7. HEP Application to Compensation Analysis

Compensation studies identify measures that would offset unavoidable HU losses due to a proposed action. Compensation occurs by applying specified management measures to existing habitat to effect a net increase in HU's. The existing habitat may or may not be located in the "impact" study area. In order to obtain compensation, the HU losses due to the proposed action must be fully offset by the specified acquisition and/or management measures.

The compensation process is depicted in Figure 7-1. A compensation study is initiated by identifying a list of evaluation species for which compensation is desired. The list may contain a single species or several species which represent an entire community.

The compensation study must have specific objectives and defined management goals. One specific objective should be to identify a list of target species for which habitat gains can be used to offset habitat losses. The list of target species does not have to be identical to the list of impacted species. The target species are partially determined by the specified compensation goal. Essentially there are three possible compensation goals.

1) In-kind (no trade-off). This compensation goal is to precisely offset the HU loss for each evaluation species. Therefore, the list of target species must be identical to the list of negatively impacted species. The ideal compensation plan will provide, for each individual species, an increase in HU's equal in magnitude to the HU losses. A mathematical expression of this goal is:

$$\sum_{i=1}^{n} (M_i + I_i)^2 = 0 \qquad (3)$$

where M = Habitat Units gained through compensation for a target species

I = HU losses for same species

i = species number

n = the total number of identified species

2) Equal replacement (equal trade-off). This compensation goal is to precisely offset the HU losses through a gain of an equal number of HU's. With this goal, a gain of one HU for any target species can be used to offset the loss of one HU for any evaluation species. The list of target species may or may not be identical to the list of impacted species. The mathematical expression of this goal is:

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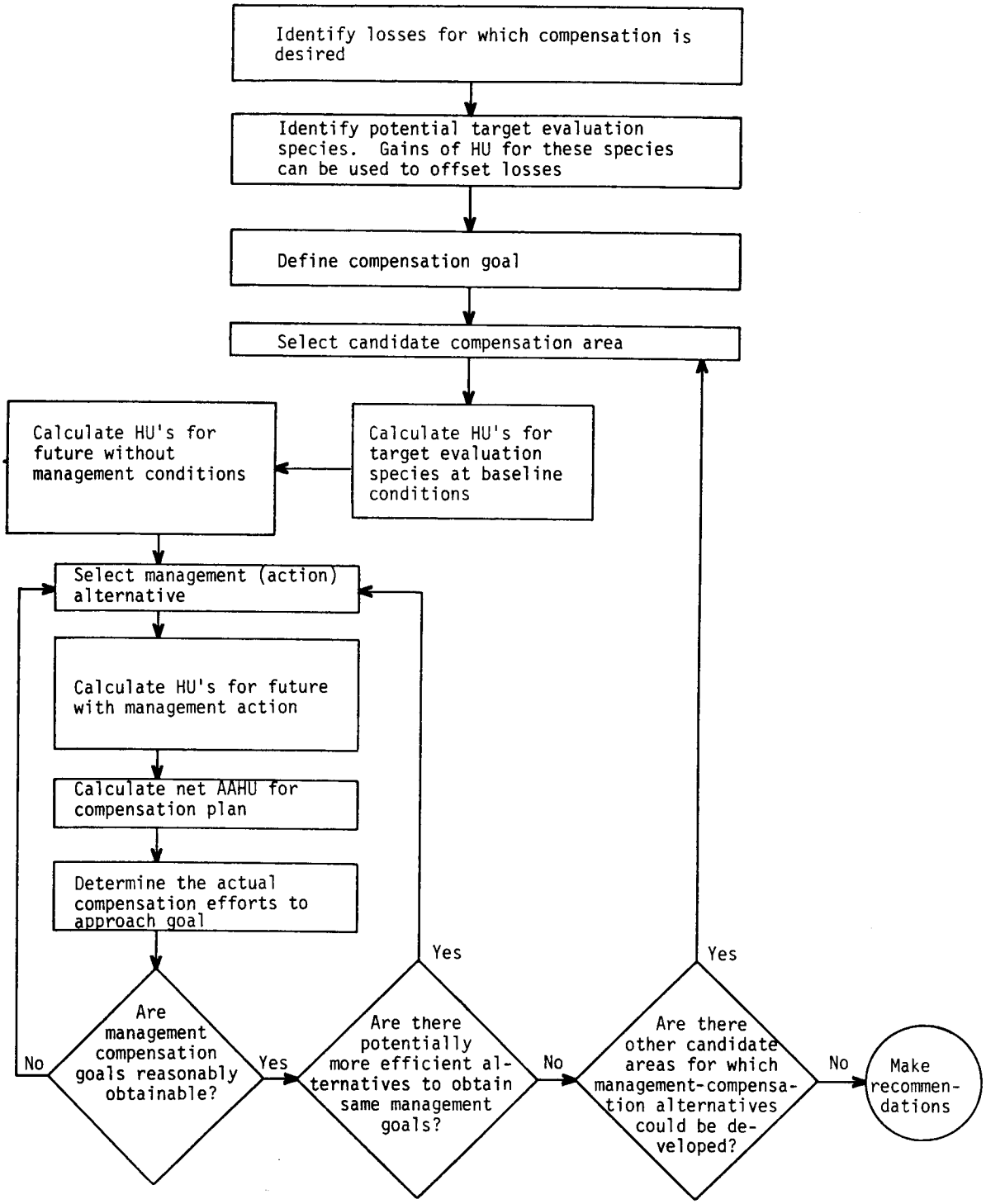

Figure 7-1. The compensation process.

$$\sum_{i=1}^{n} M_i + \sum_{i=1}^{m} I_i = 0 \qquad (4)$$

where M, I, and i conform to previous usage

n = total number of target species

m = total number of impacted species

3) Relative replacement (relative trade-off). With this goal, a gain of one HU for a target species is used to offset the loss of one HU for an evaluation species at a differential rate depending on the species involved. The trade-off rates can be defined by RVI values for each species. For example, if the RVI values for white-tailed deer and ruffed grouse are 1.0 and 0.5 respectively, one white-tailed deer HU can be used to offset two ruffed grouse HU's. The lists of target and evaluation species can differ. The mathematical expression of this goal is:

$$\sum_{i=1}^{n} M_i(RVI_i) + \sum_{i=1}^{m} I_i(RVI_i) = 0 \qquad (5)$$

where M, I, n, m, and i conform to previous usage

RVI = Relative Value Index for the species

The above compensation goals may be further clarified by specifying the type of habitat(s) that must be managed for compensation. This specification would be desirable when the loss of a specific community (e.g., a forested wetland) is to be compensated.

After the compensation objectives are set, the compensation analysis is the same as that used to identify project impacts. The steps in the process, as depicted in Figure 7-1, are to:

1) Select a candidate compensation study area. The area can be of any size but must be at least large enough to be a manageable unit for the target species. Develop a cover type map and determine the area of each cover type.

2) Conduct a baseline habitat assessment for each target species as described in Chapter 5. Baseline data for individual species in the "impact" area may be used if the candidate compensation area is similar in terms of HSI values. If this is not the case, additional field work to determine HSI's will be necessary in the compensation study area.

3) Determine the AAHU's for the compensation study area assuming no future proposed action.

4) Identify a proposed management action that will achieve specified goals. Specify the management measures (e.g., prescribed burning, selective timber cutting, and others) that will be used to increase the HU's for target species in the candidate compensation area.

5) On the compensation area, contrast the HU's without management to the HU's with proposed management measures and determine the net increase in HU's.

The process defined above is identical to the process used to assess the net impacts of any proposed action (i.e., an estimate of the net AAHU changes for a specified future action).

The next step in the process is calculating the actual size of the management area that will be required to fully offset losses. The previously stated size requirement was only that the compensation study area be large enough for a manageable unit; thus, in all probability, the area will not be large enough to meet compensation goals. The calculation of area requirements is best illustrated with an example.

The compensation data for a hypothetical study, depicted in Table 7-1, will be used to analyze the effectiveness of a proposed management plan for offsetting HU losses to five evaluation species. A 1,000 acre compensation study area was arbitrarily chosen for analysis. Based on the data in Table 7-1, compensation for each evaluation species varies from 970 acres to fully offset ruffed grouse habitat losses to 13,750 acres to fully offset yellow-rumped warbler habitat losses. The actual area that is chosen for compensation will depend on the selected goal. The area calculations are provided below for each of three goals specified earlier:

1) In-kind (no trade-offs). This compensation goal specifies that compensation should precisely offset the HU losses for each species. If hypothetical management plan A fully met this goal, the areas in Table 7-1 would be the same. If 975 acres were managed, the only species that receives full habitat compensation is the ruffed grouse. If 13,750 acres are used for the management plan, habitat for every species, with the exception of the yellow-rumped warbler, will more

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Table 7-1. Examples of HU data for compensation anaylsis.

Evaluation Species	Change in Habitat Units (a) Proposed Action	Change in Habitat Units (b) Management Plan A	Ratio of (a) to (b)	Area Needed for Compensation Ratio x Area*
White-tailed deer	-722	250	2.88	2,880
Ruffed grouse	-400	410	0.97	970
Red squirrel	-300	210	1.42	1,420
Red fox	-120	50	2.4	2,400
Yellow-rumped warbler	-550	40	13.75	13,750

*Size of area initially selected for analysis; 1,000 acres in this example.

than offset HU losses. There is no mid-range management area figure that would equally compensate HU losses for all species. However, there is one mid-range area that will optimize the achievement of the in-kind goal. This area minimizes the total HU over-compensations and under-compensations by a sum of squares technique and is calculated by formula (6):

$$\text{Optimum Compensation Area} = -A\left[\frac{\sum_{i=1}^{n} M_i I_i}{\sum_{i=1}^{n} M_i^2}\right] \qquad (6)$$

where M, I, i, and n conform to previous usage

A = size of candidate compensation study area

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The size of the candidate compensation area selected will not affect the size of the optimum compensation area as calculated with this formula. For the example in Table 7-1, the best compensation area under management plan A is:

$$\text{Optimum Compensation Area} = -1{,}000\ \frac{(-722)(250) + (-400)(410) + (-300)(210) + (-120)(50) + (-550)(40)}{(250)^2 + (410)^2 + (210)^2 + (50)^2 + (40)^2}$$

$$= -1{,}000 - \frac{435{,}500}{278{,}800}$$

$$= 1{,}562 \text{ Acres}$$

With 1,562 acres used for the specified management plan A, habitat for the yellow-rumped warbler, white-tailed deer, and the red fox will not be compensated but habitat for the other species will be over-compensated. The calculated area of 1,562 acres is the best compromise figure to satisfy the compensation goal. The degree to which the compensation plan achieved the in-kind (no trade-off) goal can be calculated with formula (3) by increasing the "M" values by a factor of 1.562, i.e., 1562/1000, as follows:

$$\sum_{i=1}^{n} (M_i + I_i)^2 = [(250 \times 1.562) - (722)]^2 + [(410 \times 1.562) - (400)]^2$$
$$+ [(210 \times 1.562) - (300)]^2 + [(50 \times 1.562) - (120)]^2$$
$$+ [(40 \times 1.562) - (550)]^2$$
$$= 465{,}712.3$$

The value 465,712.3 has meaning primarily as a reference to which other alternative management plans can be compared. A more balanced plan with respect to in-kind goals would have a lower number ("0" is ideal). Other alternative management schemes should be developed if possible to more closely meet the in-kind compensation goal. The test of a better plan would be one that more equally offsets losses to each species.

2) Equal replacement (equal trade-offs). This compensation goal specifies that the gain of one HU can be used to offset the loss of one HU for any species. In the current example, the trade-offs can be between any of the five species. The actual area that should be chosen for compensation to achieve this goal is determined by:

$$\text{Compensation Area} = -A \left(\frac{\sum_{i=1}^{n} I_i}{\sum_{i=1}^{m} M_i} \right) \qquad (7)$$

where A, M, I, i, m, and n conform to previous usage.

For the example, the compensation area will be:

$$\text{Compensation Area} = -1{,}000 \left(\frac{-2{,}092}{960} \right)$$

$$= -1{,}000 \quad (-2.179)$$

$$= 2{,}179 \text{ Acres}$$

The equal replacement goal can always be met precisely by managing the specified area.

3) Relative replacement (relative trade-offs. This compensation goal specifies that the gain of one HU can be used to offset the loss of one HU at a differential rate depending on the species involved. The RVI values in Figure 6-3 will be used to determine the differential trade-off rates. The area needed for compensation is calculated by:

$$\text{Compensation Area} = -A \left[\frac{\sum_{i=1}^{n} I_i(RVI_i)}{\sum_{i=1}^{n} M_i(RVI_i)} \right] \qquad (8)$$

where A, I, M, n, m, and i conform to previous usage

RVI = Relative Value Index for a species

For the example, the compensation area will be:

$$\text{Compensation Area} = -1{,}000 \; \frac{(-722)(0.6) + (-400)(0.78) + (-120)(0.35) + (-300)(0.1) + (-550)(1.0)}{(250)(0.6) + (410)(0.78) + (50)(0.35) + (210)(0.1) + (40)(1.0)}$$

$$= -1{,}000 \; - \frac{1367.2}{548.3}$$

$$= 2{,}493 \text{ Acres}$$

The relative replacement goal will always be met by managing the calculated area.

The foregoing compensation calculations are provided as illustrations of the use of HEP and should not imply that actual studies must conform precisely to the examples. There may be other ways that a compensation study can be performed. However, there are two factors that should always be considered. The first of these is the development of alternative compensation plans, if possible, no matter what goals are defined. The best compensation plan is one that not only meets Habitat Unit (biological) goals but also is socially acceptable and cost efficient. Determining the social acceptability of a particular plan is a function of planning and cannot be fully covered in this document. However, there are fairly simple guidelines for determining economic efficiency. Among a set of alternative compensation actions, the most economically efficient plan is the one that will meet the objectives at the lowest cost. Costs may include land acquisition, development, and continuing management costs. These cost figures should be developed for every compensation alternative that is analyzed.

The second consideration for a compensation analysis is the inclusion of species that may be negatively impacted by the management plan. The biological acceptability of a particular compensation alternative may be influenced by these losses. Potentially negative impacts of a compensation plan can be included in an analysis, even if only subjectively, and can be mathematically included using formulas (3) through (8).