



**MINISTRY OF AGRICULTURE, ANIMAL HUSBANDRY AND
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IMPLEMENTATION OF THE NEW HARVEST CONTROL RULE IN THE SURINAME SEABOB TRAWL FISHERY



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A. BACKGROUND

In November 2019, an updated stock assessment for Suriname and Guyana Atlantic Seabob shrimp was completed by Dr. Paul Medley, after various sessions of input and feedback in the CRFM Continental Shelf Fisheries Working group (CRFM, 2019). A new Harvest Control Rule (HCR) has been proposed and tested (Medley, 2019a & 2019b). The new HCR is different from the previous HCR (see MAAHF, 2012) in several aspects. Notably, the new HCR has a shorter response time, with an HCR index calculated as a moving average over the observed catch rate (catch-per-unit-effort or CPUE) rather than over the past 12 months. In case the HCR index drops below the trigger reference point, fishing effort controls are implemented in the second month after the decrease. This should allow for more rapid mitigation in case the stock declines, allowing for recovery of the seabob stock and avoiding overexploitation. To implement the new HCR, clear arrangements need to be in place to facilitate rapid and transparent communication between fishery stakeholders of HCR inputs (catch and effort data) and outputs (recommended fishing effort). **This document intends to provide more context to the HCR, propose a strategy for HCR implementation and summarize experiences with (pilot) HCR implementation in the fishery.**

B. THE NEW HCR

The new HCR is defined as follows (Medley, 2019b) (Figure 1):

1. The HCR index is calculated as a moving average of the catch rate each month so:

$$I_t = ma \frac{C_t}{f_t} + (1 - ma)I_{t-1}$$

where I_t = HCR index in month t , C_t = monthly catch associated with effort f_t , m = moving average parameter.

2. The maximum fishing effort of X trips/days-at-sea are set for each quarter (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Nov). Vessels may use that fishing effort as they see fit during the quarter, but the maximum effort must not be exceeded in any quarter. $X = 3 * f_{max}$ which is the monthly effort set at a value consistent with MSY. Effort is calculated as the nominal days at sea plus one day (to avoid 0 day trips).
3. If I_t falls below the trigger reference point I_{trig} but above I_{lim} , the monthly effort in the second month after the index has fallen will be limited according to the following:

$$f_{t+2} = f_{max} \frac{I_t - I_{lim}}{I_{trig} - I_{lim}}$$

4. If I_t falls below the limit reference point I_{lim} , the effort in the second month after the index has fallen will be limited according to the following:

$$f_{t+2} = f_{min}$$

5. The rule will apply strictly on a monthly basis when $I_t < I_{trig}$ and vessels will not be able to carry over unused effort to the following month.
6. If no effort is applied, then a “natural” recovery rate will be applied to the HCR index of R%:

$$I_{t+1} = I_t (1 + R/100)$$

and the resulting index used in the HCR rule above.

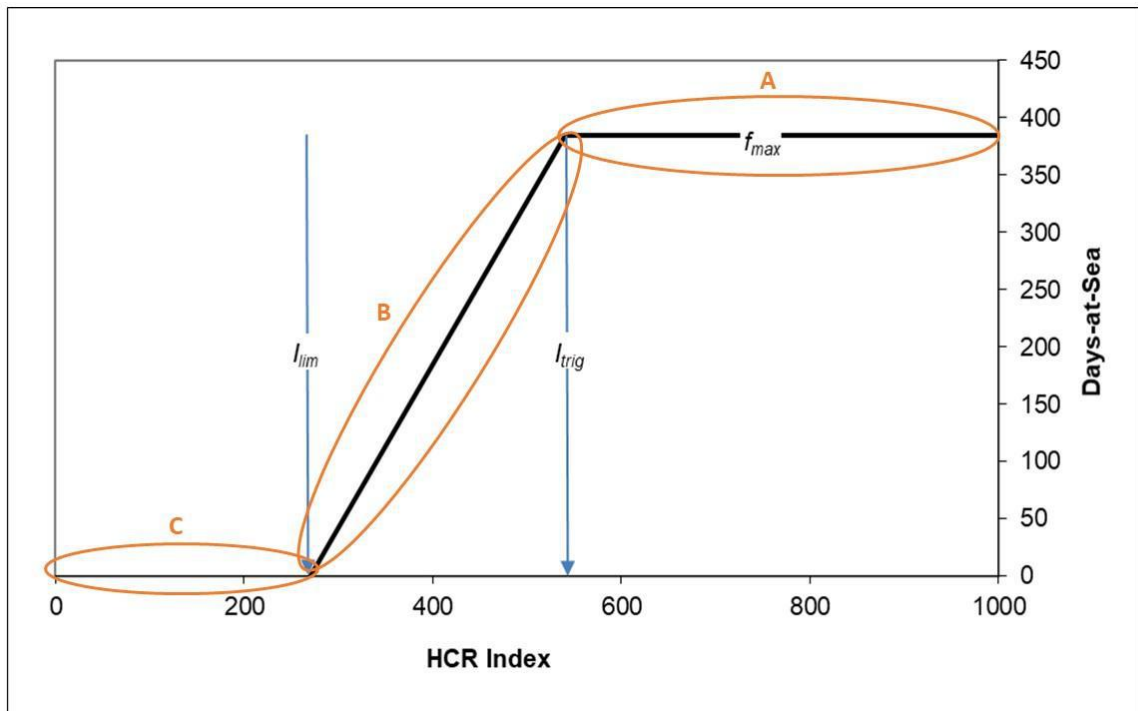


Figure 1. Diagram illustrating HCR with parameters: I_{trig} = HCR Index trigger point below which there is a reduction in the exploitation rate, I_{lim} = HCR Index limit below which effort is minimised and f_{max} = the maximum average effort spent each month, equivalent to the MSY exploitation level. Note that this graph illustrates the HCR principles, and not the real values of the HCR reference points in line with the stock assessment results.

The general HCR parameters are set as follows:

HCR Parameter	Value
f_{max}	f_{MSY}
f_{min}	0
ma	0.75
R	15%
I_{trig}	$0.8 I_{MSY}$
I_{lim}	$0.5 I_{MSY}$

Based on the 2019 stock assessment results for the Suriname seabob fishery (Medley, 2019b), the **maximum fishing effort in line with Maximum Sustainable Yield (MSY) is 346 nominal days-at-sea (DAS) per month**. This corresponds to a target reference point for the HCR index equal to **857.71**. Consequently, the trigger and limit reference points are set at **686.17** and **428.86**, respectively.

C. THE HCR EXPLAINED

The operation of the HCR is quite straightforward: if the HCR index is high, this is an indication of a healthy stock and the fishery is allowed to operate at maximum effort (in line with MSY; 346 DAS/month as defined by the stock assessment). If the index decreases below a certain number (the trigger reference point; 686.17), effort should be adapted proportionally until the index recovers. In this way, the HCR allows for a dynamic response and management of the seabob stock. The main difference with the previous HCR for the Suriname seabob fishery (see MAAHF, 2012) is the quicker response time: the HCR recommends effort reduction in the second month after the index has dropped.

For the sake of clarity, each point of the HCR outlined under B. above is explained:

1. The HCR uses an **HCR index (I) as a measure of abundance** to estimate the status of the seabob stock. This index is calculated as a moving average over the catch rate (CPUE) each month, according to formula presented under B.1. The HCR index I is also referred to as the '**HCR CPUE**'.

Note that, in contrast to the previous HCR, the index does not go back 12 months in time. The HCR index for a given month is based on the CPUE of that month, and the index of the month before.

2. As long as the HCR index is **higher than the trigger reference point** (I_{trig} , defined as 686.17), the fishery can operate at **maximum fishing effort** (f_{max}), which is set at 346 nominal days-at-sea (DAS) per month. This effort is allocated as **quarterly effort quota**, which the fishery can use as they see fit with the three-month period, but unused days cannot be carried over to the next quarter. The quarterly effort quota at maximum fishing effort is thus $3 \times 346 = 1038$ DAS. This situation corresponds to **part A of the graph** in Figure 1.

Note that f_{max} , I_{trig} , I_{lim} etc. are fixed numbers which are defined by the new stock assessment (Medley 2019b).

3. When the HCR index drops **below the trigger reference point**, but stays above the limit reference point (I_{lim} , defined as 428.86), a **monthly effort quota is defined for the second month** after the index has dropped. The lower the HCR index, the lower the quota will be, with a linear relationship between HCR index and allowable effort, as shown in **part B of the graph** in Figure 1.
4. When the HCR index drops **below the limit reference point**, the effort in the second month after the index has dropped should equal f_{min} , which has been set at zero. This means, the **fishing should stop in the second month** after the HCR index goes below I_{lim} . This corresponds to **part C of the graph** in Figure 1.
5. The **quarterly effort quota only applies when the HCR index is above I_{trig}** (situation A). When the index falls below this point (situation B), a monthly quota will be applied after the second month. The HCR will then be applied monthly, and no carry-over of fishing days between months is possible. This system of quarterly effort quota will be re-introduced the second month after the index has gone above I_{trig} again.
6. When **the effort is zero** (situation C), there is no fishery and hence no data to feed into the HCR about the status of the stock. In that case, the HCR index is calculated with the formula under B.6, assuming a **natural recovery of the seabob stock of $R = 15\%$** .

D. THE HCR VISUALISED

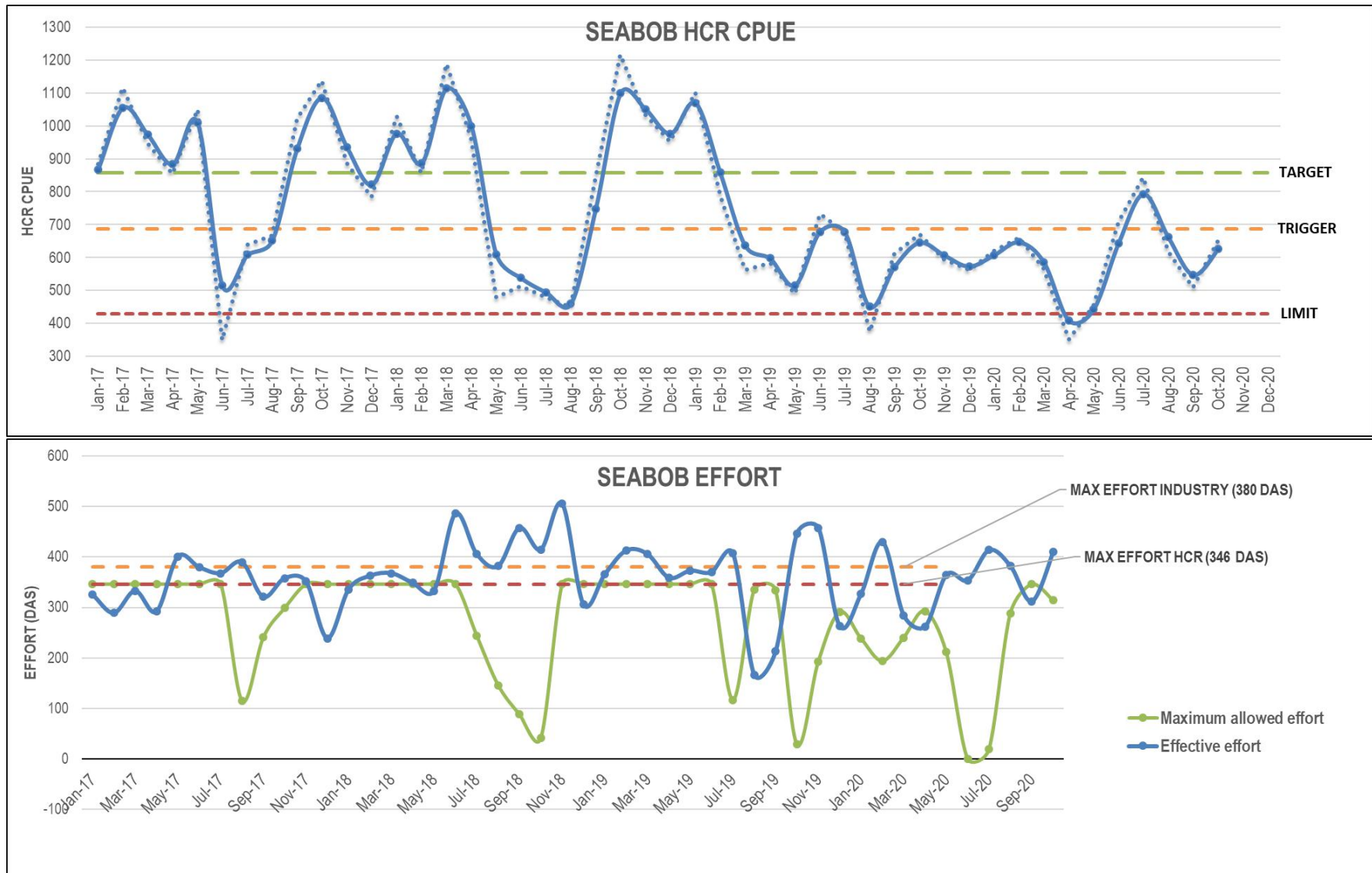


Figure 2. Plots of the HCR Index (HCR CPUE; upper graph) and effort (lower graph) for the last three years. The upper graph shows the HCR CPUE (solid line) in relation to the reference points (dashed horizontal lines) of the new HCR. The HCR CPUE is calculated as a moving average of the observed CPUE (dotted line). The lower graph represents the effective effort of the seabob fleet (blue solid line) and the maximum allowable effort according to the new HCR (green solid line). Dashed horizontal lines represent the maximum effort in line with MSY (HCR maximum, in red) and the maximum proposed by the industry (in orange, see paragraph G below). In comparing the graphs, it is clear that low HCR CPUE values cause low allowable effort, with a time lag of two months. Note that the new HCR only came into effect as of January 2020 and was not implemented in the period represented in the graph (also see paragraph G below).

E. PROTOCOL FOR HCR IMPLEMENTATION

The HCR index is calculated based on monthly catch rate (CPUE) of the fishery. It thus requires data input for from the fishery, in the form of total monthly catch and effort. Catch should be expressed as peeled weight, in kilograms. Effort is expressed in nominal days-at-sea (DAS), calculated as the departure date – return date of a trip, with the addition of 1 day (to avoid 0-day trips). The catch and effort data of trips that land their catch in a certain month are added in the month that the landing took place. E.g. data from a trip that departed in April but has a landing date in May will be added in the month May Catch and Effort). Dividing of catches in proportion to trip length is not needed and will make no difference, as the overlapping trips are believed to level out that beginning and end of every month. It is a more complicated procedure that would not lead to a significant change in the monthly catch and effort data. Based on the catch and effort of a certain month, the HCR calculates the HCR index. The HCR index defines the allowable effort for 2nd month after the month for which the index is calculate (e.g. the HCR index for March will define the effort for May). The HCR thus has a short response time, especially in situations where the HCR index is below the trigger reference point and a strictly monthly application is necessary. To implement the HCR, clear arrangements need to be in place to facilitate rapid and transparent communication between fishery stakeholders of HCR inputs (catch and effort data) and outputs (recommended fishing effort). The following protocol is proposed to facilitate HCR implementation.

1. **By the 8th day** of each month, all seabob companies should send their **final catch and effort data of the previous month to the fisheries department (FD)** in the required format.
2. **By the 12th day** of each month, all data should be processed by the FD, and **HCR outputs** should be calculated.
3. **Around the 15th day** of each month, a **Seabob Working Group (SWG) meeting** should be held, at which the HCR index and resulting effort quota are discussed. The day before the SWG meeting, at the latest, the update HCR table should be shared with all SWG members through email.
 - ⇒ When the HCR index is high (above the trigger reference point), quarterly effort quota are used and the HCR table will provide an overview of the days used and days remaining of the quota.
 - ⇒ When the HCR index is low (below the trigger reference point), the HCR table will provide the effort quota for the next month. In this way, industry is aware of the effort quota for the next month about two weeks before the start of the new month.

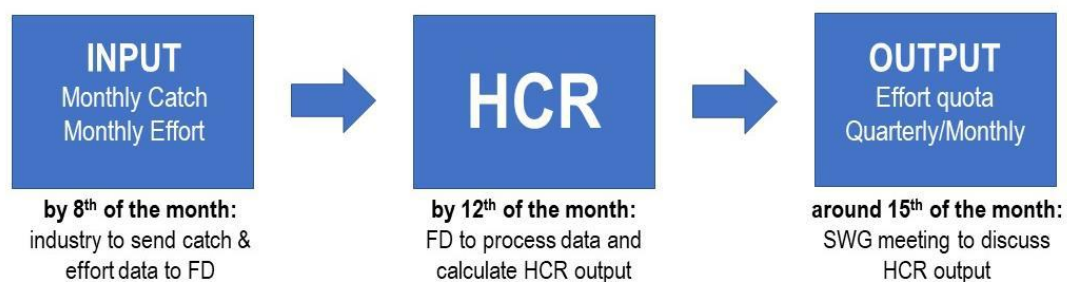


Figure 3. Proposed workflow for implementation of the seabob Harvest Control Rule

F. EXAMPLES

Below are two examples to clarify the practical implementation of the HCR. Note that, although these examples are based on real data from the fishery, they are hypothetical in the sense that the HCR was not (strictly) implemented in the period covered by the examples.

Example 1. Applying quarterly effort quota

In the SWG meeting of 15 May 2017, the HCR index for the previous month (April 2017) is presented (Figure 4). The index (884.02) is higher than the trigger reference point (686.17), just like in the two previous months (March and February 2017). This means the fishery can continue to operate at maximum fishing effort, using quarterly effort quota. At the start of the second quarter (April 1st), the maximum quarterly quota of 1038 DAS ($3 \times f_{\max} = 3 \times 346$ DAS) was allocated. In April, the fishery has used 292 DAS. This means, there are 746 DAS (1038 – 292) left for May and June combined. The industry is free to use these remaining DAS in these two months as they see fit. The companies should make arrangements to allocate the quota to companies/vessels.

C	D	E	F	G	H	I	J
							HCR
						CPUE	Control Max Effort
		MA Parameter	0.75		Limit	428.86	0
					Trigger	686.17	346
		Recovery	1.15		Target	857.71	346
Year	Month	Catch (kg)	Effort	Observed CPUE	HCR CPUE	Quarterly	Effort Quota for next month
2017	2	322962	289	1117.51	1054.90	712	712
2017	3	315050	333	946.10	973.30	423	423
2017	4	249444	292	854.26	884.02	1038	1038
2017	5	421478	401	1051.07	1009.31	746	746
2017	6	132806	380	349.49	514.44	345	345
2017	7	235301	368	639.40	608.16	1038	1038
2017	8	259757	390	666.04	651.57	670	115
2017	9	328387	321	1023.01	930.15	280	241
2017	10	407206	358	1137.45	1085.62	1038	299
2017	11	311664	352	885.41	935.46	680	680
2017	12	187274	239	783.57	821.55	328	328
2018	1	345631	336	1028.66	976.89	1038	1038

Figure 4. HCR implementation: Example 1 – working with quarterly effort quota

Example 2. Applying monthly effort quota

In the SWG meeting of 15 April 2020, the HCR index for the previous month (March 2020) is presented (Figure 5). The index (591.73) is lower than the trigger reference point just like in the two previous months (February and January 2020). This means the HCR is applied on a strictly monthly basis, using the monthly effort quota in column J rather than the quarterly quota in column I. Based on the HCR index of March 2020, the effort in May 2020 should not exceed 219 DAS. The effort for April 2020 should not exceed 290 DAS, as communicated at the previous SWG meeting (15 March 2020).

C	D	E	F	G	H	I	J
						HCR	
						CPUE	Control Max Effort
		MA Parameter	0.75		Limit	428.86	0
					Trigger	686.17	346
		Recovery	1.15		Target	857.71	346
Year	Month	Catch (kg)	Effort	Observed CPUE	HCR CPUE	Quarterly	Effort Quota for next month
2019	8	62235	166	374.91	450.57	631	335
2019	9	130313	213	611.80	571.49	465	334
2019	10	299584	447	670.21	645.53	1038	29
2019	11	271979	458	593.84	606.76	591	192
2019	12	147780	263	561.90	573.12	133	291
2020	1	202463	327	619.15	607.64	1038	239
2020	2	277663	423	656.41	644.22	711	194
2020	3	116570	203	574.24	591.73	288	240
2020	4	0	-1	-1.00	680.49	1038	290
2020	5	0	-1	-1.00	782.57	1038	219
2020	6	0	-1	-1.00	899.95	1038	338
2020	7	0	-1	-1.00	1034.94	1038	1038

Figure 5. HCR implementation: Example 2 – working with monthly effort quota. Note that the HCR index (column H) for April, May, June & July are not correct. They can only be calculated then the observed CPUE (and the catch and effort data) become available.

G. PILOT IMPLEMENTATION

The HCR was finalized late September 2019 (CRFM, 2019). In, October – November 2019 a workable spreadsheet table to implement the HCR was developed and populated with historical data, and the new HCR was explained and discussed with fishery stakeholders during several SWG sessions.

The result of the new stock assessment (Medley, 2019b) indicated that the effort in the Suriname seabob fishery was 16% higher than what would be recommended to achieve MSY. This came rather as a surprise to the seabob industry as there were no indications of effort being consistently too high under the previous HCR. The Suriname seabob industry expressed the concern that a strict and sudden implementation of the new HCR, with the associated drop in maximum allowable fishing effort by 16% would be challenging to implement and have adverse socio-economic consequences. Further, there was some scepticism towards the new stock assessment and the proposed effort reduction, as CPUE had been rather stable over the past years. The Suriname seabob industry has therefore proposed to start with an effort reduction that is smaller than recommended by the HCR, setting the maximum effort at 380 DAS per month (instead of the recommended f_{max} of 346 DAS). This corresponds to 5% reduction compared to the maximum effectuated monthly effort of 2018, and a 11% reduction against the maximum effort allowed under the previous HCR (425 DAS/month or 5,100 DAS/year). This strategy was referred to as **pilot implementation of the HCR**.

Pilot implementation of the new HCR entails that all data flows and arrangements (as described under section E.) are implemented, but the effort quota as calculated by the HCR is not strictly implemented and enforced. Pilot implementation was agreed upon in the SWG for three main reasons:

- 1) It allows all stakeholders to get used to the workflow of the new HCR. Compared to the former HCR, the new one requires faster submission and turnover of data and allocation of quarterly or monthly effort quota. This demands good arrangements and communication mechanisms between and among members of the fisheries department and the fishing industry.
- 2) The new HCR has been proposed in 2019 based on a new stock assessment. At the same time, it was stated that it should be evaluated after real-world use. The pilot phase allows for evaluation and potential adjustment of the HCR, before it becomes a hard rule for the fishery to follow.
- 3) The 2019 stock assessment concluded that effort was ca. 16% above MSY in Suriname. As such, application of the new HCR would mean a significant reduction in effort. The pilot phase

would allow the industry to get a feeling for what the effort quota under the new HCR would look like, before they become mandatory, and make necessary preparations for a future reduction in effort.

It was agreed to start pilot implementation of the new HCR as of January 1st, 2020.

A first evaluation of the HCR pilot implementation was done during a special meeting of the SWG in July 2020. The fisheries department stated that, generally, the protocol to implement the HCR is working well. Most of the time, the catch and effort data are received from the industry in a correct and timely manner. It does happen, however, that submitted data is corrected afterwards as the industry sends updated spreadsheets. This causes confusion and should be avoided in the future. SWG meetings were held each month, mostly in the third week of the month. This allowed to evaluate the HCR over the previous month and discuss the effort quota for the next month. The proposed workflow is thus working appropriately, and the meeting agreed to continue in the same way.

The fisheries department further stated that, while the new HCR would work with quarterly effort quota, this has not been possible in the period January – June 2020 due to relatively low CPUE values. This has caused the HCR CPUE to be under the trigger reference point for the mentioned period. In that case, the effort is allocated on a monthly basis instead of quarterly, as the HCR dictates. While the pilot period has allowed to test out the system of monthly quota, the quarterly system is yet to be tested out.

The seabob industry stated that the last six months were indeed exceptionally poor in terms of seabob catches, causing low CPUEs. Only in June, the catches seem to have normalized. The HCR was thus piloted in a rather exceptional period which does not seem representative for the fishery, it was argued. The seabob companies therefore requested to extend the pilot implementation period with at least another three months until the end of September 2020.

The extension of the pilot implementation phase was argued as follows:

- The seabob industry and the fishery department had agreed to an initial effort reduction of 5%, i.e. a maximum effort quota of 380 DAS, instead of 346 DAS as indicated by the HCR (see above and Willems, 2019). However, maximum effort is only allowed when HCR CPUE values are above the trigger reference point (situation A in Figure 1). As HCR CPUE was below the trigger in the period January – June 2020, monthly quota were applied (situation B in Figure 1). As such, the industry has been confronted with drastically reduced effort quota in the pilot implementation phase so far, and there has been no opportunity to introduce the proposed gradual reduction in maximum fishing effort (although effort has been well below 380 DAS/month except for February 2020).
- The catches of the period January – June 2020 were poor and do not seem to be fully representative for the fishery. It seems necessary to also pilot the HCR in a situation with better catches, causing higher HCR CPUE values and thus allowing the fishery to operate at maximum effort using quarterly effort quota. Only then can the HCR be properly evaluated.
- Finally, the industry argued that the first half of 2020 was a very difficult time from a socio-economic perspective due to the combination of poor catches and the COVID-19 crisis. While they are willing to gradually reduce effort in order to sustain higher catches on the long term, this would need to be a gradual reduction to mitigate social and economic consequences (e.g. for fishing crew and plant workers).

The SWG meeting agreed to extend the pilot phase of the HCR to at least the end of September 2020.

The July SWG meeting also discussed the following points of attention and concern:

- Efforts should continue to implement the workflow of the new HCR, including timely submission of data, timely SWG meetings and communication among all stakeholders.

- At the end of the pilot phase, an evaluation of the HCR should take place and the SWG should formulate recommendations for adjustment to the HCR if deemed necessary. In that context, concerns were raised over the two-month reaction time of the HCR. In the second month after the HCR CPUE has dropped, effort quota are reduced. Seabob shrimp seems to have a response time that is sometimes much shorter than that. E.g. low HCR CPUE values in April 2020 (below limit reference point) caused an effort quota of zero DAS for June. In June however, the fishery seemed to have recovered with an HCR CPUE value around the trigger reference point. It should be evaluated whether the two-month response time is appropriate, especially when quota are allocated on a monthly basis (i.e. when HCR CPUE is below trigger reference point).
- The industry indicated that boats often leave the docks in the evening/night and come back in the morning. This means that fishing trips are in fact shorter than they seem when DAS are calculated using the formula [arrival date] – [departure date] + 1. It was requested whether this could be taken into account in revising the HCR.
- The experience from the fishing industry is that catches are correlated with rainfall/river outflow. The SWG advised to compare rainfall patterns with trends in CPUE and this will be added to the R&D plan.
- It was stressed that, the pilot implementation should be limited in time and the HCR should be followed strictly in the future. This also related to the MSC condition that the fishery needs to close. If it appears that the new HCR is inappropriate, this should be well augmented and documented so support can be sought to adapt the HCR. This will need the involvement of the consultant Mr. Paul Medley who designed the HCR.

The pilot implementation of the HCR was evaluated again in the SWG meeting of October 2020. The meeting agreed to extend the pilot implementation phase till the end of 2020, on request by the industry and based on the same arguments as brought forwarded during the July SWG meeting.

H. CONCLUSIONS AND NEXT STEPS

Allowable effort under the new HCR is significantly lower compared to the previous HCR, reflecting the updated stock assessment which concluded that effort is above MSY. The new HCR is in a pilot implementation phase in which the industry is not yet required to strictly follow the effort quota as calculated by the HCR. It was decided that the initial pilot phase (1st half of 2020) was not sufficient to fully evaluate the performance of the new HCR. Low CPUE values have required the use of monthly (instead of quarterly) effort quota. As such, the gradual reduction in effort as agreed in December 2019 has not been into effect as the HCR did not allow maximum effort allocated as quarterly quota. Nevertheless, the average effort for the period January – October 2020 was 354 DAS. While this is slightly above the maximum HCR effort of 346 DAS, it well below the 380 DAS as originally agreed. Moreover, it represents an average 11% reduction compared to the 2018 level (which had an average of 392 DAS).

Despite the effort reduction in 2020, CPUE values in the seabob fishery remain low. Therefore, further reductions in effort to allow stock rebuilding are required. In any case, the fishery stakeholders should either:

- **accept the current HCR and start its strict implementation in the near future; or**
- **justify why the current HCR is not acceptable, and work with the stock assessment consultant to make adjustments based on experiences from the pilot implementation in 2020.**

Further, CRFM CSWG has made various recommendations to improve and validate the HCR and its implementation. These including the following (see CRFM, 2019 for more details):

1. CPUE is used as an index of abundance of seabob shrimp. The accuracy of this measure has been questioned, as it would provide an underestimation of abundance, e.g. when considerable amount of

time during a trip is spent steaming instead of fishing. It is proposed to assess the relationship between nominal DAS and the actual days spend fishing using logbook data, potentially along with CCTV and VMS data.

2. Any actions or events, whether on purpose or not, that could affect catchability and selectivity (and hence CPUE) should be carefully documented and recorded (and preferably reconstructed from the past). These could include changes in fishing gear or practices, Sargassum influx events, weather events, etc.
3. Performance of the HCR should be evaluated after for one year and adjustment should be made for practicality purposes as necessary
4. Other (data limited) assessment methods should be explored for comparison with the results of the current stock assessment
5. It should be considered how impacts of Sargassum influx events and climate change on the fishery can be incorporated into management.
6. In order to improve the stock assessment, it is advised to establish a local maturity ogive, review the value of M, characterize the 'broken shrimp' category, and to promote interaction with fishery stakeholders during the assessment process.

Most of these points have been included in the fishery's Research & Development plan and we refer to that document for updates and progress against the various points.

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