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Metrics and Equivalence in Conservation Banking

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Abstract: Offsets are increasingly used to compensate for unavoidable development impacts on species and habitats. Many offset programs pursue no net loss, but research on the success of these programs is lacking, including research on conservation banking's success in conserving protected species under the US Endangered Species Act. This article provides a case study analysis of two conservation banks in the state of California, comparing the conservation gains provided by banks with the losses from development impacts. It provides an analysis of credits and metrics to determine whether the gains are equal to the losses in terms of type, condition, and amount. Results do show that the gains exceed the losses in terms of acreage. However, the program uses indirect metrics (acreage), and the equivalence of the losses and gains, besides habitat type and size, is not reflected. Banks provide a baseline in their documentation and conduct monitoring of species abundance and habitat quality, but they do not use it to measure additional conservation gains. More detailed metrics and transparent indices to certify the acres in production could allow for a quantification of conservation benefits and an evaluation of program success. However, selecting standardized metrics is challenging because they need to be species-specific to reflect the goal of species recovery, and still be operational in practice.

Keywords: conservation banking; biodiversity offsets; Endangered Species Act; habitat banking; species conservation; metrics; equivalence; habitat quantification tools; effectiveness

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1. Introduction

Biodiversity offsets are used in many countries to compensate for unavoidable impacts on biodiversity, species, and habitats. A project developer is required to first avoid and minimize impacts of a planned project, before providing measurable conservation outcomes to compensate for residual impacts in the form of offsets. Biodiversity offset programs often aim to achieve No Net Loss (NNL, to maintain the current status of biodiversity). However, studies evaluating whether offset programs reach this goal are rare and more evidence is needed to prove if they are effective or not [1–5]. Regulators must clearly define what exactly NNL refers to (individuals, acres of habitat, species conservation status) [6,7], so NNL can be monitored. Furthermore, program evaluation requires suitable metrics to measure losses and gains and transparent tracking [8–10]. Offsets must ensure ecological equivalence of gains and losses (e.g., amount, type, and condition of biodiversity components) as well as additional conservation outcomes that would not have occurred without the compensation project, and provide at least the same amount of conservation value as the impact itself [11,12].

Researchers in this area observe consistent tension between the ecological complexity of measuring biodiversity and the need for clear and simple metrics in policy implementation. These researchers often discuss the NNL goal, respective metrics, and quantification methods to calculate gains and losses cf. [4,13–23]. The methods used to assess losses and gains should combine spatial, ecological, temporal, and uncertainty considerations [24].

To measure and trade losses and gains in a market, any offsetting program requires: (a) a unit measure in which credits are sold (e.g., one credit equals one acre of habitat) and: (b) metrics, which are used to assess the state of the offsetting site (such as quality or extent of habitat, and/or the number of species). Metrics also 'include measures of biodiversity type, amount, and condition' [10]. This requires a method to establish how the value of the compensation site should be assessed. Cochran et al. (2011) discern between vegetation-based, species-based, functions-based, and practice-based metrics [25]. Metrics should reflect ecological equivalence, spatial consideration, temporal dynamics, and uncertainties [11,24]. Review studies show that there is a vast number of available quantification tools (methods for quantifying impact and compensation) cf. [13,20,26,27]. Metrics can be based on complex methods, e.g., to assess population viability, but often remain arbitrary [28,29]. This creates a mismatch between the regulatory framework and the implementation in practice, as the measures used often do not reflect the overall policy objective [14,20]. This is perhaps because appropriate metrics do not rely on the policy framework alone, but on data availability and operationality as well ibid., [24,30–32].

An offset programs' effectiveness depends on accurate, scientifically sound measures, usability, and transparency [27]. This creates a dilemma: On the one hand, there is the need to improve evidence surrounding mitigation measures [4]. This requires somewhat standardized, or at least comparable, metrics and methods to measure losses and gains that reflect the overall policy goal. On the other hand, complex ecosystems, a large variety of species and habitats and thus limited data combined with a need for usability in practice pose a barrier to further standardization [20,33,34]. Vaissière and Meinard (2021) criticize a purely analytical approach to offsets, highlighting the limitations of metrics in measuring ecological dynamics [32]. This article contributes to the evidence base around the success of offsets in achieving their goals. It discusses the challenge of ecologically sound yet operational metrics, with a focus on the US conservation banking program. The main objective is to find out if the gains from conservation banking can be considered equivalent to the losses caused by impacts of development on protected species and their habitats.

US Conservation Banking

Biodiversity offsets are applied in many countries across the globe, including Germany, Spain, the UK, Australia, Netherlands, and the United States [35–40]. The developer is often responsible for providing compensation, but some programs do allow third-party entities to provide compensation for them. One of the oldest frameworks for third-party compensation, focusing on species and habitats, is the US conservation banking program. Conservation banks provide compensation under the 1973 US Endangered Species Act (ESA; as well as the California Endangered Species Act, CESA). Banking was first described in regulations in the early 1980s (with the first regulations to provide compensation for impacts on wetlands under the US Clean Water Act) and has been applied ever since. A conservation bank is a site (or suite of sites) that is conserved and managed in perpetuity (forever) by a bank sponsor (owner) to receive credits from the regulating agency (US Fish and Wildlife Service and/or California Department of Fish and Wildlife). After avoiding and minimizing the impacts of a development project on species and habitats, a permittee (project developer) can then buy these credits to compensate for residual adverse effects on listed species and their habitats. Expected benefits of banking are advance mitigation (the compensation takes place before the impact occurs), efficiency due to economies of scale, better habitat connectivity, and improved conservation outcomes [41–44].

Many banks preserve existing habitat in perpetuity as opposed to creating new habitat [45]. Maron et al. (2018) state that 'an overall net loss in habitat extent is the most likely outcome of conservation banking, although banks themselves may be higher in quality than the habitat lost' [14], p. 21. However, the goal of the ESA is the conservation and recovery of listed species. Habitat extent, as well as other factors (e.g., mortality, invasive species, contamination), can affect this recovery. The goal of NNL for mitigation can be traced back to the 1981 mitigation policy [46]. Although the Trump administration rescinded the new FWS mitigation policy's goal of a Net Gain (NG, to improve the status of species and their habitats), the objective of the ESA to improve the conservation status of listed species remains. Conservation banking, as well as other instruments (recovery plans, protected areas, etc.), should contribute to the protection and recovery of species under the Endangered Species Act. Under the California Endangered Species Act, banks should even fully mitigate impacts to species. Few studies have been done on the effectiveness of the conservation banking program. Bunn, Moyle, and Johnson (2014) assess the ecological value of conservation banks in different regions [47], and Sonter et al. (2019) quantified the effect of 59 banks on habitat extent [15]. However, no study compares their findings to the impacts which were compensated for at these banks in terms of credit type, metrics, and equivalence. This paper contributes to filling this gap by analyzing the crediting documents of conservation banks as well as the impact permits for which these banks compensate. Most research thus far focuses solely on the credit supply side (i.e., the banks) cf. [47,48], whereas this paper analyzes and compares supply and demand.

To allow for an evaluation of offset program effectiveness, there is a need for transparent metrics that relate losses to gains: The effect of conservation banking on species recovery can only be assessed once transparent metrics and credits reflecting this goal have been applied at the impact and compensation site. According to previous research, conservation banking measures largely in acres (1 credit = 1 acre) [49,50], but credits can also be distinguished by additional aspects, such as species occupation [26]. Recent studies show that there is no single approach employed, but rather multiple factors considered depending on regions, individual preferences, and resources affected [44,50]. Standardization and transparency in credit calculation could however foster accountability by reflecting the contribution of compensation projects to conservation objectives [27]. In 2015, Pindilli and Casey called for 'tools that can provide information on the baseline [initial condition of species and habitat] and improved status of a species or habitat condition' [26], and mentioned the difficulty in creating species-specific tools. Since then, the US Geological Survey (USGS) has developed a database of 69 quantification tools for use in biodiversity markets [27,51,52]. The authors point out that further standardization of metrics may help improve banking practices [2,11,27], but stricter standards may be perceived as a barrier to market participation [53]. Therefore, crediting in the conservation banking program walks a line between species conservation and incentivizing private entities to enter the market [48]. White et al. (2021) identify defining unit measure and equivalence as a major challenge of the program [54]. Selecting metrics is challenging, as the conservation status of different species is affected by different factors. Thus, metric selection must balance trade-offs between species-specific needs, accountability, and operationality (usable in practice with a small amount of time and at a low cost) [24]. This paper contributes to the discourse on selecting suitable metrics by reviewing which factors affect the conservation of species covered in the case studies below while discussing some challenges of increased standardization.

2. Aim, Materials, and Methods

The main objective of this article is to find out whether the gains from conservation banking can be considered equal to the losses caused by impacts in terms of amount, condition, and ecological equivalence. I begin with a multi-case-study analysis of two conservation banks from California to compare losses (as assessed in impact permits) and gains (as established in bank documents). California banks were selected because it has the strictest bank approval process due to a 2011 Memorandum of Understanding (MOU) of federal and state agencies establishing a coordinated approach to banking. Also, 129 out of 182 banks listed on RIBITS in April 2020 (Regulatory In-lieu fee and Bank Information Tracking System) are in located in the state. Information provided in the RIBITS database and the results of an analysis of bank characteristics by Carreras Gamarra and Toombs [50] were used to select the case studies. After excluding all pending/withdrawn/suspended banks, wetland mitigation banks (providing compensation for impacts under the US Clean Water Act), single client banks (selling credits to only one developer for one project), banks with fewer than 10 credit sales, and banks with missing impact permit numbers or missing crediting documents, 29 banks remained. I only included banks approved after the 2011

MOU to analyze current practice (eight banks remained) and chose banks that had sold almost all their credits. I analyze two contrasting cases: One bank from a large banking company, and one bank from a different sponsor, banks that pursue different bank management objectives (e.g., preservation vs. creation), banks that cover different species and involved different approval offices. This resulted in the following selection:

- Sparling Ranch Conservation Bank (established 2017, Ventura and Sacramento offices, 3282.6 acres, enhancement and preservation of habitat, sponsored by South Bay Conservation Resources, signed by CDFW and FWS). It provides California Tiger Salamander (*Ambystoma californiense*), upland habitat, and aquatic/breeding habitat (CDFW distinguishes the 2 habitat types, FWS does not), and California Red-Legged Frog (*Rana draytonii*) credits. A total of 2000.6 credits were released in January 2018 (phase 1 of the bank), 1282 credits will be released in phase 2.
- Dutchman Creek Conservation Bank (established 2014, Sacramento office, 501 acres, creation and preservation of habitat, sponsored by Westervelt, signed by CDFW and FWS). It provides Vernal Pool Fairy Shrimp (*Branchinecta lynchi*), Vernal Pool Tadpole Shrimp (*Lepidurus packardi*), California Tiger Salamander, San Joaquin Kit Fox (Vulpes macrotis mutica), Conservancy Fairy Shrimp (*Branchinecta conservatio*), Swainson's Hawk (Buteo swainsoni), Western Spadefoot Toad (*Spea hammondii*), and Western Burrowing Owl (*Athene cunicularia*) credits.

I analyzed the bank enabling instruments and crediting documents, as well as 30 permitting documents of credit sales, documented in the RIBITS database. I acquired the impact permits via Freedom of Information Act requests submitted to CDFW and FWS. I used the case study analysis to answer the following research questions:

- Do the gains equal the losses?
    - What unit measure is used (e.g., 1 acre = 1 credit)?
    - Is it the same for measuring gains and losses?
    - Are ratios (multipliers) applied to calculate the compensation requirement?

It is likely that the metrics, quantification methods, and currency (credits) do not reflect enough details to answer whether gains equal losses or how greatly conservation banks contribute to the recovery goal of ESA. Therefore, I asked the following questions to draw conclusions regarding bank contribution to species recovery and the equivalence of losses and gains from my case study analysis:

- Do metrics and quantification methods on the bank and permitting side reflect the key aspects of equivalence based on [10,24]?
    - Ecological equivalence: What is the target biodiversity? Does it reflect the overall policy goal of species recovery?
    - Spatial considerations: Is the landscape-context considered?
    - Temporal dynamics: Are temporal losses considered? Is a baseline established to measure gains and losses?
    - Uncertainties: Is the risk of offset failure considered?

I used my findings to discuss the question of which metrics are the 'right' metrics to reflect the overall program goal and the contribution of conservation banks to species conservation. I reviewed species recovery plans (documents describing the current status of species, threats, and recovery objectives) and bank monitoring reports to discuss which aspects (besides acreage) play a role in species recovery and could therefore be used in crediting.

3. Results

3.1. Gains and Losses

This chapter explores whether gains at the conservation bank and losses at the impact site are measured with the same unit measure. Results show that both bank documents and impact permits define one credit as one acre. Results also show that the gains in acreage exceed the losses in acreage and that ratios are used to reach this outcome.

In the spring of 2018, Sparling Ranch sold 1038.78 credits out of their total of 2000.6 released credits. As the bank is not sold out, Table 1 does not reflect the final tally of the bank's gains and losses. All credits sold are group credits that can be used to compensate for impacts on both the California Tiger Salamander and California Red Legged Frog. I analyzed 18 RIBITS ledger entries (14 CDFW and 4 FWS permits): In a few cases, permittee-responsible mitigation (PRM, compensation projects implemented by the developer) was mentioned, but it was not always clear whether this was a potential alternative to purchasing credits from a bank or whether additional PRM was taking place. It is possible that the permittee protected and managed additional off-site habitat. Some permits clearly required on-site habitat restoration of disturbed areas—this acreage was not included in the tally, because its implementation could not be determined. A total of 956,796 acres of habitat was impacted, resulting in a total compensation requirement of 961,797 acres. It is unclear why the compensation requirements in the impact permits do not equal the total number of credit sales listed in RIBITS. For some impacts, only the CDFW permits and not the FWS permits were accessible. It is possible that the FWS asked for additional compensation. Overall, the compensation credits sold exceeded the acreage impacted by 81,984 acres and the compensation required by 76,983 acres, resulting in a gain of habitat acreage.

Table 1. Gains and Losses in Acres.

Bank	(a) Acres	(b) Credits Released (RIBITS)	(c) Credits Sold (RIBITS)	(d) Compensation Required (Permit Documents)	(e) Acres Impacted (Permit Documents)	(e) Discrepancy? (c–d)
Sparling Ranch	3282.6	2000.6 (+ 1282 in phase 2)	1038.78	961.797	956.796	+ 81.984
Dutchman Creek (incomplete analysis)	501	496.8	104.54 analyzed (out of 489.04 sold)	164.67	119.28	+ 60.13

The Dutchman Creek conservation bank sold 489.04 out of its 496.8 released credits, and although the bank has almost sold all credits, missing permit documents made a full assessment of debits and credits impossible. One of the missing documents permitted an impact that required the purchase of 377.50 credits, which is nearly the total number of bank credits, and another missing permit resulted in a purchase of 0.1 credits. I excluded these credits from the gains vs. losses calculation in Table 1 and analyzed the available seven impact documents, covering nine out of 14 RIBITS ledger entries. In one case, the required credit purchase was only a portion of the affected acreage and the total compensation requirement included PRM. As the permitting process for the California High-Speed Rail is still ongoing, I excluded this ledger entry from the analysis (required the purchase of 6.9 credits). The results include the sales of 104.54 credits. For some credit purchases, I analyzed CDFW and FWS permits, which in some cases had different compensation requirements. In these cases, I assumed that the larger compensation requirement satisfied the requirements of the smaller one. With these assumptions and lack of data, the gains exceeded the losses by 60.13 acres. It is important to note that Dutchman Creek is the only bank analyzed that is listed in RIBITS as a 'creation' bank, meaning that it should create a new habitat for covered species. However, the credit release schedule shows that RIBITS was inaccurate, and the bank generates credits by preserving and managing existing habitat.

Table 1 shows the results of the analysis. The two conservation banks preserve a total of 3783.6 acres of habitat, credited with 2497.4 credits (or 3779.4 when Sparling Ranch reaches phase 2). In sum, they sold 1527.82 credits, out of which I analyzed the available impact permits for the sale of 1143.32 credits. According to these permit documents, a total of 1076.076 acres was impacted, leading to a total compensation requirement of 1126.467 acres/credits. This resulted in an overcompensation of 142.117 acres between the two conservation banks. Unfortunately, the bank selection process or the implementation of additional PRM after the impact permit is issued are not documented. This made it difficult to establish a full tally of all compensation and on-site restoration.

This outcome was based on the use of ratios, which can make up for a discrepancy in habitat quality and thus support a NNL or NG goal [18]. For Sparling Ranch, only four permits stated clear mitigation ratios. These included 3:1 or 2:1 for permanent impacts, 1:1 or 0.75:1 for temporary impacts, or 1:1.98 due to habitat quality without a detailed explanation. A total of two cases required less compensation than the acres impacted but gave no explanation. For Dutchman Creek, only one permit required the exact impacted amount to be compensated for (1:1). Most permitting documents clearly stated a ratio but offered no explanation (ratios such as 2.2:1, 2:1, 1.16:1, and 1.34:1). Only one permit chose ratios based on the impacted habitat type and the duration and type of the impact (e.g., a negative ratio of 0.1:1 for temporary impacts to California Tiger Salamander upland habitat and 5:1 for permanently trenching aquatic habitat). CDFW permits often state that the required compensation is 'based on factors including an assessment of the importance of the habitat in the project area, the extent to which the covered activities will impact the habitat, and CDFW's estimate of the acreage required to provide for adequate compensation'. However, none of the permits clearly explained the reasoning behind the applied ratios. A standardized method [55] with set indicators (e.g., habitat quality, duration of the impact, time lag) could provide more clarity for permittees and inform an evaluation of the banking program when used in combination with suitable metrics.

The agencies do not distinguish how a credit has been developed (e.g., whether by creating a new habitat or preserving an existing habitat) in crediting. This can be problematic for NNL, as a credit developed by the protection of existing habitat is an 'averted loss' offset, which by definition cannot contribute to a NNL goal in the short term [1,56]. However, the agreement among practitioners is that banks generally provide higher quality habitat than the impacted habitat [44] and the results of two case studies show an overall gain in habitat acreage. Still, with the available data, it is not possible to confirm that the protection and management of existing habitat in banks provide sufficient additional conservation outcomes to fully make up for the loss of the habitat at the impact site. The issue is that neither quality nor ecological equivalence of losses and gains are reflected in the current credits. The degree to which metrics and quantification methods in the case studies reflect key aspects of equivalence is explored in the following section.

3.2. Metrics and Equivalence

Conservation banks conserve and manage listed species habitat and receive species- or habitat-specific credits for these actions. As mentioned before, 1 credit usually equals 1 acre. Behind this measure, the metrics and methods used to determine the suitability of habitat for bank credits (e.g., which acres count as breeding habitat) seem to vary across banks, species, and regions and are often not transparent [44]. Quétier and Lavorel (2011) review offset metrics in the context of their regulatory settings, including those for conservation banking [11]. They find that the target biodiversity component is species, that indicators are not predefined, and that some metrics consider a landscape component, but temporal loss or uncertainties are not considered. My case study results below mostly align with these findings:

3.2.1. Ecological Equivalence

All conservation banking credits are sold to compensate only for impacts to a single or multiple target species (in-kind compensation), and some even distinguish between several habitat types for a single species: For example, CDFW distinguishes between 'upland' and 'breeding' habitat credits for the California Tiger Salamander. The ecological targets for Sparling Ranch are California Red Legged Frog habitat, and aquatic and upland habitat for the California Tiger Salamander. Dutchman Creek has multiple ecological targets: Preservation of vernal pool habitat occupied by Vernal Pool Fairy and Tadpole

Shrimp, Conservancy Fairy Shrimp habitat preservation (partially occupied), California Tiger Salamander upland and breeding habitat, upland habitat for San Joaquin Kit Fox, Burrowing Owl, and Swanson's Hawk. Although some factors in determining the habitat type are clear (e.g., all habitat within 0.7 miles of a known breeding pond is potential aquatic breeding habitat for the California Tiger Salamander), others are not (e.g., which criteria define upland habitat for the San Joaquin Kit Fox). The target biodiversity is species habitat, but habitat feature, the condition of the habitat, or the occupancy and abundance of species is not reflected in the crediting. These factors do play a role in the bank approval process: Banking documents explain why habitat is credited (e.g., vernal pool hydrology, observation of larvae, species composition) but the factors included appear to be bank-specific. Banks also establish a baseline and provide monitoring plans, but the target is not to improve the established baseline. In general, the way the bank contributes to species recovery is not stated in bank management, maintenance, and monitoring goals. The documents describing credits do not link metrics or credit amounts directly to the bank's contribution to species survival and recovery.

I observed a similar situation on the permitting side: The FWS impact analysis, which generates the compensation requirement, analyzes whether the proposed action jeopardizes the continued existence of the species, basing this analysis on:

- Species status and range-wide conditions,
- Factors affecting these conditions and recovery needs,
- A baseline of the condition in the project area (incl. factors responsible, relationship of the area to recovery and survival),
- Effects, indirect and direct impacts of the project, and
- Cumulative effects (combined impacts of current and future activities).

However, this analysis does not result in a measure of the effects of the actions on species recovery, or a measure of how exactly compensation can mitigate such impacts. While they are both measured in credits defined as acres, there is no similar equivalence in measurement between habitat lost at the impact site and habitat gained at the credit site. CDFW permits often require that all impacts on species be fully mitigated, but do not state the number of individuals 'taken' (killed, harmed, captured, shot, etc.). FWS attempts to do so but often clarifies that the numbers are estimates, used to identify a threshold at which the permittee must seek a new permit. Also, the compensation requirements on the permitting side are often based on best professional judgment [57]. Agency staff may require a permittee to buy credits from a specific bank, because they deem this bank to be the most suitable option in terms of habitat quality, but this process is not documented, as it takes place after the permit has been given [57]. This makes it challenging to evaluate equivalence in losses and gains beyond habitat acreage. Overall, the difference in habitat quality between the impact and the bank site or its contribution to species conservation is unclear, as neither assessment uses a baseline to measure losses and gains in more detail than lost or gained habitat acreage.

3.2.2. Spatial Considerations

To maximize ecological outcome, offsets should be implemented in a landscape context, e.g., to consider habitat connectivity, meta-populations, and overall conservation objectives [58–61]. Each conservation bank has a service area, a geographic area in which impacts that occur can be compensated through credits from that bank. This establishes a spatial relation between the impact and the bank site. Sparling Ranch uses the recovery unit (a spatial management unit crucial for species recovery) outlined in species recovery plans to set its service area. The reasoning behind the size and location of the Dutchman Creek bank's service area was not analyzed due to limited document availability. However, the service areas for California Tiger Salamander, vernal pool species, and San Joaquin Kit Fox covers part of the range information listed in the FWS ECOS database [62]. Whether landscape-scale consideration affected the site selection of the bank or was considered in any of the metrics, is not clear.

The information contained in the permits for the impacts rarely refers to the landscape context; instead, the permitting agencies rely on the bank service area to limit the compensation to an appropriate landscape context. As the bank selection process is not documented in the impact permits, I could not say whether spatial considerations other than the service area play a role. Bezombes et al. (2017) consider examples where the relation to the offset location or the role of the impact site for species distribution affects the ratios [24]. However, almost none of the ratios in the analyzed impact permits came with a clear justification.

To further consider a landscape context in crediting, Regional Habitat Conservation Plans (large-scale plan for future development to obtain an ESA permit early on), as well as species recovery plans, can provide useful data sources [47,61]. In addition, different methods to assess habitat value based on connectivity or spatial conservation priorities already exist [19,52] and can provide a basis for evolved conservation banking metrics.

3.2.3. Temporal Dynamics

Temporal loss describes a time lag in habitat restoration when the compensation project is not functional by the time the impact occurs. Some temporal loss is avoided by establishing a bank before developers can purchase credits, and credits generally need to be purchased before the impact occurs. In one permit case, the required compensation was adjusted with an increased ratio, as previous permit requirements had not been met by the permittee. Another relevant aspect is that the Sparling Ranch credits are not all based on species occupancy (e.g., suitable California Red-Legged Frog habitat credits). The Dutchman Creek conservation bank monitoring report includes species occupation and breeding success of California Tiger Salamanders. However, credits at both banks are released for sale when the endowment fund to finance bank management has been established and is not based on performance criteria. Many banks follow this process. Therefore, banks do not measure an additional conservation outcome before the impact occurs. These crediting schedules only preclude risk based on financial uncertainties.

3.2.4. Uncertainties

With any ecological restoration and preservation project, uncertainties (e.g., due to climate change, lack of knowledge on species behavior) can lead to project failure. To reduce this risk of failure, the California conservation banking program requires financial securities (endowment funds) and/or plans for remedial actions [44,50]. It also requires adaptive management, an iterative management process including monitoring to reduce uncertainties over time [ibid.]. However, uncertainties about the conservation outcome of the project or the potential failure of the project are not addressed in the quantification methods or metrics for bank credits or the impact assessment. When determining the number of individuals approved to be impacted under the permit, some FWS permits clarify that estimates are used. Carreras Gamarra and Toombs (2017) found that while credit ratios are used for many purposes, only 12% of analyzed banks rely on ratios to manage the risk of failure, which seems inadequate, as banks are not legally responsible in the case of force majeure events (e.g., natural disasters) [50]. However, ratios can be used to reach at least NNL by contributing to additional conservation outcomes [18].

In the case of Sparling Ranch and Dutchman Creek, a performance security analysis was not required by CDFW, but adaptive management is included to deal with unforeseen changes and adapt the management plans when necessary. The management at the case study banks includes removal of fish, cattle fencing, vegetation management, and grazing in upland habitat, but the success of these measures is not a prerequisite for credit release and so the uncertainty associated with the management plan is not addressed. Credit releases for conservation banking are mostly based on the banks performing certain management actions (endowment funding, signing a conservation easement) and not outcome-based, as Cochran et al. (2011) suggest [25]. The program needs to move towards performance-based crediting (or at least performance-based indices used to certify the acres in production) to ensure success and allow for a quantification of conservation benefits and to avoid temporal losses. Metrics to assess bank crediting could also include risk viability factors, such as the influence of adjacent land, contamination, or invasive species [52]. Some of these factors are already addressed in bank management and monitoring, but not consolidated into a risk assessment for the bank.

4. Discussion

4.1. Conservation Banking Credits and Metrics

In the previous section, I showed that there is a gain in habitat acreage created in the two banks, but the equivalence of the losses and gains besides habitat type and size is not reflected in the metrics or credits. There is also no data explaining how this relates to the overall goal of the ESA: Species recovery. The contribution of banks to species recovery should be measured in the metrics but is not. Below, I explore which parameters could be used to reflect the conservation status of the species when measuring losses and gains and discuss the difficulty of using comparable, standardized metrics due to data availability, accuracy, and operationality.

The scope of species covered by the ESA makes the selection of suitable metrics that reflect the overall policy goal of species recovery challenging. The conservation status of different species is affected by different factors. Therefore, acreage alone as a proxy does not reflect all aspects relevant for species conservation, making it impossible to measure the overall success of the program in reaching policy goals. California conservation banks cover many different animal and plant species and associated habitat types. In 2017, all US banks listed in RIBITS covered 77 species [50]. Whereas some species occur in only 1–3 banks (e.g., San Joaquin LeConte's Thrasher, Delhi Sands Flower-Loving Fly, San Bernardino Kangaroo Rat), others occur quite frequently: Burrowing Owl, San Joaquin Kit Fox, Swanson's Hawk, California Tiger Salamander, California Red Legged Frog, as well as vernal pools and associated shrimp species. The credit types are often grouped (e.g., Swanson's Hawk and San Joaquin Kit Fox) and in some cases are distinguished by species occupancy. When credits also count as wetland mitigation credits, they may be differentiated by management focus (preservation, establishment, enhancement, restoration). This leads to an almost infinite combination of credit types, making the use of measures besides acreage somewhat difficult. Marshall et al. (2020) find that simply using suitable habitat acreage likely fails to provide NNL and that the benefits of offsets are species-specific, which makes considering multiple species rather complex [63]. Still, to allow for an evaluation of the conservation banking program, we need comparable metrics behind the unit measure that reflect the conservation status of the species.

To assess the effects of an impact or a compensation site on the status of a species, it is first relevant to know which factors affect a species. For conservation banking, recovery plans already provide specific objectives for each species. I reviewed major threats, recovery objectives, and factors considered for the federally listed species covered by the two banks analyzed above [62], and which habitat quantification tools already exist for these species, and which factors are included therein [51]. The quantification tools focus on species presence, abundance, habitat or population connectivity, and risk as relevant factors, which are also listed in species recovery plans. All but one of the methods for these species listed in the USGS database can also be used to assess impacts, allowing for a comparison of debit and credit. Overall, habitat loss and degradation are major threats for all target species [62], making habitat acreage one suitable proxy. In addition, pollution and contamination, diseases, invasive species, road mortality, inadequate grazing, and climate change are additional threats [62] that should be accounted for when assessing the value of credits at a bank site. Some of them, e.g., invasive species management and grazing, are already integral parts of bank management plans, but are not reflected in crediting. Species recovery objectives and criteria (listed in recovery plans) rely on protected and managed habitat, species distribution, population sizes, and resilience [62]. These relevant factors are also recommended by the European Commission to measure compensation:

For measures to ensure the favorable conservation status of protected species population dynamic, distribution area, sufficiently large habitat, and long-term survival prospects are relevant [64].

Banks contribute to protecting habitat and likely also to other recovery objectives, but only the size of the protected habitat is reflected in credits. FWS five-year reviews of the conservation status of the covered species status list many bank sites as places of species occurrence. This shows that banks contribute to protecting and managing crucial habitats. However, this contribution is not reflected in the assessment system for certifying credits. Considering that bank instruments and monitoring reports already include baseline conditions (but usually do not set a clear goal of improving that condition), monitor overall habitat quality as well as invasive species, species abundance, or occurrence, it is not clear why these baselines and other data points are not reflected in the way credits are assessed and awarded.

4.2. Challenges to Standardized Metrics

To use this data already collected by conservation banks, several metrics and quantification tools already exist. Bunn et al. (2014) introduce a metric to assess the conservation value of conservation banks which includes their size, connectivity, habitat diversity, and regional conservation planning [47]. However, they found that site assessments only provided some of the necessary information for their evaluation method and had to rely on regional conservation planning. The data Bunn et al. (2014) use is likely not available for impact sites to assess the ecological damage in comparison to the value provided by conservation banks [47]. As Barral (2019) points out, habitat quantification tools applied in Habitat Credit Exchanges (another market-based program that credits private landowners for undertaking conservation activities) under the ESA provide increased accountability: They focus more on habitat quality and restoration (using quantity and 'functional acre' along a gradient from the initial state to the resulting state) [31]. To see which other methods are already available, USGS provides a useful database. For California alone, the database lists 26 quantification tools applicable to species and eight tools applicable to habitats [51].

So, with all these methods available, why do banking practices not apply more of these tools? With the availability of species recovery plans, why does banking practice not focus on more factors that influence recovery? With banks already establishing baselines and providing monitoring reports, why is this data not included in the crediting? Barral (2019) finds that conservation banking uses 'simple metrics as a result of coordination issues' (n.p.) due to the harmonization of procedures [31]. More research may be needed to identify and solve such coordination issues. The reasons for not standardizing more sophisticated metrics may lie in the challenge of managing trade-offs between comprehensiveness (must reflect policy requirements), operationality (must be usable in practice), and scientifically sound measures [24,30]. Comprehensiveness and scientific basis especially are facing uncertainties relating to species ecology (e.g., understanding what factors affect a species conservation status in what way). Even if this is understood in one region, it may not be applicable in another. For example, the central coast population segment of California Tiger Salamander is well understood, and researchers and agencies have developed a habitat valuation method [27,57]. However, California Tiger Salamanders in the Central Valley live in a different eco-region and their ecology is not so well understood, which is why the method is not applied there [57]. White et al. (2021) also identify a lack of species knowledge as a major challenge in conservation banking. Therefore, more research is needed to understand the ecology of listed species. To increase data collection and gain knowledge on species occurrence, or support monitoring at banks, environmental DNA (eDNA) might be used [65,66]. eDNA is defined as 'genetic material obtained directly from environmental samples (soil, sediment, water, etc.) without any obvious signs of biological source material' [65] (p. 4). However, while the presence of a species can be shown, abundance can only be roughly estimated at this point, and size and age cannot be identified (making statements on reproduction rates or population structure impossible with this method) [67,68]. But further research or combining e-DNA with fieldwork might change this. Another challenge might be the conversion of an ecological value to the traded unit measure. For example, the California Tiger Salamander habitat value method focuses on the reproductive value as the core proxy for PRM and impact assessment, but for banking still assigns credits based on acreage.

Bezombes et al. (2018) suggest a framework to select relevant indicators to find metrics that are operational in practice, scientifically sound, and comprehensive [30]. This should include all key aspects of equivalence. Such an approach could be used to establish a more comparable method for US conservation banking, based on factors that can affect species recovery. Relevant factors must then be selected for each species and converted into a tradeable unit (credits). Even if the 1 credit = 1 acre unit measure did prevail, banks should transparently show which ecological indices were used to certify the acres in production. Using a baseline to measure additionality would also be an improvement. Most importantly, the selected metrics should reflect the overall policy goal and allow for a comparable measurement of the total amount of losses and gains. Finally, a transparent database that links the data on RIBITS to relevant impact permits could simplify tracking overall program performance. However, banking already requires large upfront investments from bank sponsors [44,53], and more detailed metrics may be perceived as an additional barrier to bank establishment. Despite this, a study on wetland mitigation banks found that policies dictating the release of credits did not affect market participation [69]. Overall, greater tool standardization in combination with increased transparency may increase participation in the conservation banking program [27], and could lead to program improvement and a much-needed assessment of its success.

5. Conclusions

The main objective of this article was to find out whether the gains from conservation banking equal the losses caused by impacts in terms of habitat acreage and ecological value. Results show that banks 'overcompensate' in comparison to impacted acreage, but the actual contribution to species conservation is not measured. In addition, many banks conserve habitat (which may be of higher quality than impacted habitat), but the additional conservation outcome is not quantified. Banks already provide a baseline in their documentation and conduct monitoring of species abundance and habitat quality, but they do not use it to measure conservation gains. This could be a good starting point to show conservation gains at bank sites and compare them to losses, not only in terms of acreage but also habitat quality and contribution to species conservation. Conservation banking metrics need to reflect the target species as well as the overall policy goal [13]. The same metrics should then be applied to measure impacts to allow for a comparison of gains and losses in terms of their effect on species recovery.

More than 10 years ago, Schwartz (2008) stated that in terms of the success of the Endangered Species Act, the status of many listed species has improved [70]. However, the contribution of conservation banking to the recovery of species is unclear. None of the species covered by the banks analyzed in this article have been removed from the lists of threatened or endangered species or reclassified [62]. Banks are clearly not the only instrument for achieving the goals of the ESA, and species may be adversely affected by actions not subject to impact permits, making permitting and banking just one piece of the puzzle. However, the five-year reviews for most of the species and their recovery plans recommend additional habitat protection and management, e.g., through conservation banks. The banks analyzed here not only provide protection of species occurrences, but banks can also help alleviate federal funding issues as outlined by Evans et al. (2016) by providing a private protection mechanism [71]. Furthermore, banks may also provide benefits to species that are not (yet) listed. Conservation bank sponsors already describe an environmental baseline (as do impact permits), frequently survey individuals, and monitor habitat status and management actions. Therefore, they already collect data that could be used for more detailed metrics to quantify conservation outcomes.

Banks also contribute to actions outlined in species recovery plans by protecting and managing habitat (e.g., through vegetation and invasive species control). Transparent tracking of impact permits and conservation banks based on metrics that reflect the policy objective could allow for an evaluation of this contribution to species recovery. Potentially relevant factors for metrics could be collected in a catalog, considering species-specific needs and operationality. Using such semi-standardized metrics to evaluate the California conservation banking program would contribute to reducing uncertainties regarding the success of offsetting programs. The initiation and enforcement of such a framework may require more agency resources [72], but the newly collected data could enable public research assessing conservation banking and the overall ESA policy. Such policy monitoring could then inform the policy cycle and provide long-term improvements to offsetting policies and species conservation.

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