

Prioritization of depleted stocks for rebuilding plans

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In 2017 Oceana Canada published its first annual Fishery Audit, revealing the state of Canada's marine fisheries and providing an assessment of how the government is managing them (<http://fisheryaudit.ca/>). The 2018 Fisheries Audit uses newly available information published over the last year to examine changes in indicators used to measure progress toward maintaining or rebuilding fisheries to healthy levels in Canada and to track how well Fisheries and Oceans Canada (DFO) is implementing its commitments from year to year. The results show that Canadian fisheries are in trouble: with only about one-third that can confidently be considered healthy, 16 per cent depleted into a state of caution and 13 per cent in critical condition (Oceana Canada 2018a). Further, the health of 37 per cent was uncertain. What was more concerning was that only three rebuilding plans were in place to rebuild 26 critically depleted populations.

Consistent with recommendations from global bodies such as the Organisation for Economic Co-operation and Development Committee for Fisheries and the FAO Code of Conduct for Responsible Fisheries, rebuilding plans must contain elements to ensure that the depleted populations will recover to a healthy level of abundance. According to DFO policy incorporating the precautionary approach (PA), rebuilding plans must be in place when a stock has reached the critical zone and development of a rebuilding plan should be initiated far enough in advance to ensure the plan is ready to come into effect at the boundary of the critical and cautious zones (DFO 2009). DFO currently has rebuilding plans in place for three critical-zone stocks and one cautious-zone stock and has committed to developing plans for 18 more depleted stocks, some of which are in the cautious zone (DFO 2017, DFO 2018).

The public release of work plans outlining priorities for developing rebuilding plans is encouraging progress towards increasing transparency in fisheries management in Canada. However, last year only one of five rebuilding plans committed for completion were finished and posted online as expected by the end of June 2018 (Oceana Canada 2018b), and several critically depleted stocks still do not have commitments for rebuilding plan development.

Although rebuilding plan development can sometimes be a long process, Oceana Canada believes that DFO already has many components in place required to promote the rebuilding of several more stocks. If rebuilding plan development is made a priority, plans can be in place for all critical-zone stocks and many cautious-zone stocks within five years. This process should refine and further develop priorities and timelines for drafting and implementing rebuilding plans, with a focus on stocks in the most depleted state, those declining rapidly or those for which rebuilding has stagnated.

Last year we suggested that stocks could be prioritized based on the number of components in place for rebuilding plan development (Oceana Canada 2017). Here we update that prioritization, identifying marine fish and invertebrate stocks in the critical and cautious zones¹ that still do not have commitments to develop rebuilding plans but have most of these components in place. Stocks for which DFO has publicly committed to developing plans should be completed as soon as possible, followed by those without commitments for plans. Those stocks with plans already in existence must be regularly assessed and updated as required.

To prioritize the depleted stocks without rebuilding plans or a public commitment to develop one, Oceana Canada identified those stocks which already have four of the main components that would facilitate

¹ Marine fish and invertebrate index dataset stocks included in Oceana Canada (2018a) *Fisheries Rebuilding Success Indicators: 2018*.

rebuilding progress and scored them as detailed below. It should take less work to complete rebuilding plans for those with the highest score, so they could be prioritized. Within those with equal scores, the priority could be assigned to those that are most depleted. Regardless of prioritization, it is expected all plans will be of the same quality and contain the objectives, timelines and management measures required to promote rebuilding to a healthy level.

The four components and depletion state are defined as follows:

1. **Reference points:** Without reference points it is difficult to apply the PA Framework (DFO 2009), assess the health of a stock and develop benchmarks for rebuilding depleted ones to healthy levels. When reference points are in place, the basic building blocks for developing abundance or biomass objectives and targets already exist, which should facilitate rebuilding plan development. We assigned one point for the presence of each reference point, such that stocks were assigned a score of two if they have both a lower reference point (LRP) and an upper stock reference (USR) and zero if there are no reference points.
2. **Inclusion in an Integrated Fisheries Management Plan (IFMP):** Although fisheries rebuilding should take place through a clearly defined process — related to but distinct from fisheries management for healthy fish stocks — much of the content of a good rebuilding plan and process is also included in an IFMP. Rebuilding plans for stocks already included in an IFMP could be published as an appendix to the IFMP and refer to the IFMP for background information, rather than create a more robust stand-alone plan. Thus, rebuilding plan development will be facilitated when a stock is already included in an IFMP. If a stock is included in an IFMP we assigned a score of one, and zero if it is not.
3. **Recent stock assessments:** It is difficult to develop a plan for rebuilding without recent estimates of abundance. If a stock has a recent estimate of abundance, then there is already a process developed for its assessment, which should facilitate developing a rebuilding plan and provide more confidence in projections evaluating alternative management options. If a stock has been assessed recently (within the last five years), we assigned a score of one, and zero if not.
4. **Sources of mortality known:** Fish are removed from a population due to natural causes and fishing. Estimates of how much fish are being removed is critically important to managing stocks. Fishing mortality (F) is the removal rate of fish from the population, as estimated from population models. Ideally, estimates will include information from all potential sources of fishing mortality: directed commercial fisheries, recreational fisheries, bait fisheries, food-social-ceremonial fisheries and bycatch. One or more of these sources are often missing from mortality estimates, and they may end up being associated with an estimate of natural mortality. Natural mortality (M) is the removal rate of fish from the population from causes not directly attributable to fishing, which can include disease, competition, cannibalism, old age and predation but may also include unreported or unaccounted-for catch. Most common stock assessment models assume natural mortality is constant and input it into the model using an informed guess. However, several approaches have been developed to estimate natural mortality within models and to allow it to vary. Having estimates of all sources of mortality already in place should facilitate rebuilding plan development, as the stock has robust enough data and modelling approaches to allow for their estimation to help inform decision making. We assigned one point for the presence of known estimates of fishing and natural mortality rates, such that stocks with both rates estimated were assigned a score of two and a score of zero was assigned if there are no estimates.

State of depletion: Stocks that are most depleted are in most need of a rebuilding plan to return them to a healthy state. We assess depletion status using the most recently available biomass abundance estimate,² expressed as a percentage of the USR. If a USR was not defined, we assumed the value used to assess depletion status to be double the limit reference point LRP. We also show depletion status in relation to LRPs. It should be noted that some depletion statuses are calculated using biomass estimates more than five years old, as shown in the recent assessment indicator.

Oceana Canada recognizes that other considerations may influence the prioritization of rebuilding plans, such as recovery potential and economic potential of the fishery. These and other factors may influence the readiness of industry to participate in the rebuilding process. For example, for a number of stocks, environmental conditions and climate change will pose challenges that need to be acknowledged within rebuilding plans.

Among the critical zone stocks without a plan, or without a commitment for a plan, this process identified two stocks that scored a total of six out of a possible six (indicating four of the components necessary to facilitate the development of rebuilding plans have been completed): yellowtail flounder in the Southern Gulf of St. Lawrence (4T) and Atlantic cod in the northern Gulf of St. Lawrence (3Pn, 4RS) (Table 1), the latter of which recently had a rebuilding plan that expired and requires updating. None of the cautious-zone stocks without a plan or commitment for a plan scored as high, but four stocks were identified with a total score of five, indicating they nearly have all the components in place (Table 2).

Most critical-zone stocks requiring rebuilding plans are on the Atlantic coast (Figure 1), with only one critical-zone stock in the Pacific (pink shrimp in SMA 18-19) that requires a plan but does not have one or a commitment to creating one. Within the Atlantic coast region, the Newfoundland region is responsible for six critical zone stocks without rebuilding plans or commitments, the Gulf and Quebec region for two stocks each, and the Maritimes and National Capital region for one stock each.

² If more than one biomass estimate was presented in assessment documents, these were averaged. Similarly, if the stock was comprised of more than one sub-unit with separate reference points, an average of depletion status was used. See the dataset published with Oceana Canada (2018a) for assessment references.

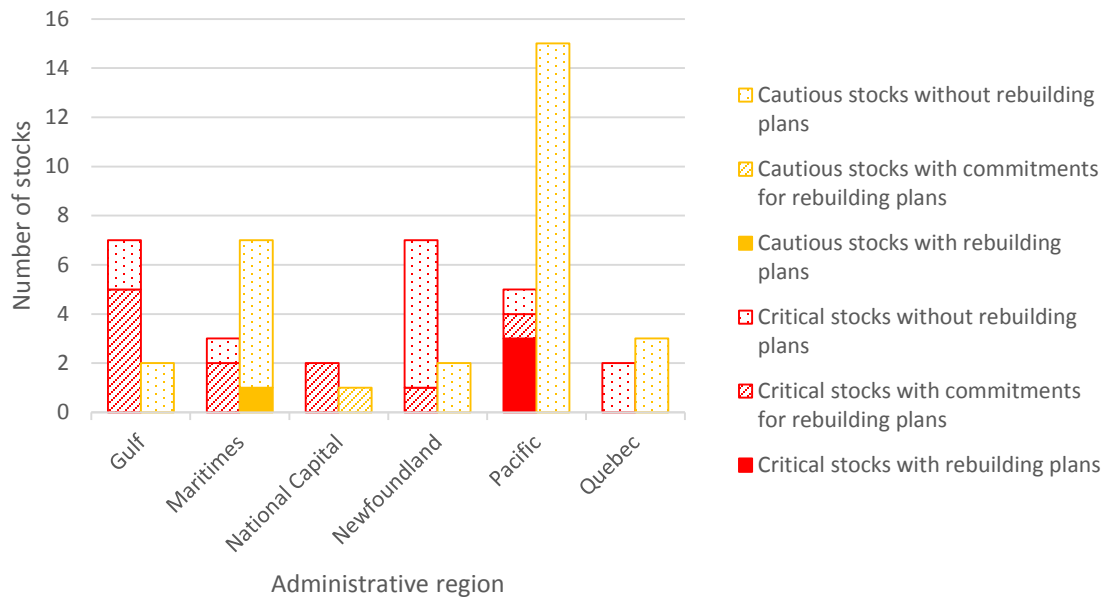


Figure 1. The number of critical-zone and cautious-zone stocks in each DFO administrative region, broken down into the number that are included in rebuilding plans, the number with commitments to develop rebuilding plans, and the number without rebuilding plans or commitments.

Only the Maritime region has a rebuilding plan in place for a cautious-zone stock (Atlantic herring Scotian Shelf, Bay of Fundy (4VWX)). The National Capital region has committed to developing a rebuilding plan for one more cautious-zone stock, Acadian redfish in the Gulf of St. Lawrence and Laurentian fan (Unit 1+2), but development for this plan was recently suspended, precisely because it has recently grown into the cautious zone and a plan is therefore not required by policy. It is not only important to have rebuilding plans in place for declining cautious-zone stocks, with the aim of rebuilding before they reach the critical zone, but also for cautious-zone stocks that have recently grown from the critical zone without a rebuilding plan in place. A rebuilding plan for these stocks is important to guide the development of a sustainable fishery and ensure the stock does not decline once more into the critical zone. The recent change in status for Acadian redfish is largely due to a few recent large cohorts (2011–13), and currently there is no fisheries management plan (rebuilding plan or IFMP) that covers the entire stock area to guide a rebuilding fishery.

References

1. DFO (2009). A Fishery Decision-Making Framework Incorporating the Precautionary Approach. <http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm>
2. DFO (2017). Fisheries and Oceans Canada's Work Plans for Fiscal from 2017 to 2018 in Response to Recommendation 2.28, 2.63 and 2.65 in the Commissioner of the Environment and Sustainable Development's (CESD) October 2016 Report 2: Sustaining Canada's major fish stocks: Fisheries and Oceans Canada. <http://www.dfo-mpo.gc.ca/ae-ve/audits-verifications/16-17/work-plan-travail-eng.html>
3. DFO (2018). Work Plans for Fiscal 2018-19. Fisheries and Oceans Canada's Work Plans for Fiscal 2018-19 in Response to Recommendation 2.28, 2.63 and 2.65 in the Commissioner of the

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4. Oceana Canada (2017). Priorities for Rebuilding Critical Fisheries. <http://www.oceana.ca/FisheryAudit2017>
5. Oceana Canada (2018a). Fisheries Rebuilding Success Indicators: 2018. <http://www.oceana.ca/FisheryAudit2018>
6. Oceana Canada (2018b). Assessing Progress Towards the Completion of Commitments. <http://www.oceana.ca/FisheryAudit2018>

Table 1. Prioritization of Canada's marine fish and invertebrate **critical-zone stocks** for rebuilding plan development based on state of depletion and the presence of components required for rebuilding plans. Green shading indicates stocks committed for rebuilding plan development, orange shading indicates stocks with commitments to develop rebuilding plans, and blue shading indicates stocks already included in rebuilding plans. Stocks in italic font are included in the 2016 results of the Sustainability Survey for Fisheries.

PRIORITY RANK	Species	Stock	Rebuilding plan	LRP	USR	IFMP	Recent assessment	Fishing mortality	Natural mortality	TOTAL SCORE	% of LRP	% of USR*	Directed fishery?
1	<i>Winter flounder</i>	<i>Southern Gulf of St. Lawrence (4T)</i>	<i>Commitment</i>	✓	✓	✓	✓	✓	✓	6	52	26	Yes
2	<i>Atlantic herring</i>	<i>Southern Gulf of St. Lawrence (4T) – spring spawner</i>	<i>Commitment</i>	✓	✓	✓	✓	✓		5	65	23	Yes
3	<i>Atlantic cod</i>	<i>Eastern Georges Bank (5Zjm)</i>	<i>Commitment</i>	✓	✓	✓	✓	✓		5	45	20	Yes
4	<i>American plaice</i>	<i>Southern Gulf of St. Lawrence (4T)</i>	<i>Commitment</i>	✓		✓	✓	✓	✓	5	40	20	No
5	<i>Northern shrimp</i>	<i>SFA 6 – Labrador NE Newfoundland</i>	<i>Commitment</i>	✓	✓	✓	✓			4	65	24	Yes
6	<i>Atlantic cod</i>	<i>Scotian Shelf and Bay of Fundy (4X5Y)</i>	<i>Commitment</i>	✓	✓		✓	✓	✓	4	44	22	Yes
7	<i>Atlantic cod</i>	<i>Southern Gulf of St. Lawrence (4TVn)</i>	<i>Commitment</i>	✓		✓	✓		✓	4	43	21	No [†]
8	<i>Atlantic cod</i>	<i>Northern cod (2J3KL)</i>	<i>Commitment</i>	✓		✓	✓	✓		4	37	18	No ^{††}
9	<i>White hake</i>	<i>Southern Gulf of St. Lawrence (4T)</i>	<i>Commitment</i>	✓		✓	✓		✓	4	30	15	No [†]
10	<i>Pacific herring</i>	<i>Haida Gwaii (QCI)</i>	<i>Commitment</i>	✓		✓	✓			3	70	35	No [†]
11	<i>Atlantic mackerel</i>	<i>Atlantic (NAFO 3-4)</i>	<i>Commitment</i>	✓		✓	✓			3	39	19	Yes
12	Yellowtail flounder	Southern Gulf of St. Lawrence (4T)	No	✓	✓	✓	✓	✓	✓	6	61	31	Yes
13	<i>Atlantic cod</i>	<i>Northern Gulf (3Pn, 4RS)</i>	No	✓	✓	✓	✓	✓	✓	6	26	17	Yes
14	American plaice	Grand Banks (3LNO)	No	✓	✓	✓	✓	✓		5	60	30	No [†]
15	Atlantic cod	Southern Grand Banks (3NO)	No	✓	✓		✓	✓		4	64	32	No [†]
16	White hake	Northern Gulf of St. Lawrence (4RS)	No	✓	✓		✓	✓		4	55	28	No
17	American plaice	St. Pierre Bank (3Ps)	No	✓	✓	✓	✓			4	40	20	No [†]
18	Winter skate	Gulf of St. Lawrence (4T)	No	✓			✓	✓	✓	4	3	2	No
19	<i>Pink shrimp</i>	<i>Pacific Shrimp Management Area 18–19</i>	No	✓	✓	✓				3	85	42	No [†]
20	Deepwater redfish	Labrador NE Newfoundland (2+3K)	No	✓	✓	✓				3	35	18	No [†]
21	Acadian redfish	Labrador NE Newfoundland (2+3K)	No	✓	✓	✓				3	27	13	No [†]
22	White hake	Eastern Scotian Shelf (4VW)	No	✓			✓			2	50	25	No
23	American plaice	Labrador NE Newfoundland (23K)	No	✓		✓				2	24	12	No
24	<i>Yelloweye rockfish</i>	<i>Outside population</i>	Yes	✓	✓	✓	✓	✓		5	90	45	Yes
25	<i>Yelloweye rockfish</i>	<i>Inside population</i>	Yes	✓	✓	✓		✓		4	54	26	Yes

26	<i>Bocaccio rockfish</i>	<i>Pacific</i>	Yes	✓	✓	✓				3	18	6	No
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* If a USR was not defined, we assumed the value used to assess depletion status to be double the LRP.

† These stocks are under moratorium or have been declared closed to targeted fishing.

†† This stock is under moratorium but has a directed commercial stewardship fishery in the inshore areas of 2J+3KL.

Table 2. Prioritization of Canada's marine fish and invertebrate **cautious-zone stocks** for rebuilding plan development based on state of depletion and the presence of components required for rebuilding plans. Green shading indicates stocks committed for rebuilding plan development, orange shading indicates stocks with commitments to develop rebuilding plans, and blue shading indicates stocks already included in rebuilding plans. Stocks in italic font are included in the 2016 results of the Sustainability Survey for Fisheries.

PRIORITY RANK	Species	Stock	Rebuilding plan	LRP	USR	IFMP	Recent assessment	Fishing mortality	Natural mortality	TOTAL SCORE	% of LRP	% of USR*	Directed fishery?
1	<i>Acadian redfish</i>	<i>Gulf of St. Lawrence and Laurentian fan (Unit 1+2)</i>	<i>Commitment (suspended)</i>	✓	✓	✓	✓			4	135	68	Yes
2	Pacific cod	Hecate Strait (5CD)	No	✓	✓	✓	✓	✓		5	137	87	Yes
3	<i>Snow crab</i>	<i>Scotian Shelf (4X)</i>	No	✓	✓	✓	✓	✓		5	164	82	Yes
4	<i>Atlantic herring</i>	<i>Southern Gulf of St. Lawrence (4T) – fall spawner</i>	No	✓	✓	✓	✓	✓		5	193	65	Yes
5	Lingcod	Strait of Georgia (4B)	No	✓	✓	✓	✓	✓		5	128	64	Yes
6	<i>Northern shrimp</i>	<i>Gulf of St. Lawrence (SFA 8, 9, 10, 12)</i>	No	✓	✓	✓	✓			4	190	88	Yes
7	<i>Northern shrimp</i>	<i>Scotian Shelf (SFA 13–15)</i>	No	✓	✓	✓	✓			4	226	85	Yes
8	<i>Atlantic cod</i>	<i>Southern Newfoundland (3Ps)</i>	No	✓	✓	✓	✓			4	150	75	Yes
9	<i>Pacific halibut</i>	<i>Pacific</i>	No	✓		✓	✓	✓		4	133	67	Yes
10	<i>Witch flounder</i>	<i>Gulf of St. Lawrence (4RST)</i>	No	✓	✓	✓	✓			4	116	55	Yes
11	<i>Sablefish</i>	<i>Pacific</i>	No	✓	✓	✓	✓			4	105	53	Yes
12	<i>Greenland halibut</i>	<i>Gulf of St. Lawrence (4RST)</i>	No	✓		✓	✓			3	278	139 [†]	Yes
13	<i>Canary rockfish</i>	<i>Coastwide (west coast Vancouver Island, Strait of Georgia, Queen Charlotte Islands)</i>	No	✓	✓	✓				3	235	118 [†]	Yes
14	<i>Pacific herring</i>	<i>Central Coast</i>	No	✓		✓	✓			3	225	113 [†]	Yes
15	<i>Thorny skate</i>	<i>Grand Banks (3LNO)</i>	No	✓		✓	✓			3	200	100 [†]	Yes
16	<i>Iceland and sea scallop</i>	<i>Magdalen Islands (areas 20A, 20B, 20C, 20E and 20F)</i>	No	✓	✓		✓			3	195	97	Yes
17	<i>Side-stripe shrimp</i>	<i>Mayne Island, Saanich, William Head (SMA 18–19)</i>	No	✓	✓	✓				3	180	90	Yes
18	<i>Quillback rockfish</i>	<i>Outside waters</i>	No	✓	✓	✓				3	175	88	Yes
19	Dogfish	Inside	No	✓	✓	✓				3	163	82	Yes

PRIORITY RANK	Species	Stock	Rebuilding plan	LRP	USR	IFMP	Recent assessment	Fishing mortality	Natural mortality	TOTAL SCORE	% of LRP	% of USR*	Directed fishery?
				✓	✓	✓			✓				
20	<i>Pink shrimp</i>	Georgia Strait East	No	✓	✓	✓				3	160	80	Yes
21	<i>Pacific herring</i>	West Coast Vancouver Island (WCVI)	No	✓		✓	✓			3	155	78	No†
22	Atlantic cod	Eastern Scotian Shelf (4VsW)	No	✓	✓				✓	3	125	63	No†
23	<i>Quillback rockfish</i>	Inside waters	No	✓	✓	✓				3	122	61	Yes
24	<i>Pacific herring</i>	Prince Rupert District	No	✓		✓	✓			3	116	58	Yes
25	<i>Pink shrimp</i>	Oyster River, Parksville (SMA 14)	No	✓	✓	✓				3	105	51	Yes
26	Cusk	Scotian Shelf, Georges Bank (4VWX5Z)	No	✓	✓					2	143	71	No
27	American plaice	Scotian Shelf (4VWX)	No	✓	✓					2	124	62	Yes
28	White hake	Western Scotian Shelf, Bay of Fundy and northern Georges Bank (4X5Zc)	No	✓			✓			2	100	50	No
29	<i>Krill (Euphausiids)</i>	<i>Pacific</i>	No			✓				1	—	— ⁵	Yes
30	<i>Atlantic herring</i>	Scotian Shelf, Bay of Fundy (4VWX)	Yes	✓		✓	✓			3	110	55	Yes

* If a USR was not defined, we assumed the value used to assess depletion status to be double the LRP.

†These stocks are under moratorium or have been declared closed to targeted fishing.

1. The most recent assessment for this stock states “cautious zone,” but there is no USR. When you assume the USR is twice the LRP, it results in a depletion status > 100% of the USR.

2. This stock has a highly uncertain biomass from an assessment nearly a decade old where 3 of 5 models indicated that stock was in cautious zone, while 2 of 5 models indicated the stock was in the healthy zone. The average of these highly variable biomass estimates results in a depletion status > 100% of the provisional USR of 40% B_{MSY}.

3. There are two assessment model results presented in the latest assessment for this stock, with quite different biomass estimates. Using the average of these two estimates and assuming the USR is twice the LRP, the resulting depletion status is > 100% of the USR.

4. This stock is assessed by the North Atlantic Fisheries Organization (NAFO) which classifies its status as yellow or intermediate, but there is no USR. When you assume the USR is twice the LRP, the stock is very likely at the assumed USR.

5. No biomass estimates could be found on the Canadian Science Advisory Secretariat website for this stock in order to assess depletion status. Stock status was assigned based on expert opinion in the 2015 results of the DFO Sustainability Survey for Fisheries and was not updated in 2018, as no new assessments have been published.