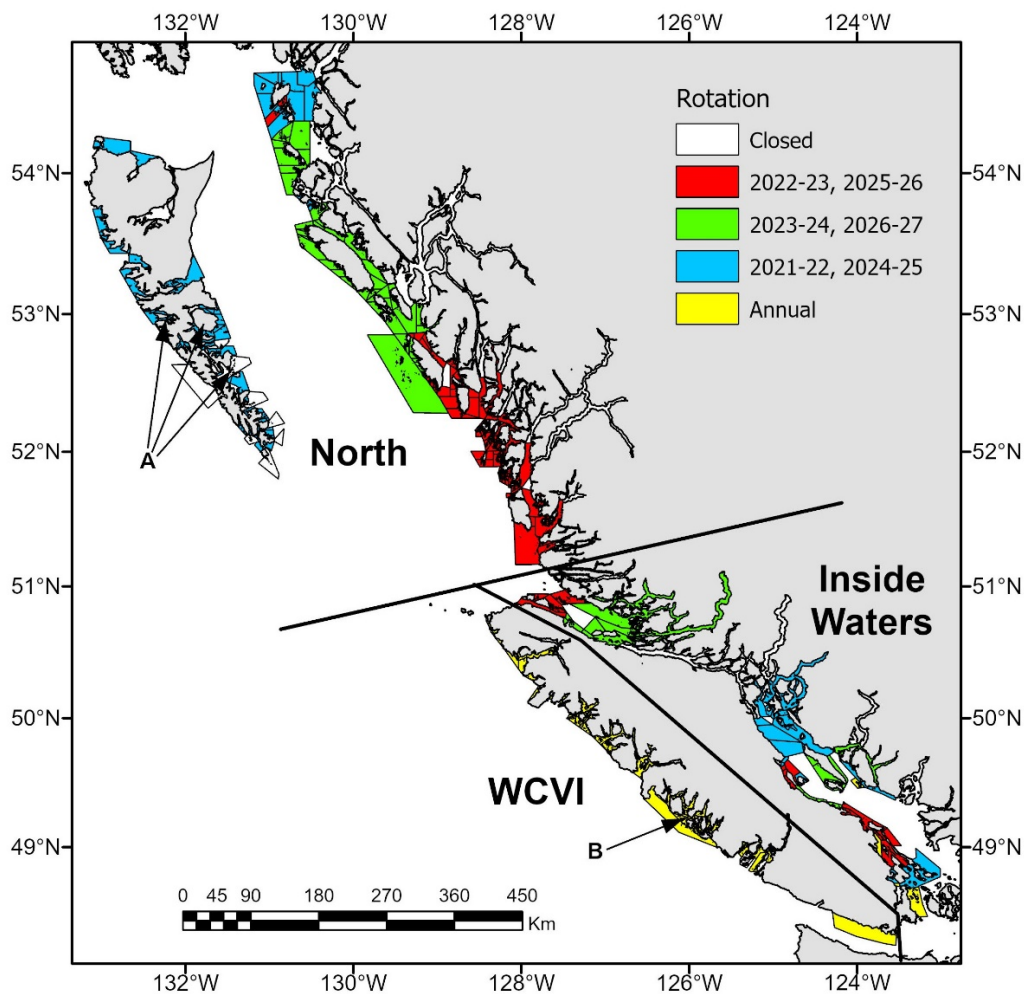


Figure 1: Map of British Columbia coast showing Geoduck “Quota Areas” (North, WCVI = West Coast of Vancouver Island, and Inside Waters, separated by solid lines) and “Rotational Areas” (different colors). Location of 2019 Geoduck density surveys indicated by letters: A = Englefield Bay, House Island and Louise Island, Haida Gwaii, North Coast, and B = Russell Channel and Elbow Bank, WCVI.

Pacific Region

Total Allowable Catch (TAC), in the context of this report, refers to the annual commercial catch allocation, established by fishery managers, for the BC wild Geoduck fishery. The TAC was relatively stable around 1,800 t between 1996 and 2004, but then was decreased to 1,559 t between 2005 and 2011 and was 1,497 t from 2012 to 2015. The TAC was decreased to 1,397 t for the 2016-2017 to 2019-2020 fishing seasons (Figure 2). The TAC was decreased to 1,372 t for the 2020-2021 fishing season (DFO 2020b), and then to 1,297 t for the 2021-2022 fishing season, due to the implementation of closures in the Gwaii Haanas National Marine Conservation Area Reserve and expected impacts of Sea Otter predation (DFO 2021b). There has been 100% dock side validation of commercial landings by a third-party service provider since 1989.

The fishery operated on the calendar year until 2015. The fishery operated for fourteen months for the 2016-2017 season to change the season start date to March 1st, starting with the 2017-2018 fishing season. The 2019-2020 season was scheduled from March 1, 2019 to February 28, 2020 but was extended until May 15, 2020 due to impacts of the COVID-19 pandemic. The 2020-2021 season started on May 16, 2020 and ran until April 30, 2021. The 2021-2022 season will run from May 1, 2021 to April 30, 2022.

Since 2007, harvest options have been based on estimates of current biomass (B_c) and regional annual exploitation rates of 1.2 – 1.8% and the LRP has been set to 40% of estimated unfished documented biomass (B^*) (Zhang and Hand 2006, 2007). Harvest options for portions of the coast under three year rotation are three times the annual rate once every three years.

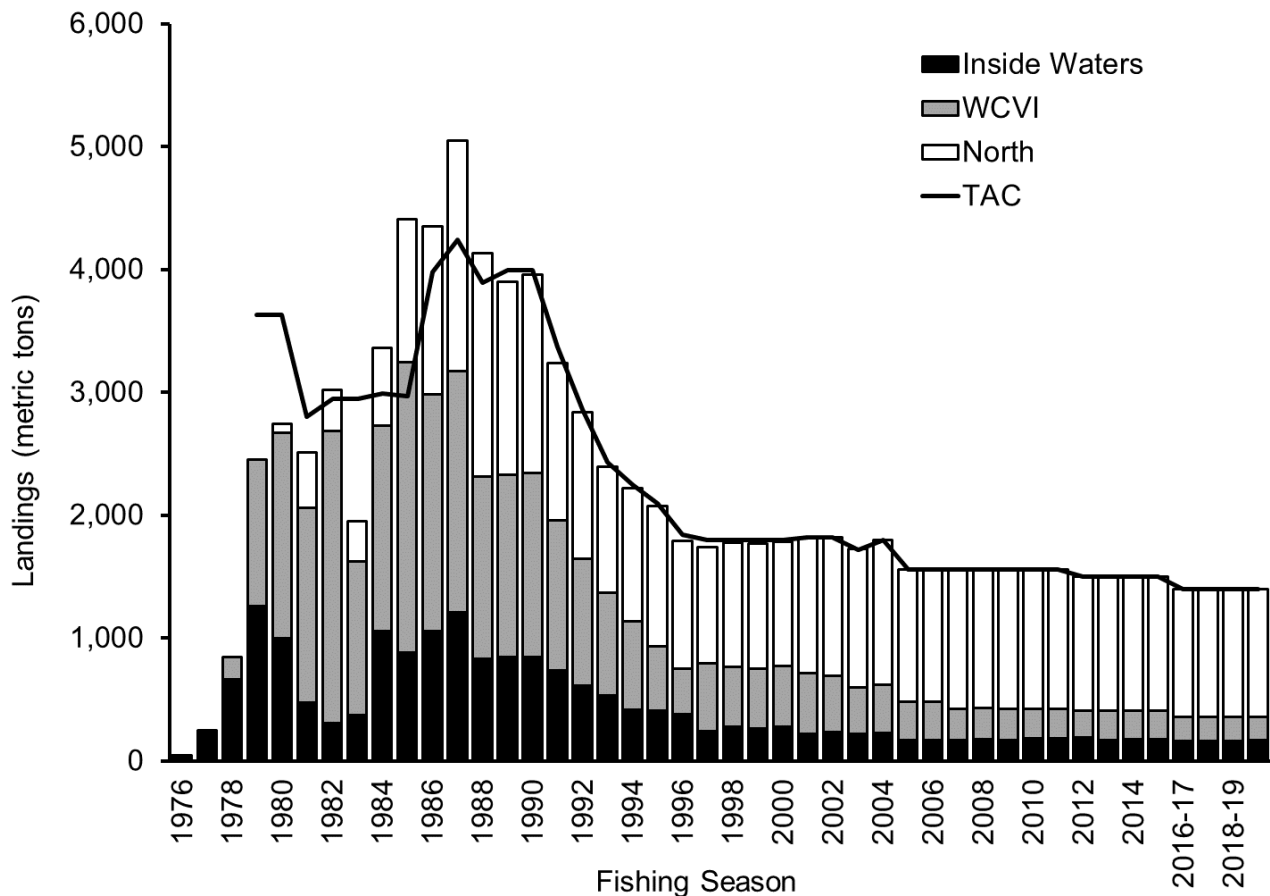


Figure 2: History of landings (metric tons) for the BC Geoduck fishery.

Analysis and Response

Stock Status and Stock Index

Stock Status

This stock status update follows the methods presented in the Geoduck stock assessment framework (Bureau et al. 2012) and later modifications (DFO 2014, Bureau 2017, DFO 2017) for estimating Geoduck stock biomass. Geoduck biomass is estimated on a by-Geoduck-sub-bed basis as the product of Geoduck density, mean weight and sub-bed area. Although the assessment methods are only updated when required, Geoduck biomass is re-estimated annually to include the latest available dive survey density data as well as new data on Geoduck mean weights, bed areas and harvest.

Geoduck surveys occur in different portions of the BC coast each year and only a portion of the beds are surveyed each year. On average 1,007 ha are surveyed annually and 810 ha were surveyed in 2019. Therefore, each year, density estimates are updated for some beds. Also, each year, estimates of sub-bed area and mean weights are updated for some sub-beds. Although harvest is accounted for in biomass estimations, changes in biomass from year to year also reflect increased or updated knowledge for portions of the stock and may therefore not be reflective of stock trends over time.

This 2020 stock status update incorporates new data from Geoduck fishery-independent density dive surveys conducted in 2019 as well as revisions to mean weight and bed area estimates based on the 2018-2019 fishing season harvest events.

Bed Area

The main source of data used to delineate the extent of Geoduck beds is harvest events. Estimates of Geoduck bed area are updated yearly to incorporate newly available data. Each year, harvest events from two seasons prior are reviewed to refine bed areas (Bureau et al. 2012). Any new beds discovered or extensions to existing beds are then documented. Results from density dive surveys and hydro-acoustic substrate-mapping surveys are also used to refine the area of beds surveyed the previous year. In 2018, hydro-acoustic substrate classification (single-beam) was replaced by multi-beam surveys of the target beds prior to the dive surveys. Comments from harvesters or on-ground monitors at annual meetings are also used to refine bed area boundaries. Because of the fishery-dependent nature of the data used to delineate beds, only areas where Geoducks are found in commercially harvestable quantities are documented. Geoduck beds therefore do not represent a full inventory of locations where Geoducks occur on the BC coast.

Geoduck beds in some areas are not harvested due to the impact of Sea Otter (*Enhydra lutris*) predation on Geoduck stocks. Beds in areas where Sea Otters are reported to have had an impact may or may not have quota assigned to them. In this report the term “available” beds refers to beds not impacted by closures and not reported to be impacted by Sea Otters; previously referred to as “open” beds (DFO 2020a, 2021a).

The total area of documented Geoduck beds in BC was estimated to be 22,388 ha, of which 15,465 ha are potentially available to harvest over three rotations (Table 1). Beds that were impacted by closures represented 3,554 ha (16%) of the bed area on the BC coast. Beds reported to be impacted by Sea Otter predation represented 3,369 ha (15%) of the bed area on the BC coast.

Pacific Region

Table 1: Amount of Geoduck bed area (hectares) under various categories, by Pacific Fishery Management Area (PFMA) and coastwide. "Closures" refers to beds in parks, reserves, research closures, contamination closures, unclassified waters, management closures, or tenured for aquaculture. "Otters" refers to beds that have been impacted by Sea Otter predation. "Available" refers to beds not impacted by closures and not reported to be impacted by Sea Otters.

PFMA	Bed Area (ha)			
	Total	Closures	Otters	Available
1	199	5	0	194
2	2,299	419	0	1,880
102	10	10	0	0
3	190	4	0	186
4	658	6	0	652
5	796	29	32	735
6	1,352	63	50	1,239
106	96	1	0	94
7	1,223	103	536	584
8	151	0	0	151
9	103	0	7	97
10	107	2	13	91
11	21	21	0	0
111	43	43	0	0
12	692	107	95	490
13	746	148	0	598
14	3,759	101	0	3,658
15	1,421	531	0	891
16	721	62	0	658
17	684	189	0	495
18	137	6	0	131
19	585	75	0	510
28	30	30	0	0
29	164	4	0	160
20	299	0	0	299
23	1,291	830	0	461
24	2,272	567	535	1,170
124	14	0	0	14
25	1,039	3	1,033	3
26	608	195	389	24
27	679	0	679	0
Coastwide	22,388	3,554	3,369	15,465

Pacific Region

Density

In 2019, density dive surveys were conducted on a portion of the Geoduck beds in the following areas of the BC coast (Figure 1):

- Englefield Bay, House Island and Louise Island; Haida Gwaii, North Coast
- Russell Channel and Elbow Bank; WCVI

The 2019 Geoduck density surveys covered 56 beds representing 810 ha of area. To date, 1,550 beds have been dive surveyed, representing 15,969 ha of bed area (71% of total) (Table 2). Of the surveyed beds, 462 have been surveyed more than once, representing 8,864 ha (40% of total). The average of mean current density estimates from all surveyed beds was 1.89 Geoducks/m². Average density was higher in the North Coast than in the South Coast (Inside Waters and WCVI). Density of Geoducks was below 1.0 Geoduck/m² for 66% of the surveyed bed area (Table 3).

Table 2: Current Geoduck density (mean and range) on surveyed beds, number of beds and bed area surveyed, by region.

Region	Number of Surveyed Beds	Density (Geoducks/m ²)		Bed Area Surveyed (ha)
		Mean	Range	
Haida Gwaii	333	1.64	(0.00 - 5.39)	1,979
Prince Rupert	416	2.52	(0.14 - 9.06)	2,325
Central Coast	509	2.14	(0.09 - 12.04)	1,661
North - All	1,258	2.14	(0.00 - 12.04)	5,964
Area 12	45	1.02	(0.09 - 2.69)	468
Strait of Georgia	95	0.30	(0.04 - 1.68)	6,014
Inside Waters - All	140	0.53	(0.04 - 2.69)	6,482
Area 24	41	1.10	(0.05 - 3.04)	2,034
Area 23	38	0.74	(0.23 - 1.84)	381
Area 23 Closures	49	1.75	(0.35 - 4.06)	447
Rest of WCVI	24	0.41	(0.00 - 1.28)	661
WCVI - All	152	1.11	(0.00 - 4.06)	3,524
Coastwide	1,550	1.89	(0.00 - 12.04)	15,969

Table 3: Number and percentage of surveyed Geoduck beds and bed area within different mean current density categories, coastwide.

Mean Current Density Geoducks/m ²	Surveyed Beds		Cumulative % Number	Bed Area		Cumulative % Area
	Number	%		Hectares	%	
0 to <1	575	37.1	37.1	10,504	65.8	65.8
1 to <2	422	27.2	64.3	2,979	18.7	84.4
2 to <3	261	16.8	81.2	1,020	6.4	90.8
3 to <4	131	8.5	89.6	656	4.1	94.9
4 to <6	104	6.7	96.3	519	3.2	98.2
6 to <8	33	2.1	98.5	226	1.4	99.6
≥8	24	1.5	100.0	66	0.4	100.0

Pacific Region

Mean Weight

Since 2001, Geoduck mean weights have been estimated from commercial fishery landings data (Bureau et al. 2012, DFO 2014). Mean weights are updated annually after adding the latest year of available commercial landings data to the dataset. For Geoduck beds where insufficient data are available to estimate mean weight, the mean weight is extrapolated from nearby beds (Bureau et al. 2012).

For beds where bed-specific estimates of mean weight are available, the average of mean Geoduck weight estimates was 1.10 kg coastwide (n=923), 1.13 kg in the North Coast (n=678), 0.99 kg on the WCVI (n=127) and 1.09 kg in the Inside Waters (n=118). Mean weight estimates ranged from 0.57 to 1.83 kg. Mean Geoduck weight was between 1.0 and 1.5 kg for 72% of the beds while 26% of beds had a mean weight between 0.5 and 1.0 kg (Table 4).

Table 4: Number and percentage of Geoduck beds and bed area within different mean weight ranges (for beds where bed-specific mean weight data are available).

Mean Geoduck Weight (kg)	Beds		Cumulative % Number	Bed Area		Cumulative % Area
	Number	%		Hectares	%	
< 0.5	0	0.0	0.0	0	0.0	0.0
0.5 to <1.0	241	26.1	26.1	3,860	23.3	23.3
1.0 to <1.5	665	72.1	98.3	12,568	75.8	99.1
1.5 to <2.0	16	1.7	100.0	143	0.9	100.0
≥2	0	0.0	100.0	0	0.0	100.0

Geoduck Biomass

Geoduck biomass is estimated only for the exploitable portion of the population (Bureau 2017). The biomass of Geoducks outside of documented Geoduck beds, including the portion of the population that exists deeper than harvestable depths, is unknown. Only Geoducks large enough to be counted by survey divers (approximately 5 years and older) are included in the density estimates and therefore biomass estimates do not include juvenile Geoducks.

Geoduck biomass is reported by Pacific Fishery Management Area (PFMA), for several categories of sub-beds (Table 5). Total biomass includes all documented beds on the coast. Available biomass refers to biomass on beds not impacted by closures and not reported to be impacted by Sea Otter predation. Few surveys have been conducted in areas impacted by Sea Otters. Consequently, there is greater uncertainty in the biomass estimates in these areas and it is likely that biomass is overestimated for areas impacted by Sea Otters.

The Geoduck stock biomass for all available sub-beds in BC was estimated at 175,815 t (95% CB: 96,524 – 309,840 t, Table 5). The Geoduck stock biomass for all documented sub-beds coastwide was estimated at 232,431 t (95% CB: 119,637 – 433,819 t, Table 5). Consequently, 14% of the Geoduck biomass on the BC coast is impacted by closures and 11% is reported to be impacted by Sea Otter predation.

**Science Response: 2020 BC Geoduck
Stock Status Update**

Pacific Region

Table 5: Estimated Geoduck biomass (metric tons), by Pacific Fishery Management Area (PFMA) and coastwide, for sub-beds that are available, impacted by Sea Otter predation, impacted by closures and total. 95% CBs are low and high 95% confidence bounds.

PFMA	Available		Otters Median	Closures Median	Total	
	Median	95% CBs			Median	95% CBs
1	1,166	294 – 3,562	0	50	1,216	300 – 3,756
2	33,155	17,593 – 57,038	0	7,096	40,251	20,447 – 71,657
102	0	0 - 0	0	133	133	17 - 521
3	3,551	1,710 – 6,266	0	13	3,564	1,716 – 6,288
4	22,545	13,169 – 36,686	0	106	22,651	13,210 – 36,923
5	22,357	14,188 – 33,480	549	221	23,127	14,650 – 34,655
6	32,160	15,791 – 58,013	689	732	33,581	16,554 – 60,447
106	4,903	3,195 – 7,830	0	2	4,905	3,196 – 7,833
7	12,168	5,011 – 25,989	11,088	874	24,130	10,327 – 52,260
8	3,868	1,827 – 7,219	0	0	3,868	1,827 – 7,219
9	903	356 – 3,041	103	0	1,006	375 – 3,487
10	992	383 – 2,020	123	6	1,121	419 – 2,699
11	0	0 - 0	0	223	223	24 - 603
111	0	0 - 0	0	147	147	0 - 610
12	4,563	2,102 – 8,448	1,338	908	6,808	3,110 – 13,529
13	1,027	618 – 1,986	0	283	1,310	770 – 2,885
14	6,173	4,420 – 8,743	0	127	6,301	4,489 – 8,985
15	1,320	510 – 4,699	0	688	2,008	806 – 7,568
16	2,442	1,535 – 4,881	0	147	2,589	1,624 – 5,244
17	1,243	718 – 3,188	0	363	1,607	814 – 5,460
18	800	521 – 1,366	0	8	808	524 – 1,407
19	892	236 – 4,892	0	171	1,064	276 – 6,035
28	0	0 - 0	0	50	50	12 - 335
29	350	157 – 1,184	0	5	355	159 – 1,221
20	744	0 – 2,842	0	0	744	0 – 2,842
23	3,830	2,056 – 5,903	0	16,979	20,809	8,874 – 35,387
24	14,325	10,035 – 19,800	3,910	1,910	20,145	13,625 – 28,734
124	181	15 - 497	0	0	181	15 - 497
25	38	14 - 57	3,224	7	3,269	312 – 11,600
26	119	71 - 209	1,791	602	2,511	898 – 6,647
27	0	0 - 0	1,949	0	1,949	269 – 6,485
Coastwide	175,815	96,524 – 309,840	24,765	31,851	232,431	119,637 – 433,819

Stock Index

The stock index for the BC Geoduck fishery is defined as the ratio of total coastwide current biomass to total coastwide unfished biomass (B_c/B') and is estimated for the stock as a whole. The coastwide stock index is re-estimated yearly when biomass estimates are updated.

Pacific Region

The stock index based on total documented coastwide Geoduck biomass was estimated at 83% (for all beds). The stock index of Geoduck biomass within available beds was estimated at 91% (for available beds only).

The provisional LRP for BC Geoducks is defined as current biomass (B_c) being equal to 40% of the estimated unfished documented biomass (B') (Zhang and Hand 2007). Zhang and Hand (2007) recommended that the LRP for Geoducks be applied on a by-Geoduck bed spatial scale. However, Geoduck beds are not individual stocks, they are linked through larval dispersal as evidenced by genetic analyses (Miller et al. 2006). Since Geoducks are considered to be a single genetic stock on the BC coast, it is recommended that the LRP be applied on a coastwide spatial scale and that stock status be determined coastwide. Management of the fishery occurs at a smaller spatial scale to ensure the sustainability of the fishery. The value of the Limit Reference Point for the BC Geoduck stock in 2020 was estimated at 111,625 t (95% CB: 60,506– 212,299 t).

Zhang and Hand (2007) recommended a Target Reference Point of 50% of pre-fishery biomass for BC Geoducks. Although Zhang and Hand (2007) used the term “target”, their meaning or intent for the 50% threshold was not a target stock level to achieve but rather a stock level to avoid reaching. DFO (2021c) states that a Target Reference Point is meant to represent a desirable stock status state while the primary role of the Upper Stock Reference (USR) is to serve as a threshold to progressive reduction of the fishing mortality rate to avoid stock status reaching the LRP. Zhang and Hand (2007) defined their target reference point as the point where harvest rate is progressively decreased to avoid reaching the LRP; which clearly aligns with the definition of the USR in DFO’s Precautionary Approach Framework (DFO 2009) and according to DFO (2021c). Zhang and Hand (2007) was published before the DFO Precautionary Approach Framework (DFO 2009) which explains the difference in terminology used. It is therefore recommended setting the provisional USR for the Geoduck stock as total coastwide current biomass being equal to 50% of total coastwide estimated unfished documented biomass. If adopted, the value of the USR for the BC Geoduck stock in 2020 would be 139,531 t (95% CB: 75,632 – 265,374 t) which would place the stock in the Healthy Zone.

The LRP recommended by Zhang and Hand (2007) is provisional and therefore may not meet the definition of LRP under the Precautionary Approach Framework (DFO 2009), i.e., “the point below which serious harm is occurring to the stock”. Because of the absence of Sea Otters from the BC coast for nearly a century, it is believed that Geoduck abundance at the beginning of the fishery may have been at a historical high. It is therefore possible that the point below which serious harm is occurring to the stock is actually lower than the provisional LRP currently in use for the Geoduck stock. In the future, DFO intends to review the LRP for Geoduck to align more fully with the intent of the Precautionary Approach Framework (DFO 2009) as the point below which serious harm occurs to the stock.

An additional margin of safety for Geoduck conservation exists because portions of the Geoduck stock are sheltered from harvest. Not all documented Geoduck beds can be harvested, some are located in areas that fall under a variety of closure types (contamination closures, parks, research closures, management closures, etc.) or areas where water quality has not been classified by Environment and Climate Change Canada (known as unclassified waters). Some Geoducks exist in areas that are un-harvestable due to substrate characteristics and many beds extend to shallower and/or greater depths than where harvest takes place. The Geoduck biomass in these *de-facto* reserves has, however, not been quantified. Since Geoduck beds are defined primarily through harvesting events, the inventory of Geoduck populations in BC is not complete.

Conclusions

Geoduck biomass on available sub-beds on the BC coast in 2020 was estimated at 175,815 t (95% CB: 96,524 – 309,840 t, Table 5). Total coastwide biomass for all documented sub-beds was estimated at 232,431 t (95% CB: 119,637 – 433,819 t, Table 5), well above the LRP of 111,625 t (95% CB: 60,506– 212,299 t) and proposed USR of 139,531 t (95% CB: 75,632 – 265,374 t); which would place the stock in the Healthy Zone.

For all available Geoduck sub-beds in BC, the sum of the lower 95% confidence bounds of annual harvest options was 1,651 t. The TAC for the BC commercial Geoduck fishery for the 2021-2022 fishing season was set at 1,297 t by fishery managers (DFO 2021b); below the lower 95% confidence bound of harvest options.

The removal reference (maximum allowable harvest rate for the stock as a whole) for the BC Geoduck stock was defined as 1.8% of the coastwide current Geoduck biomass estimate (DFO 2021a). Although regional annual harvest rates of 1.2 to 1.8% are used in estimating harvest options (Zhang and Hand 2007) for each Geoduck sub-bed, the actual harvest rate, defined as the TAC divided by biomass, for the BC Geoduck stock as a whole is lower. The actual Geoduck annual harvest rate for the 2021-2022 fishing season was estimated at 0.6% of the estimated median total documented biomass and 1.1% of the estimated lower 95% confidence bound of total documented biomass (i.e. biomass on all documented sub-beds); well below the 1.8% removal reference.

Based on biomass estimated for the 2021-2022 Geoduck harvesting season, the coastwide Geoduck stock index was 83% and 91% for all documented sub-beds on the coast and for available sub-beds only, respectively, well above the proposed 50% USR, which would place the stock in the Healthy Zone.

Contributors

Contributor	Affiliation
Dominique Bureau	DFO Science, Pacific Region
Amy Ganton	DFO Fisheries Management, Pacific Region
Roger Kanno	DFO Fisheries Management, Pacific Region
Janet Lohead	DFO Science, Pacific Region
Erin Porszt	DFO Science, Pacific Region (Lead author)
Pauline Ridings	DFO Fisheries Management, Pacific Region
Erin Wylie	DFO Fisheries Management, Pacific Region

Approved by

Andrew Thomson
Regional Director
Science Branch, Pacific Region
Fisheries and Oceans Canada

June 01, 2021

Sources of Information

- Bureau, D. 2017. [Update to estimation methods for Geoduck \(*Panopea generosa*\) stock index](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2017/070. ix + 55 p.
- Bureau, D., Hand, C.M. and Hajas, W. 2012. [Stock Assessment Framework for the British Columbia Geoduck Fishery, 2008](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2011/121. vii + 79 p.
- DFO. 2009. [A fishery decision-making framework incorporating the precautionary approach](#).
- DFO. 2014. [Effects of Geoduck biological sample handling and transport time on mean weight estimation](#). DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/046.
- DFO. 2017. [Update to estimation methods for Geoduck \(*Panopea generosa*\) stock index](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/037.
- DFO. 2020a. [2018 Stock status update of British Columbia wild Geoduck](#). DFO Can. Sci. Advis. Sec. Scai. Resp. 2020/054.
- DFO. 2020b. [Integrated Fisheries Management Plan](#). Geoduck and Horseclam. March 1, 2020 to February 28, 2021.
- DFO. 2021a. [2019 Stock Status Update of British Columbia Wild Geoduck](#). DFO Can. Sci. Advis. Sec. Sci. Resp. 2021/007.
- DFO. 2021b. [Integrated Fisheries Management Plan](#). Geoduck and Horseclam. May 1, 2021 to April 30, 2022.
- DFO. 2021c. [Science Advice for Precautionary Approach Harvest Strategies under the Fish Stocks Provisions](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2021/004.
- Hand, C.M. and Bureau, D. 2012. [Stock Assessment Framework for the British Columbia Geoduck Fishery, 2002](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2011/120. vi + 33 p.
- Miller, K.A., Supernault, K.J., Li, S. and Withler, R.E. 2006. Population structure in two marine invertebrate species (*Panopea abrupta* and *Strongylocentrotus franciscanus*) targeted for aquaculture and enhancement in British Columbia. J. Shellfish Res. 25:33-42.
- Zhang, Z., and Hand, C. 2006. Recruitment patterns and precautionary exploitation rates for Geoduck (*Panopea abrupta*) population in British Columbia. J. Shellfish Res. 25:445-453.
- Zhang, Z. and Hand, C. 2007. [Determination of Geoduck Harvest Rates Using Age-structured Projection Modelling](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2007/064. iv + 49 p.

This Report is Available from the:

Centre for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Telephone: (250) 756-7208

E-Mail: csap@dfo-mpo.gc.ca

Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-3769

ISBN 978-0-660-39633-0 Cat. No. Fs70-7/2021-035E-PDF

© Her Majesty the Queen in Right of Canada, 2021



Correct Citation for this Publication:

DFO. 2021. 2020 Stock Status Update of British Columbia Wild Geoduck. DFO Can. Sci. Advis.
Sec. Sci. Resp. 2021/035.

Aussi disponible en français :

*MPO. 2021. Mise à jour de 2020 sur l'état des stocks de panopes sauvages en
Colombie-Britannique. Secr. can. de consult. sci. du MPO. Rép. des Sci. 2021/035.*