Baltic Marine Environment Protection Commission

Fifth Meeting of the Working Group on Reduction of Pressures from the Baltic Sea Catchment Area

PRESSURE 5-2016

Warsaw, Poland, 25-27 October 2016

Document title	Accounting for extra reductions to follow up CART assessment
Code	8-3
Category	DEC
Agenda Item	8 - Pollution load compilation
Submission date	4.10.2016
Submitted by	RedCore DG
Reference	

Background

The Baltic Sea comprises of a series of connected basins, and changes in the environment will lead to changes in adjacent basins as well due to transport of nutrients between the basins. That is why the HELCOM nutrient reduction scheme, updated by the Ministerial declaration 2013, implies an option to account in proportion the effect of extra reductions on a neighboring basin with reduction targets. This methodology can be applied for the assessment of the progress towards implementation of the country wise allocated reduction targets.

PRESSURE 4-2016 discussed a methodology for accounting an extra reduction as well as approaches and constrains for its application in CART follow-up. The meeting emphasized that accounting of extra reduction is important for several Contracting Parties to reach the reduction targets.

PRESSURE 4-2016 requested the RedCore DG to elaborate more detailed documentation describing the methodology and limits for its application as well as provide examples.

This document contains a description of the methodology to account extra reduction for CART assessment. It provides a scientific background, an overview of the main principles to account the effect of extra reduction for neighboring basins, and tables with the co-efficients used to calculate the effect of extra reduction. The document also contains examples calculated for Denmark, Estonia, Finland, Germany and Sweden.

Action requested

The Meeting is invited to consider the methodology, provide feedback on the document, including the parameters for equivalent reduction, and endorse testing the methodology in the assessment of progress towards CART in the frame of PLC-7 project.

Accounting for extra reductions

Introduction

As a part of the nutrient reduction scheme in the 2013 HELCOM Ministerial Declaration, the following principle was approved:

> *RECOGNIZING that reductions in nutrient inputs in sub-basins may have wide-spread effects, WE AGREE that extra reductions can be accounted for, in proportion to the effect on a neighboring basin with reduction targets, by the countries in reaching their Country Allocated Reduction Targets.*

The rationale behind this statement is that MAI was calculated focusing on offshore major basins and with the optimization of aiming for a maximal total nutrient input, which in principle would be the most cost efficient solution. The necessary reductions to meet MAI were allocated country-wise within each basin. Due to lack of detailed information of reduction potential (or/and costs of measures) in the different countries one had resided on simple principles for this allocation, i.e., countries have to reduce in proportion to their emissions. However, one have to acknowledge that the reduction targets calculated in this way do not necessarily match national plans or be the most cost-efficient solution for individual countries. Several countries implement and/or have implemented measures because of other policies than BSAP (e.g. WFD, Nitrates Directive, Gothenburg Protocol) that results in reductions in basins without reduction requirements or with a magnitude that significantly exceeds the reduction requirements. Thus, inputs to some basins may become significantly lower than MAI leading to winter nutrient concentrations decreasing below the environmental targets. That effect will to some extent spread to adjacent basins, and as a consequence the environmental targets can be reached with somewhat higher inputs than MAI to these “downstream” basins. Thus, under these conditions, making overall larger reductions than required by MAI may be the most cost effective and should be accounted for if it can be shown that the environmental targets are met everywhere.

The paragraph above is somewhat vaguely formulated in the Ministerial Declaration, and the following clarifications based on the groundwork for the Declaration can be made:

- The paragraph was clearly developed in the spirit that this accounting would be done for countries individually, (for example, Sweden could take into account some of extra reductions done in the Bothnian Sea in their bookkeeping of reductions to Baltic proper), and not shared between all countries.
- Any relocation of measures should lead to the same environmental improvement as if CART were implemented.

To illustrate the potential of this principle in preparation of the Ministerial Declaration, BNI quantified how much reduction needs to be done in one basin to get the same environmental effect in a “downstream” basin. However, the mechanisms on how to estimate expected effects or how to evaluate compliance were not discussed in the groundwork for the Ministerial Declaration. This ambiguity has led to some confusion as to how to plan and implement the programs of measures to obtain the goals of the BSAP nutrient reduction scheme in this respect. BNI provided a basis for discussing these issues to the PRESSURE 4 (Document 7-4 and Presentation 7). On the basis of this, PRESSURE 4-2016 requested RedCore DG to elaborate further documentation of the methodology and limits for its application as well as provide examples.

This document provides a) principles that should be used when evaluating extra reductions, b) a brief description of the methodology and c) examples as to how the methodology could be used for involved countries, although limited to phosphorus at this stage.

Principles for accounting extra reductions

RedCore DG has developed the following principles to be used in the accounting of extra reductions

1. **Accounting should be based on countries individually**

   This implies that countries can plan and implement measures across basins at their own discretion as long as it results in conforming to CART after accounting of extra reduction is performed.

2. **Countries could claim accounting for missing reductions even if MAI is exceeded due to inputs from other countries**

   No country should need to wait for any other country before claiming themselves fulfilment of CART.

3. **Any relocation of measures should lead to at least the same environmental improvement as if CART were implemented**

   This is imperative for the GES to be achieved eventually. Inevitably, using extra reductions will lead to less inputs than MAI as seen as a total for the Baltic Sea, but its distribution need to be such that GES will be achieved everywhere.

4. **The effect of extra reductions on neighboring basins with missing reductions should be estimated given that these are minor deviations from MAI**

   The Baltic Sea is a strongly perturbed system and hence, functioning quite different today compared to how it will function when measures been implemented and status approach GES. The whole calculation of MAI is taking this into account and when deviations to MAI are to be analysed, it should be done assuming that we are close to GES.

5. **Accounting for extra reductions in connection with CART follow-up assessments are to be performed in a uniform way supervised by RedCore DG**

   Accounting for extra reductions should be included in the regular CART assessment using a common and harmonized methodology. RedCore DG is the forum that supervises development of methodology and, after appropriate approval, implementation of this in the assessment.

6. **The Archipelago Sea phosphorus input reductions should be accounted in the Finnish CART for Gulf of Finland (cf. BSAP 2007)**

   Already in BSAP 2007, Finland pointed out that models failed to separate the Archipelago Sea from Bothnian Sea and that this should be taken into account at a later stage. Also in the 2013 revision of the nutrient reduction scheme, model limitations failed to address separate MAI calculations for the Archipelago Sea. However, within the context of accounting for extra reduction can be an opportunity to take into account separately the nutrient inputs to Archipelago Sea from the remaining Bothnian Sea inputs.

7. **In the context of extra reduction accounting, reductions of phosphorus to Baltic Proper could be accounted as input reduction in Gulf of Finland**

   In the calculations of MAI, the most limiting targets affecting the distribution of MAI for phosphorus were the winter nutrient concentrations in the Baltic Proper. Strictly following the principle of “maximum” inputs, led to a situation where this gave an optimal solution resulting in removal of virtually all phosphorus inputs to the Baltic Proper and barely any reductions to Gulf of Finland. This solution clearly violated the principle of cost-efficiency so additional calculations based on cost functions for phosphorus input reductions were performed to distribute reductions between Baltic Proper and Gulf of Finland in a cost-efficient way. The obtained MAI results in conforming to phosphorus target in Baltic Proper, but in

Gulf of Finland the resulting phosphorus concentrations will be significantly less than target. In line with this, it could be argued for states having phosphorus inputs both to Baltic Proper and Gulf of Finland, that *extra reductions* to Baltic Proper could be deducted from missing reductions in Gulf of Finland with 100% efficiency. However, one should bear in mind that the MAI for nitrogen to Gulf of Finland was determined from applying the HEAT approach, balancing nitrogen and phosphorus concentrations, so if MAI for phosphorus to Gulf of Finland is not achieved fully additional reductions on nitrogen inputs might be necessary.

8. Following the precautionary principle, extra reduction accounting cannot be used to purposely increase inputs to a basin

Although accounting of extra reductions is based current scientific knowledge and modelling, it comes with significant uncertainty and will sooner or later be subject of improvement. Therefore, it would be a risk for the environment to increase inputs to basins based on this methodology. In addition, a prerequisite for the calculations here is an environment close to GES and additional inputs today may cause significant deterioration of the present eutrofied state.

RedCore DG, with assistance of the MAI-CART OPER project, will test the methodology presented here and in document 7-4 to PRESSURE 4-2016 when preparing the next CART assessment in connection with the HELCOM PLC-7 project.

Extra reduction is the margin to CART (or input ceiling) including the statistical uncertainty for a given country and basin combination.

Missing reduction is defined additional input reduction needed to reach CART including the statistical uncertainty for a given country and basin combination.

Understanding effects of extra and missing reductions

The Baltic Sea comprises of a series of connected basins, and changes in the environment will lead to changes in adjacent basins as well due to transport of nutrients between the basins. In simple terms, if the nutrient concentrations change in one basin it will cause changes in the nutrient transports to adjacent basins. The magnitude of the nutrient transport change will depend on the water exchange between the basins and concentration difference between the basins. Note, however, that the nutrient transport also includes nutrients within organic matter and not only the inorganic nutrients. In Figure 1, the simulated phosphorus transports between the basins are shown for the present day situation and for the situation when MAI is achieved. It is clear that at present day, the quite high phosphorus concentrations in the Gulf of Finland and Baltic Proper cause significant fluxes to the other basins, thus causing elevated production also in these basins. When MAI is achieved, concentrations in Gulf of Finland and Baltic Proper decrease significantly and therefore fluxes to the other basins decrease significantly.

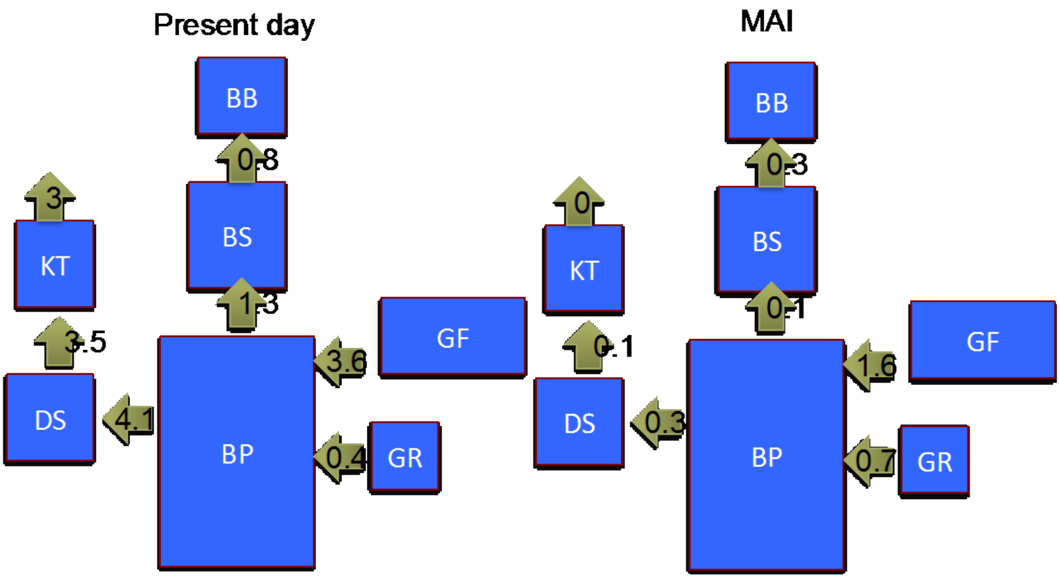

Figure 1: The average fluxes of phosphorus between the Baltic Sea sub-basins at present day (to the left) and when Baltic Sea adjusted to MAI (to the right). Unit is kTon/yr.

When inputs to a basin deviate from MAI, the fluxes in Figure 1 will be perturbed. When inputs are lower than MAI (*extra reduction*), fluxes will increase to that basin and status will improve somewhat in the other basins as well and while higher inputs than MAI (*missing reduction*) will lead to export of nutrients and deterioration in adjacent basins. In Figure 2, examples are shown on what happens with fluxes when there is extra reduction to Bothnian Sea and missing reduction to Baltic Proper, respectively. In this example, if one would trade the missing reduction to Baltic Proper with the extra reduction in Bothnian Sea one must ensure that a) the eutrophication status of the Baltic Proper retained by the additional export to the Bothnian Sea and b) there is no deterioration of status in the other basins. For large missing and extra reductions, this becomes a relatively complicated calculation, but if the reductions are small compared to the MAI and focus is on single basin pairs a significantly simpler approach is valid. In principle, one could picture it as ensure that the missing reduction is compensated by a flux of nutrient to the basin with extra reduction. In example in Figure 2, we could assume that the extra reduction in Bothnian Sea will cancel out all the red and green arrows to the basins south and east of Baltic Proper and these basins can then not benefit from extra reduction in Bothnian Sea. However, there will still be some benefit in the Bothnian Bay from the extra reduction, although it should be smaller than if Baltic Proper fulfilled MAI because of the elevated nutrient flux to the Bothnian Sea. Assuming small changes one could probably assume that the net effect of the extra reduction in Bothnian Sea and missing reduction in Baltic Proper on Bothnian Bay would be the difference between the green and red arrow in Figure 2.

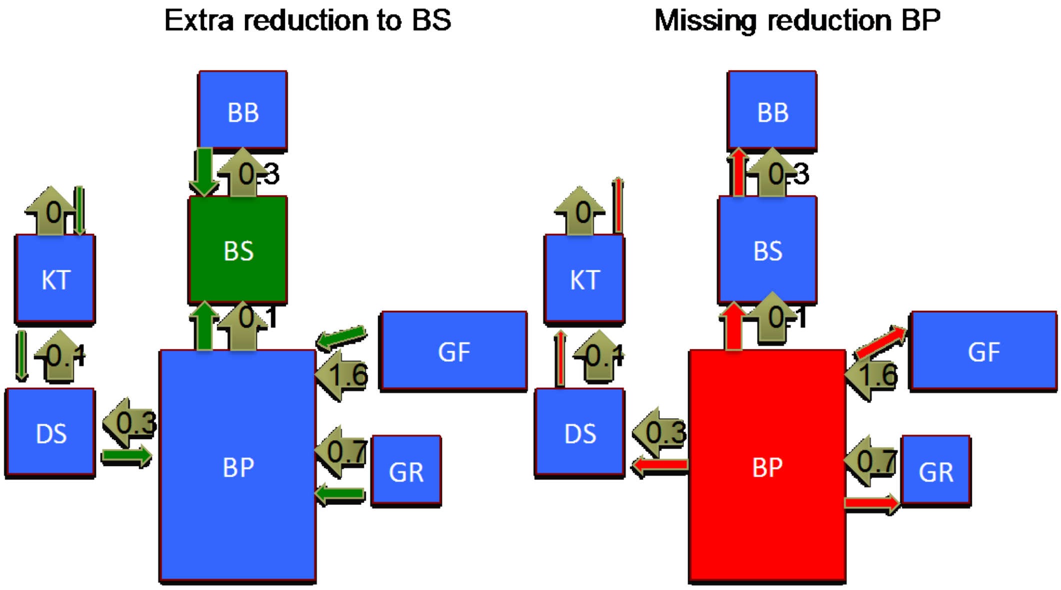

Figure 2: Illustration how extra reduction and missing reduction changes the phosphorus fluxes between the basins. To the left it is illustrated with green arrows how an extra reduction to the Bothnian Sea cause additional flux from the Baltic Proper and decreased flux to Bothnian Bay, and how these effects propagate to the exchange with the other basins. To the right it is illustrated with red arrows how missing reduction to the Baltic Proper causing additional flux to Bothnian Sea and the other basins. If the green arrow from the Baltic Proper to the Bothnian Sea is so large that it equals the missing reduction, the environment will be the same in the Baltic Proper as if MAI was applied and the red arrows would all be zero. NB! If there is missing reduction to the Baltic Proper, the basins GF, GR, DS and KT will no longer get any benefit from the extra reduction in BS.

A method to match missing reductions with extra reductions

The BALTSEM model was used to find the combination of inputs (MAI) that would eventually lead to the good environmental status as quantified by the eutrophication status targets taking into account the circulation and biogeochemical cycles of the Baltic Sea. The same model can be used to as basis for a method to match missing reductions with extra reductions.

The methodology takes the starting point from the state obtained when MAI is achieved and GES is reached, i.e., the model is run with inputs as given by MAI for a very long time. From this state, a series of model experiments are performed for which N and P inputs are systematically perturbed from MAI, that is different N and P input combinations for one basin at a time. In total about 160 simulations were performed providing a large data set on how the state change in the Baltic basins depending on a nutrient input change to one basin.

To simplify the further analysis, a few assumptions were made:

1. assume that deviation from MAI is relatively small so that linear response can be expected;
2. assume the analysis can be done separately for each single nutrient and basin combination.

It would be straightforward to evaluate single cases that violate the two assumptions, but presenting the results in an easily-understandable way would be difficult.

The equivalent reductions for phosphorus and nitrogen obtained from BALTSEM simulations are shown in Tables 1 and 2. Since in general nitrogen retention is higher, the equivalent reductions are in most cases higher for nitrogen than phosphorus. The uncertainty increases for distant basins when the effective reduction becomes really small and equivalent reduction high. Rather arbitrarily, values higher than 10 is not shown in the tables.

Table 1: Equivalent reductions on phosphorus. The table should be read so that each row provides the necessary input reduction to the basins to the left to provide the equivalent environmental effect in the basins in the top row, e.g. 1.5 ton reduction to BS gives the same effect in the BP as 1 ton reduction directly to BP. NB! That the factors are valid on single basin pairs under condition that all other basins fulfil MAI.

	KT	DS	BP	BS	BB	GR	GF
KT	1	4.0	–	–	–	–	–
DS	0.8	1	3.2	–	–	–	–
BP	2.4	2.8	1	3.3	7.7	–	3.8
BS	3.8	4.6	1.5	1	2.6	–	5.8
BB	–	–	9.0	8.3	1	–	–
GR	3.6	4.3	1.6	4.8	–	1	6.5
GF	3.6	4.2	1.3	4.1	–	–	1

Table 2: Equivalent reductions on nitrogen. The table should be read so that each row provides the necessary input reduction to the basins to the left to provide the equivalent environmental effect in the basins in the top row, e.g. 1.3 ton reduction to GR gives the same effect in the BP as 1 ton reduction directly to BP. NB! That the factors are valid on single basin pairs under condition that all other basins fulfil MAI.

	KT	DS	BP	BS	BB	GR	GF
KT	1	7.3	–	–	–	–	–
DS	1.7	1	4.6	–	–	–	–
BP	–	–	1	–	–	–	–
BS	–	–	–	1	7.8	–	–
BB	–	–	–	1.1	1	–	–
GR	–	–	1.3	–	–	1	–
GF	–	–	4.0	–	–	–	1

How to use the equivalent reductions tables

Below in Annex A to this document there are examples on how one can use Tables 1 and 2 to calculate the achieved effective reductions from extra reductions published in the CART follow-up[1] in the case of follow-up. Exactly the same calculation should be used when relocating measures in developments of programs of measures, but it may be on future expected extra reductions rather than achieved reduction.

It should be noted that not fulfilling CART in one basin leads to that other basins may not reach GES as defined by the environmental targets because of the same reasons behind the equivalent reduction calculation. This implies that one cannot necessarily use the extra reduction to one basin to compensate for missing reduction in several basins. Thus calculation is quite straightforward when analyzing single pairs of basins, one with extra reduction and one taking benefit of the effective reduction. In more general terms, it quickly becomes more complicated.

If desirable, one could in each follow-up assessment directly take into account the extra reductions when evaluating progress towards achieving CART following the approach outlined in Annex A.

[1] http://www.helcom.fi/baltic-sea-action-plan/progress-towards-reduction-targets/in-depth-information/data-on-fulfillment-of-nutrient-input-ceilings/

Annex A: Examples of follow-up calculations

Extra and missing reductions were calculated and presented in the CART follow-up[1]. Here we use these figures to show some examples on calculations for some involved countries. Calculations are limited at this stage to phosphorus. The examples start with Sweden, because that illustrates the complication of having extra reductions in several basins and how that complicates the calculation. As long as one consider only a pair of basins the values in Table 1 can be used without concern, but one cannot use extra reduction from one basin to compensate for missing reduction in several basins without additional considerations.

Sweden:

In Table 3, the extra and missing reductions of phosphorus for Sweden are summarized based on the results of table 5k in the CART follow-up[1]. Sweden has available extra reductions of 176 and 16 ton phosphorus to the Bothnian Sea and Danish Straits, respectively. To calculate what the effective reductions from the Bothnian Sea are in the other basins, we divide by the values on the Bothnian Sea row in Table 1, see Table 4. The effective reductions from the extra reduction available to the Danish Straits (16 ton) is calculated in the same way, see Table 5.

If we just consider a single pair of basins, for example, how much less do Sweden need to reduce to Baltic Proper when taking into account the extra reduction to Bothnian Sea the calculation is straightforward and the number 117 ton can be used directly (leaving 313 ton remaining). Similarly, Sweden could deduct 20 tons on the missing reduction to Kattegat (leaving 47 ton remaining) from the extra reduction to Danish Straits.

The results from a full calculation of remaining reductions for Sweden are presented in Table 6. The starting point of this calculation was to use the 117 ton from Bothnian Sea on Baltic Proper and we see that for Kattegat the remaining reduction is quite close to what is given by the missing reduction minus the effective reduction from the Danish Straits as expected. We see that because reductions are less in Baltic Proper, the full effective reduction to Bothnian Bay from the extra reduction in Bothnian Sea cannot be accounted.

Table 3: The extra and missing reductions of phosphorus from Sweden according to the latest CART assessment. Sweden has no reduction requirements on phosphorus to Gulf of Riga and Gulf of Finland.

Basin	Extra reduction	Missing reduction
KT		67
DS	16	
BP		430
BS	176	
BB		100

Table 4: Calculation of effective reductions for the extra reduction from Sweden to Bothnian Sea.

Basin	Equivalent reduction	Calculation	Effective reduction
BP	1.5	176/1.5	117
BB	2.6	176/2.6	68

Table 5: Calculation of effective reductions for the extra reduction from Sweden to Danish Straits.

Basin	Equivalent factor	Calculation	Effective reduction
KT	0.8	16/0.8	20
BP	3.2	16/3.2	5

Table 6: The extra and remaining reductions of phosphorus from Sweden in relation to the estimates in the last CART assessment. In the calculation of remaining reductions the extra reductions are taken into account.

Basin	Extra reduction	Remaining reduction
KT		47
DS	16	
BP		313 (308 if the 5 tons from DS is also subtracted)
BS	176	
BB		48

Finland:

The extra and missing reductions for Finland are shown in Table 7. Finland is a special case because, firstly, the Archipelago Sea should according to Ministerial Declarations be treated separately as far as possible, and secondly, that additional phosphorus reductions needed to be placed on Gulf of Finland to obtain the environmental targets in Baltic Proper (see BNI presentation to PRESSURE 4). NB! The latter only applies to phosphorus, not nitrogen.

Table 8a shows the effective reductions due to extra reduction to Bothnian Sea, if applying equivalent reductions from Table 1 directly without considering the special cases. This leads to extra and remaining missing reductions shown in Table 9a.

To illustrate calculations separating Archipelago Sea from Bothnian Sea, we had to estimate how large part of the extra reduction that stems from Archipelago Sea. This was done using a Finnish calculation that compared the latest 5 year inputs with the reference inputs for the two seas separately. The 82 tons extra reduction was then split according to the proportions of the input reductions according to the Finnish calculation and this resulted in that Archipelago Sea had 28 tons extra reduction and Bothnian Sea had 54 tons. In an assessment one would of course need to redo the calculation using the proper methodology, i.e., split the CART for Finland to Bothnian Sea and calculate the extra reductions including statistical uncertainty in the same way as for other basins.

Table 8b shows the effective reductions in the case that the Archipelago Sea inputs are accounted as part of Baltic Proper, i.e. with equivalent reduction = 1 (cf. principle 6), while the remaining extra reduction for Bothnian Sea is accounted for in Bothnian Bay and Gulf of Finland. Following argumentation above (principle 7), the effective reduction to Baltic Proper from Finland could directly be accounted for in the missing reduction in Gulf of Finland as shown in Table 9b.

Table 8c shows a case were also the remaining extra reduction in Bothnian Sea is accounted for in Baltic Proper, however, using the equivalent reduction between the seas from Table 1 (= 1.5) and Table 9c shows the remaining missing reductions using these effective reductions taking into account principle 7.

Note that in the use of extra reductions in Bothnian Bay, it is assumed that missing reductions to Gulf of Finland does not affect the environment in Bothnian Bay (no efficient reduction in Table 1), but this is a case where some deeper analysis may be necessary so remaining reductions for Bothnian Bay in Tables 9a-9c should be regarded as preliminary.

Table 7: The extra and missing reductions of phosphorus from Finland according to the latest CART assessment. Finland has no reduction requirements on phosphorus to Gulf of Riga, Baltic Proper, Danish Straits and Kattegat.

Basin	Extra reduction	Missing reduction
BS	82	
BB		28
GF		417

Table 8a: Calculation of effective reductions for the extra reduction from Finland to Bothnian Sea following strictly the methodology above.

Basin	Equivalent reduction	Calculation	Effective reduction
GF	5.8	82/5.8	14
BB	2.6	82/2.6	32

Table 8b: Calculation of effective reductions for the extra reduction from Finland to Bothnian Sea following that the reductions to Archipelago Sea should be regarded as reductions to Baltic proper directly (principle 6).

Basin	Equivalent reduction	Calculation	Effective reduction
BP	1	28/1	28
GF	5.8	54/5.8	9
BB	2.6	54/2.6	21

Table 8c: Calculation of effective reductions for the extra reduction from Finland to Bothnian Sea following that the reductions to Archipelago Sea should be regarded as reductions to Baltic proper directly (principle 6). In addition, the remaining Bothnian Sea reductions should be accounted to the Baltic proper since this basin needs the largest phosphorus reductions (principle 7).

Basin	Equivalent reduction	Calculation	Effective reduction
BP	1	28/1	28
BP	1.5	54/1.5	36
BB	2.6	54/2.6	21

T**able 9a**: The extra and remaining reductions of phosphorus from Finland with effective reductions in Table 8a are taken into account.

Basin	Extra reduction	Missing reduction
BS	82	
BB		-4
GF		403

Table 9b: The extra and remaining reductions of phosphorus from Finland with effective reductions in Table 8b are taken into account. The effective reduction to BP is to be deducted directly from the Finnish missing reduction to GF as explained in the text.

Basin	Extra reduction	Missing reduction
BS	82	
BB		7
GF		380

Table 9c: The extra and remaining reductions of phosphorus from Finland with effective reductions in Table 8c are taken into account. The effective reduction to BP is to be deducted directly from the Finnish missing reduction to GF as explained in the text.

Basin	Extra reduction	Missing reduction
BS	82	
BB		7
GF		353

Denmark:

Denmark has made a national evaluation of the extra and missing reduction based on data up to 2014, and using a more sophisticated statistical approach. For Denmark we use these numbers (presented in Table 10) as basis for exemplifying the accounting for Denmark. Denmark is in the fortunate position to have managed to get extra reductions both to Kattegat and Danish Straits. The effective reductions stemming from the extra reductions in Danish Straits are shown in Table 11 and in Kattegat in Table 12. Since Denmark already is fulfilling the reduction targets in Danish Straits, the extra reduction in Kattegat is not needed. However, the missing reduction in Baltic Proper is 49 tons and the extra reduction in Danish Straits will only cover 5 tons of this leaving a missing reduction of 44 tons (Table 13).

Table 10: The extra and missing reductions of phosphorus from Denmark according to the latest CART assessment. Denmark has only phosphorus inputs to these basins.

Basin	Extra reduction	Missing reduction
KT	114	
DS	17	
BP		49

Table 11: Calculation of effective reductions for the extra reduction from Denmark to Danish Straits.

Basin	Equivalent reduction	Calculation	Effective reduction
KT	0.8	17/0.8	21
BP	3.2	17/3.2	5

Table 12: Calculation of effective reductions for the extra reduction from Denmark to Kattegat.

Basin	Equivalent reduction	Calculation	Effective reduction
DS	4	114/4	28

Table 13: The extra and missing reductions of phosphorus from Denmark after taking into account the extra reduction to Danish Straits in the missing reduction to Baltic Proper.

Basin	Extra reduction	Missing reduction
KT	114	
DS	17	
BP		44

Germany:

Germany has phosphorus inputs to Danish Straits and Baltic Proper, and the extra and missing reductions to these basins are shown in Table 14. Since it is only two basins, calculations are straightforward. Table 15 shows the effective reduction calculation based on the extra reduction in Danish Straits and Table 16 shows the resulting remaining reduction in the Baltic Proper after deducting the effective reduction.

Table 14: The extra and missing reductions of phosphorus from Germany according to the latest CART assessment. Germany has only phosphorus inputs to Danish Straits and Baltic Proper.

Basin	Extra reduction	Missing reduction
DS	30	
BP		208

Table 15: Calculation of effective reductions for the extra reduction from Germany to Danish Straits.

Basin	Equivalent reduction	Calculation	Effective reduction
BP	3.2	30/3.2	9

Table 16: The extra and missing reductions of phosphorus from Germany after using effective reduction in Baltic Proper.

Basin	Extra reduction	Missing reduction
DS	30	
BP		199

Estonia:

Estonia has phosphorus inputs to Gulf of Finland, Gulf of Riga and Baltic Proper. According to the latest CART assessment Estonia managed to achieve their reduction targets with a small margin to the Gulf of Riga and got an extra reduction of 3 tons, see Table 17. The effective reduction from the extra reduction in Gulf of Riga can be used in Baltic Proper, see Table 18. The adjusted missing reductions are shown in Table 19. We see that Estonia could meet their Baltic Proper reduction targets by reducing another 15 × 1.6 = 24 tons to Gulf of Riga. If they do reduce even more than this, one could consider using the same argument as for Finland that phosphorus reductions to Baltic Proper could be accounted for in Gulf of Finland.

Table 17: The extra and missing reductions of phosphorus from Estonia according to the latest CART assessment. Estonia has only phosphorus inputs to Gulf of Riga, Gulf of Finland and Baltic Proper.

Basin	Extra reduction	Missing reduction
GR	3	
GF		285
BP		17

Table 18: Calculation of effective reductions for the extra reduction from Estonia to Baltic Proper.

Basin	Equivalent reduction	Calculation	Effective reduction
BP	1.6	3/1.6	2

Table 19: The extra and missing reductions of phosphorus from Estonia according to the latest CART assessment. Estonia has only phosphorus inputs to Gulf of Riga, Gulf of Finland and Baltic Proper.

Basin	Extra reduction	Missing reduction
GR	3	
GF		285
BP		15