Appendix 3 – Impact of the willingness to pay for biodiversity on the solution with highest contribution to social welfare

A3.1 – Transformation of the willingness to pay value units

The willingness to pay (WTP) values by Hirschfeld et al. (in press) are in €/person/a and refer to agricultural land within a 15 km radius of the respective respondent. For further processing, we had to transform the units to €/ha/a, which has been done in Equation 2 under the assumption that population and agricultural land are evenly distributed in Germany. In order to make the spatial reference of the WTP values more visible, Equation 2 can also be formulated as:

$$\frac{22\ €/pers}{70{,}685.8\ ha} * \frac{67.23 * 10^6\ pers}{16.7 * 10^6\ ha} * 70{,}685.8\ ha = 88.57 \frac{€}{ha} \qquad \text{(Eq. A. 1)}$$

The first factor determines the WTP per person per hectare within a 15 km radius ($70{,}685.8\ ha$). The second factor calculates the number of people per hectare agricultural land and multiplied with the third factor, this gives the number of people per hectare agricultural land within a 15 km radius. Since the $70{,}685.8\ ha$ can be cancelled, Equations A.1 and 2 are equivalent.

Alternatively, it is also possible to formulate Equation 2 as:

$$\frac{22\ €/pers}{33012.18\ ha} * \frac{67.23 * 10^6\ pers}{35{,}758{,}100\ ha} * 70{,}685.8\ ha = 88.57 \frac{€}{ha} \qquad \text{(Eq. A. 2)}$$

The first factor calculates the WTP per person per hectare agricultural land within a 15 km radius. It is determined by:

$$\frac{16.7 * 10^6 ha}{35{,}758{,}100\ ha} * 70{,}685.8\ ha \qquad \text{(Eq. A. 3)}$$

Here, $16.7 * 10^6 ha$ is the agricultural land in Germany in 2013, $35{,}758{,}100\ ha$ the total area of Germany and $70{,}685.8\ ha$ the area defined by a 15 km radius.

The second factor of Eq. A.2 calculates the number of people per hectare in Germany and multiplied with the third factor, this gives the number of people per hectare within a 15 km radius.

By using Eq. A.3, it is trivial to proof that Equations A.1 and A.2 are equivalent.

A3.2 – Sensitivity analysis of the impact of the WTP for biodiversity on the solution with highest contribution to social welfare

With changing values for the WTP for biodiversity, the trade-offs between the two objectives – max WTP for biodiversity and max WTP for agricultural production – will not change significantly since they are based on two biophysical models. This means that high values for the

bird index and, respectively, high values for the WTP for biodiversity can only be achieved at lower levels of agricultural production.

With changing values of the WTP for biodiversity, the solution with highest contribution margin would most likely not change. However, the total contribution margin calculated by Eq. 6 will be affected. Let us differentiate three cases (assuming no change in the modelling of WTP for agricultural production):

WTP for biodiversity decreases, WTP for agricultural production > WTP for biodiversity: In this case, WTP for agricultural production > WTP for biodiversity since even the lowest value of WTP for agricultural production (i.e. 253.48 €/ha in Biomax) is larger than the currently highest value of WTP for biodiversity (i.e. 213.36 €/ha). Due to the small range of WTP for agricultural production values, the solution with the highest WTP for biodiversity would thus mostly be the solution with the highest contribution margin, too. Only, if the highest achievable value for the WTP for biodiversity is lower than the difference between the highest and lowest value of the WTP for agricultural production (e.g. 260.79 €/ha – 250.48 €/ha = 10.31 €/ha), solutions with high WTP for agricultural production will be selected.

WTP for biodiversity increases, WTP for agricultural production = WTP for biodiversity: Due to the almost linear negative trade-off relation, all solutions would roughly lead to the same contribution margin, i.e. they would be equally preferable.

WTP for biodiversity increases, WTP for agricultural production < WTP for biodiversity: In this case, solutions with a higher WTP for biodiversity would lead to a higher contribution margin.