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Monitoring Effectiveness of an Operational Project on Two Threatened Landbirds: Applying a Before–After Threat Analysis and Threat Reduction Assessment

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Abstract: Human activities are at the origin of anthropogenic threats altering ecosystems at any hierarchical level. To mitigate them, environmental managers develop projects to obtain effective outcomes on biological targets of conservation concern. Here, we carried out two new approaches (TAN = Threat Analysis and TRA = Threat Reduction Assessment) aimed at assessing the effectiveness of conservation actions on two threatened beach-nesting landbird species, the Kentish Plover (*Charadrius alexandrinus*) and the Little Ringed Plover (*C. dubius*), breeding along a coastal beach of central Italy. Using a score-based evaluation (TAN approach), a panel of experts assessed the extent, intensity, and magnitude of a set of species-specific threats, ranking them from more to less impacting. Domestic dogs, dune trampling, and synanthropic predators appeared as the threats with the most significant magnitudes. Using the TRA approach, experts obtained a rank of threats that were more urgent to solve: i.e., domestic dogs and dune trampling. To contrast with these threats, in 2021, we carried out a conservation project with specific measures that were aimed at reducing the threat magnitude on birds. They included: dune borders demarcation, anti-predatory cages on plover nests, the removal of beach-stranded fishing lines and hooks, field surveillance by volunteers, dog control, social- and mass-media communication, and alliances with stakeholders and institutions. After the project, mechanical beach grooming (>80%), dune trampling, and synanthropic predators (both >60%) showed the highest percentage of impact reduction. The project showed a medium–high level of effectiveness in reducing the total threat magnitude (TRA-I index = 63.08%). The Threat Analysis should be routinely used to arrange a causal chain that is useful for defining the relationships among human-induced threats and ecological targets, selecting the threats with the highest magnitudes. After the projects, the Threat Reduction Assessment may assess the level of threat reduction, suggesting measures for adaptive management.

Keywords: causal chains; TRA-I index; *Charadrius alexandrinus*; *Charadrius dubius*; magnitude; effectiveness; adaptive management

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1. Introduction

Human activities trigger a series of factors and processes (named anthropogenic threats [1,2]) that are capable of altering ecosystems at any hierarchical level (populations, communities, landscapes, and processes), at different spatial and temporal scales [1]. Recently, these human-induced processes have been classified in taxonomic categories (urban settlements, agricultural and aquaculture, energy production and mining, transportation and service corridors, biological resource use, human intrusions and disturbance, natural system modifications, invasive and other problematic species and genes, pollution, and climate change and severe weather), each with many sub-categories of specific threats [2].

To mitigate the impacts of human-induced threats on biological targets of conservation concern (population/species, communities, ecosystems, and ecological processes), environmental managers develop projects and actions (hereafter, "measures" [1,2]) to obtain effective outputs and outcomes [3].

In this regard, to assess the effectiveness of measures, managers use specific biological indicators to compare before–after changes in these targets [4,5]. However, the monitoring of the project effectiveness, focusing only on biological targets, may show points of weakness due to the long response times of animal and plant species and communities. Moreover, the effects of conservation measures on biological targets are often observable at different spatial scales, due their eco-behavioral patterns [6]. To overcome these weaknesses, Salafsky et al. [2] suggested that managers should focus the monitoring not only on biological targets, but also on human-induced threats, partially shifting the focus from the status of the biological targets to the pressures induced by the anthropogenic threats (see the Driving forces-Pressure-State-Impact-Response—DPSIR—framework [7]). In this regard, any threat could be quantified using specific regime attributes (extent, intensity, duration, frequency, and so on) [8–10], e.g., for shorebirds [11].

The assessment of threat regime is expert-based. When compared to biological monitoring, threat monitoring shows interesting points of strength, since an expert-based evaluation (based on the local expertise of practitioners and managers) may be conducted, having available short times and reduced human, economic, and technological resources. This fact is particularly strategic, since time and economic resources are often scanty in conservation [1]. Moreover, for a cost/benefit balance, these strengths may overcome the points of weaknesses in this type of evaluation (as the lack of analytical data to understand the severity of threat magnitude [12]).

To carry out an expert evaluation of human-induced threats, project managers and practitioners use the IUCN approach of 'Threat Analysis' (hereafter, TAN), assigning a standardized code and providing a quantification of human-induced events impacting on specific local conservation targets [13]. This approach is useful for defining threat-specific measures. The relationships among targets, threats, and conservation measures allow for the building of conceptual frameworks, including all of the components of these cause–effect relationships [1]. Moreover, experts may assign a score allowing for an assessment of threat regime, i.e., of the extent, intensity, and magnitude. In this way, it will be possible to obtain a ranking among threats (from the most to the least impactful), defining priorities among them (i.e., threats deserving to be solved with urgency), and therefore supporting decision-making [2]. The quantification of threat regimes using scores may also be used to carry out a before–after comparison to monitor whether specific threats have been significantly reduced by the project, and therefore, to assess the effectiveness of measures [14]. With this expert-based procedure (named Threat Reduction Assessment; hereafter, TRA; [15]), the project team obtained a synthetic value (TRA-I index) expressing how much the human-induced threats have been reduced once the conservation measures have been completed [16–20].

In this paper, first we carried out a TAN on a case study representative of a conservation project focused on two threatened beach-nesting plover birds of high conservation concern (Kentish Plover, *Charadrius alexandrines*; Little Ringed Plover, *C. dubius*), breeding in a coastal Special Protection Area of central Italy. These two species showed a strong decline in the last few decades, mainly due to the action of anthropogenic threats acting on their breeding sites. Therefore, analogous to many other threatened shorebirds, conservation actions carried out on these species have been focused on breeding successes in nesting areas [21].

For this purpose, we identified a set of threats locally acting on these targets, to the aim of building a conceptual framework, with driving forces-threats-targets as causal chains. This framework will be useful for defining threat-specific conservation measures. We quantified the threats using scores assigned by a panel of experts to obtain a ranking in extent, intensity, and magnitude, i.e., three attributes of its regime [2]. After TAN, we developed a conservation project with a set of specific measures oriented toward the reduction in human-induced threats. Finally, we performed a TRA procedure to monitor the level of threat reduction obtained through the project [14,15,20,22]. Therefore, using these approaches, our aims were to respond to these two questions. First, what are the threats that have the greatest impacts (expressed in total magnitude) on our conservation targets (bird plovers)? Second: what has been the overall effectiveness of our measures carried out inside this specific conservation project? To our knowledge, this is the first application of both these two approaches (i.e., TAN and TRA) in a coastal Mediterranean site, hosting habitat types of conservation concern (embryonic shifting dunes), and two rare bird species [23,24].

2. Materials and Methods

2.1. Study Area

The study area (Torre Flavia wetland—"Special Protection Area", SPA n. IT6030020) is located on the Tyrrhenian coast (Ladispoli, Rome, Central Italy, 41.57′ N; 12.02′ E, Figure 1). In this SPA, >40 species included in Annex 1 of the EC 147/2009/"Birds" Directive occur. The present wetland (about 43 ha) is a remnant of a larger area that was recently drained and transformed [25]. The coastline shows a high degree of ecological interest, including a landscape mosaic of wetlands with reedbeds and rushbeds, surrounded by coastal dunes and characterized by typical coastal habitats classified in accordance with the 92/43/EC "Habitat" Directive' (European Commission). Among them, the most commonly represented are the embryonic shifting dunes (Habitat 2110), characterized by the dominance of *Thinopyrum junceum, Cakile maritima, Anthemis maritima, Pancratium maritimum, Salsola kali, Echinophora spinosa, Eryngium maritimum*, and others [26,27]. These dunes host threatened animal species, also of continental (European) interest, such as the loggerhead turtle (*Caretta caretta*, Annex 1, 92/43 "Habitat" Directive) and plovers (Aves Charadriidae, with the Kentish Plover, *Charadrius alexandrinus*, being included in 147/2009/EC "Birds" Directive) [25,28,29].

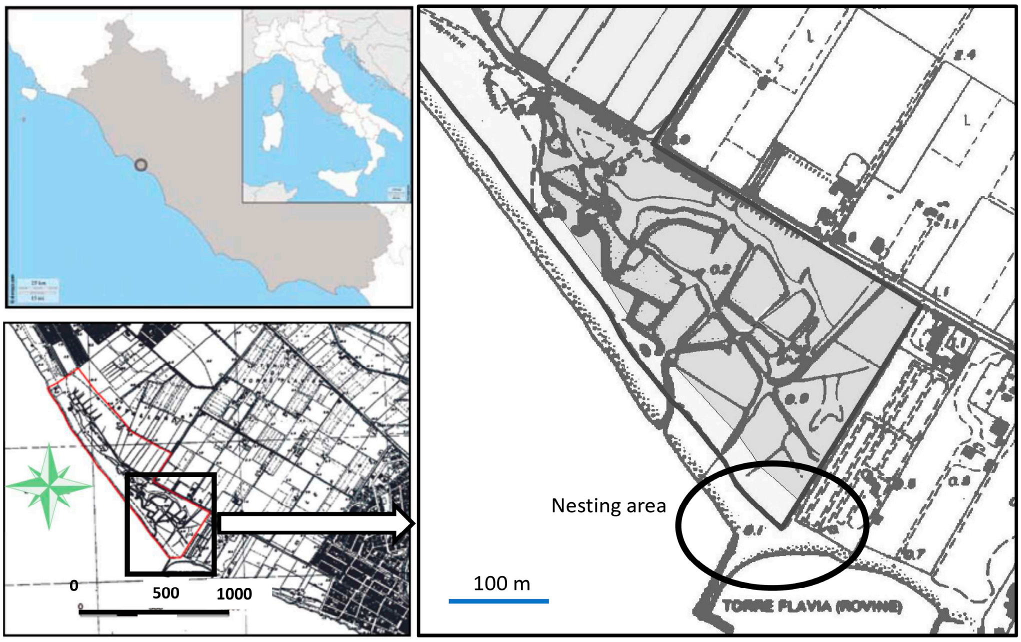

Figure 1. Map of the study area. Top left: geographical location at regional and national levels. Bottom left: "Palude di Torre Flavia" Special Protection Area (SPA; Rome, central Italy; in red color: perimeter of the protected area; source: Regione Lazio—Technical Map having a grid of 1 km × 1 km-wide units). Right: southern sector of the SPA with the nesting sites (circle).

The protected area is managed by a Public Agency (Città Metropolitana di Roma Capitale) that periodically carries out actions on conservation targets for mitigating anthropogenic threats (e.g., trampling on dunal plants) [14,28].

These coastal dunes are characterized by a conflict between high ecological value and high anthropogenic pressure (a high level of conflict, according to the classification of McLachlan et al. [30]). In this classification, the conservation level of the site may be compared to the level of recreation potential. In this case, our extensive beaches show a high index of recreation potential (i.e., easy accessibility, low bathing hazards, and little pollution, since the beach litter is periodically removed by volunteers). Regarding the conservation index, the beaches are well-vegetated (with halo-psammophilous plants), with little disturbance, hosting iconic nesting species of high conservation interest, with a rich macrobenthic diversity and abundance. The match between high recreation potential and high conservation level causes a high conservation conflict (sensu [30]), especially when the anthropogenic pressures overlap the nesting periods of threatened species (plover birds and *Caretta caretta*) in late spring and summer. Since 2017, some interventions have been commenced to protect the dunes from people trampling them, delimiting these areas with poles, ropes, and signs to increase public awareness of the value of these neo-ecosystems.

2.2. The Panel of Experts

Both the Threat Analysis (TAN) and Threat Reduction Assessment (TRA) procedures were carried out by the same qualified panel of experts. We selected 10 experts (managers, practitioners, and volunteers) belonging to local non-profit organizations (n = 8), and personnel belonging to the Departments in charge of national strategies for protected areas (n = 2). All of the experts participated in the selection and in the operational steps of the conservation measures adopted. Moreover, each one had a good degree of knowledge, both on the project site (coastal beaches, ecological values, and surrounding social context) and on the local threats, so that they had all of the evidence useful for conducting the threat naming, magnitude assessment, and ranking in priorities. All the experts had been involved in the conservation project, so they obtained all the information necessary to assess the management effectiveness, and to perform the TRA analysis.

2.3. Target Species

The conservation project focused on two beach-nesting bird species (Kentish Plover and Little Ringed Plover; Aves, Charadriidae) as targets in this case study (sand dunes in Torre Flavia SPA).

The Little Ringed Plover is a migratory species, wintering in Africa. Their breeding habitats are open gravel areas near freshwater, and secondarily, coastal dunes across the Palearctic, including North-Western Africa. They nest on the ground on stones with little or no plant growth (sandy beaches and muddy edges along rivers). This species is classified as 'Least Concern' in the IUCN list, and is included in the Conservation of African-Eurasian Migratory Waterbirds (AEWA: [31,32]). In Italy, the population of Little Ringed Plovers is estimated at 2300–4000 pairs, of which about 1000–1500 are found in the central-southern regions; in Latium (central Italy) in 2008, 42 breeding pairs were estimated, but also in this specific case, a decreasing trend of about 18–20% in number has been observed over the 2011–2014 period [33,34].

The Kentish Plover is a small Palearctic partially migrant shorebird, with some populations wintering in Southern Europe (e.g., Sicily) and Northern Africa [35]. Usually, to lay its eggs, the Kentish Plover prefers sandy dune areas consisting of low vegetation, often with nests positioned near halo-psammophilous plants, used to partially hide the eggs, mostly in habitats near water [36,37]. More particularly, this species follows a strategy of the early detection of predators, maximizing its visibility from the nest. Therefore, the selection of open sites with little or no vegetation cover responds to a trade-off between the detectability of predators, the camouflage of the nest against predators, and the thermoregulation of its eggs [38,39].

The Kentish Plover is a species listed in Annex II of the Bern Convention, and in Annex II of the Bonn Convention (IUCN category: Least Concern). Furthermore, it is a species considered as SPEC 3 (unfavorable conservation status in the European territory) by Birdlife International [32]. At a regional level, Biondi et al. [33] observed a decline of about 18–20% in breeding pairs during the 2011–2014 period.

At the European level, there was a large decrease in the number of individuals between 1990 and 2000 [40]. The Italian wintering population, on the other hand, is moderately stable [41], with populations having different migratory dynamics and phenologies. Nationally, a wintering population of 2400–3200 wintering individuals, and a breeding population of 1500–1850 pairs were estimated along the Italian peninsula, Sicily, and Sardinia [33,42,43].

In Latium (central Italy) in the early 1990s, the populations of Kentish Plovers were distributed in a basically stable manner along the coastline. From 1990 to 2016, a progressive decline was recorded, both in the number of breeding pairs, and in the nesting sites on a regional scale: from 36 pairs distributed in 12 nesting sites in 1993, to only 11 pairs in 3 nesting sites in 2016 [44,45], with very low breeding success over the last decade (<10%) [45,46].

2.4. Threat Analysis

We defined "threats" as "any human-related process that negatively affects the specific components of ecosystems (species abundance, species-specific habitat suitability, structural characteristics at community level as species richness, diversity index, evenness; ecosystem services) in a real context" [2]. In this work, we analyzed the set of threats to the focal species selected and locally acting in our study area. Threat nomenclature was carried out in 2021 using the IUCN unified classification of direct threats ("threat taxonomy") [2], where any anthropogenic threat factor or process has been named and coded [10]. Once assigned an IUCN code to any target-specific threat, we asked the experts the following questions.

First: what are the local threats acting on the two plover birds (targets) in the Torre Flavia SPA, and specifically, which can be reduced (mitigating their impacts) with a specific local project? To respond to this question, the experts analyzed all of the factors and processes acting locally on these two targets. After, these factors/events were named and classified using the IUCN coded nomenclature [10].

Second: what is the extent, severity, and magnitude of any threat? How can any threat be ranked in order of priority? To respond to this question, for each direct threat, the panel of experts assigned a score to two regime attributes (extent and severity) using a scale from 1 (low) to 4 (high). Among the different attributes, extent and severity (i.e., intensity as perceived by targets) seemed the easiest to calculate when using an expert-based approach [2]. 'Extent' can be measured as the proportion in species habitat that has been, is, or will be affected by the threat, when compared to the total surface available (all of the suitable area of habitat for the two focal species: i.e., locally, all the coastal dune system in the SPA [47]). 'Severity', as a proxy of threat intensity on the targets, constitutes an evaluation of the past, present, or future pressure, which are estimated to be caused by the threat event and that may affect the target, leading to an impact in our targets, i.e., a potential or real specific alteration [48]. After this step, the two scores of extent and severity, calculated for each threat, were summed to obtain a 'Magnitude' score, as a compound variable, representing a proxy of the threat pressure (and consequent impact) of any threat on the selected targets [2]. When the experts assigned scores to any threat attribute (extent, severity, and magnitude), we calculated their averaged values (and standard deviation). Finally, the experts ranked the threats when regarding the magnitude values, obtaining a list in decreasing order. The threats with the highest average value represented the priority threats. All the indicated threats manifested themselves with a yearly based regime articulated in time, space, and pattern: therefore, the assessments on the regime attribute (area, intensity, and magnitude) expressed by the experts refer to the 2021 project period.

2.5. Plover's Nest Detection

During the first period of the patrol, particular attention was paid to the search for "nest evidence"; with this term, we mean the "courtship scrapes" (or "nest scrapes"), i.e., small holes dug by the male in the sand, which could potentially turn into real nests when the females accepted them and laid the eggs inside them [49]. In this way, whenever nest evidence was found, it was georeferenced by saving the geographic coordinates. For bird sampling, Nikon Prostaff 3S 10 × 42 Waterproof binoculars were used.

Twice a week, in addition to repeating the patrol of the entire coastal strip examined in the two study areas, the previous nest evidence sites were also monitored to verify the possible presence of a real nest. Once the eggs were identified, each nest was signed and georeferenced by saving the GPS coordinates.

2.6. Conservation Measures

Since the early 2000s, the local Park Agency carried out a set of ordinary actions (fences, communication by panels, and direct control) without a specific project. During any year, these ordinary and periodic actions started in late winter and early spring, and they were focused to mitigate some of the threats acting on these two beach-nesting birds (dune trampling, dogs, and mechanical beach clean-up). After 2017, the park operators improved measures, also targeting volunteers and guards to control the plover nests. Lastly, in 2021, the Park Agency launched a local conservation project on both the species. Thanks to the TAN procedure, the operators obtained an arrangement of local threats, naming and ranking them, thus defining the priorities and suggesting standardized actions (measures). A TAN assessment was carried out in March 2021 before the start of the conservation actions. The formal process of reducing the threats within the project took place between January 2021 and autumn 2021.

All threat-specific actions were classified using the standard reported in [2].

This project involved different categories of measures.

Field operational actions: dune borders demarcation, assembling fences (IUCN category 2.1—site management) aimed to mitigate people trampling on halo-psammophilous plants and plover nests; the building and location of anti-predatory cages on nests (a wire metal mesh composed of a grid with 76.2 × 63.5 mm units) and of shelters in dunes (category 3.2—species recovery) aimed at protecting nest sites and clutches; the manual cleaning of beaches, conducted by removing fishing lines and hooks, a type of litter entrapping plovers (category 2.1: Monthly clean-up) [50]; clean-ups were conducted before the breeding period in January and February, and using a standardized protocol [51].

Surveillance and control: The Park Agency obtained the emanation of specific regulations (Municipality's Ordinances) that interposed the transit of dogs along the beach and the dunes during the nesting periods (category 5.2—Legislation, policies, and regulations; moreover, the Park Agency carried out training to improve skills and expertise in volunteers and guards (category 4.2—training courses and stakeholder education), which monitored the nests, controlling disturbances by people near the nests.

Communication was aimed at improving awareness in two categories of stakeholders (fishermen, as drivers for fishing lines and hooks entrapping plover birds, and dog owners: categories 4.1. and 4.3); these actions have been conducted, involving scholar students, sending messages to local radios, mass- (local TV and magazines) and social media, the reporting of information on panels along park paths, and distributing information leaflets to bathers.

Alliances with Institutions and Associations (category 7.2) aimed to provide some strategic actions (for example, blocking the mechanical clean-up of dunes: these last actions were promoted seasonally by the local Municipalities).

2.7. Threat Reduction Assessment

When the project was closed, we carried out a TRA procedure [15], submitting a set of questions to a panel of local experts in October 2021 [20].

We asked the experts the following questions regarding local threats: (i) what score (from 1 = low to 4 = high) would you assign to the attributes of area, intensity, and urgency (having in mind the effects on the two selected targets)? For 'area', we considered the extent of habitat(s) in the site that the threat affects; for 'intensity', we considered the effect (or severity) of the threat; and for 'urgency', we considered the immediacy of addressing actions against the threats [17], and (ii) how much would you assess the project's effectiveness (i.e., the reduction in each threat after the project, assessing a percentage score from 0 to 100)?

After each step, we collated the data, obtaining the averaged values (and standard deviation) for each threat regarding the area, intensity, urgency, and percentage reduction after the project.

From the averaged values, we ranked the threats according to their relative importance (from 1: the lowest, to 6: the highest). A total threat score was computed after all of the threats were ranked. Finally, we added the value of mean percentage reduction for each threat [15].

After the ranking and scoring exercises, the total ranking scores for each threat were multiplied by the percentage of the threat met to yield a raw score for that threat. The Threat Reduction Index (TRA-I) value was derived by dividing the sum of the raw scores for each threat by the total possible rankings of all the threats, and multiplying by 100, i.e.: TRA-I = total raw scores/total rankings $\times$ 100 (details in [15]). Thus, the TRA-I value indicates the response to all of the combined threats to the overall conservation project over the assessment period. All calculations were carried out using Microsoft Excel software for Windows.

2.8. Statistical Analyses

We used a score evaluation, obtaining the averaged values and dispersion measures. To compare the averaged threat magnitudes among >2 samples, we performed the non-parametric Kruskall–Wallis test for equal medians [52], obtaining H values using the PAST 1.89 software [53]. The alpha level was set to 0.05.

3. Results

3.1. Target Species and Threat Analysis

We found and brought under protection six plover nests, with 21 eggs laid (18 of Little Ringed Plover and three of Kentish Plover) and 8 eggs hatched (three of Kentish Plover and five of Little Ringed Plover).

Regarding the TAN procedure, the panel of experts identified the following human-induced direct threats: Fishing lines and hooks (IUCN category 9.4—Garbage and solid waste), Dune trampling (1.3—Tourism and recreation areas), Domestic dogs (8.2—Problematic native species), Synanthropic predators (2.2—Invasive/problematic species control, 8.2—Synanthropic predators), Mechanical beach grooming (4.1—Roads and infrastructures), all having specific driving forces (Figure 2).

The values of threat regime attributes showed as domestic dogs and dune trampling, and synanthropic predators appeared as the threats with the largest magnitude (Table 1; Figure 2). We observed a significant difference in magnitude among the threats ($H = 19.01$, $p < 0.001$).

Table 1. Threat Analysis (TAN) procedure. Mean values (and ±standard deviation) in regime attributes (area, intensity, and magnitude) for the human-induced direct threats selected in the 'Torre Flavia' Special Protection Area.

Threats	Area	Intensity	Magnitude
9.4—Fishing lines and hooks	2.1 (±0.88)	2.6 (±0.97)	4.7 (±1.57)
1.3—Dune trampling	3.4 (±0.70)	3.7 (±0.48)	7.1 (±0.74)
8.2—Domestic dogs	3.8 (±0.63)	3.7 (±0.48)	7.5 (±0.97)
2.2—Synanthropic predators	3.7 (±0.68)	3 (±0.94)	6.7 (±1.16)
4.1—Mechanical beach grooming	1.9 (±1.20)	4 (0)	5.9 (±1.20)

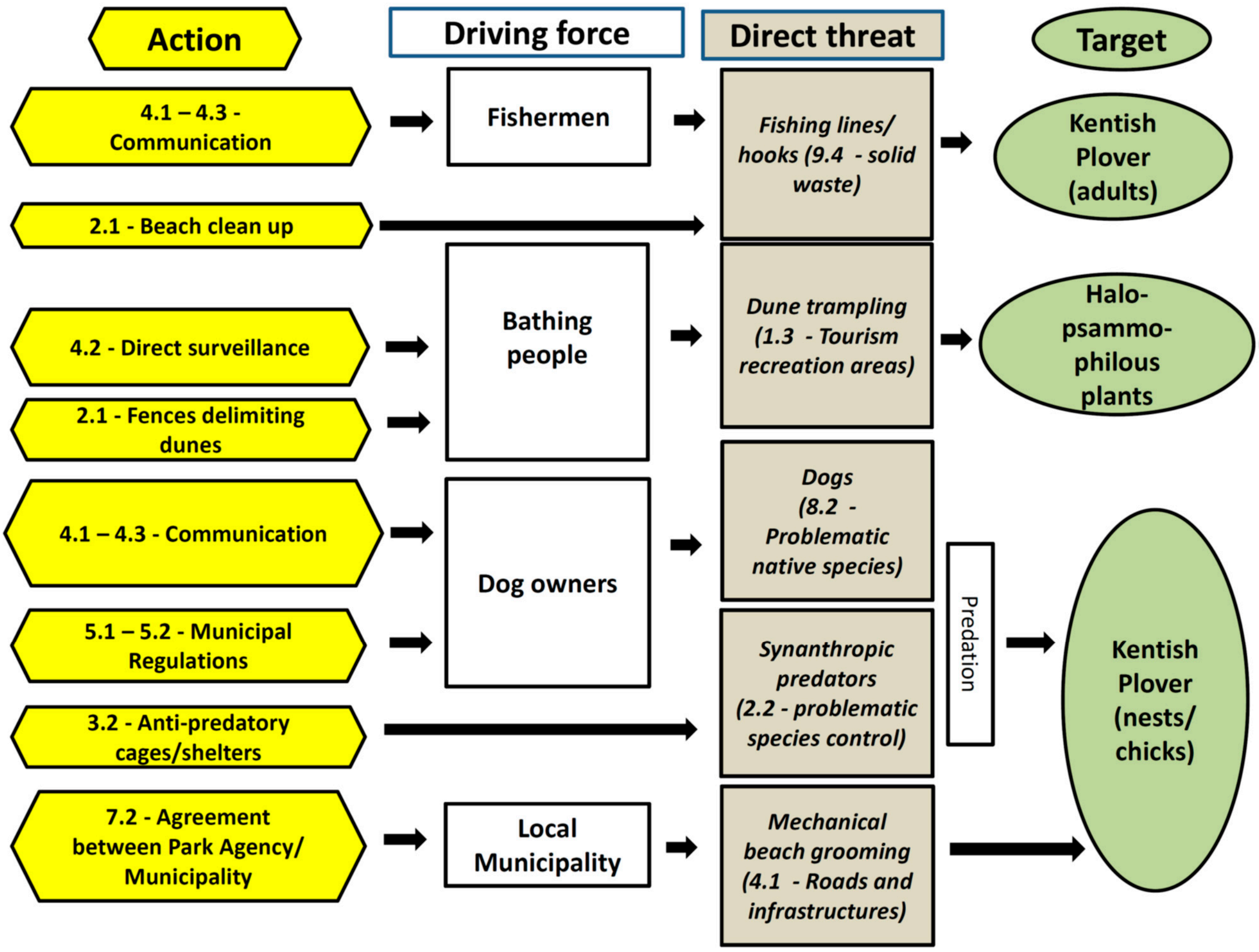

Figure 2. Threat Analysis (TAN) in the 'Torre Flavia' Special Protection Area, with causal chain driving forces (social actors, white boxes)—threats, (grey boxes)—targets (green circles), and measures (yellow hexagons). IUCN nomenclature of threats and conservation measures follows [8]; review in [10].

Direct threats differ significantly in extent and severity (both of them, $H = 14.18$, $p < 0.001$), with domestic dogs and synanthropic predators being the most largely diffused (extent), and with domestic dogs and dune trampling being the most intense (Table 1).

3.2. Conservation Measures

For any threat, a set of conservation measures has been carried out, as outputs of the project (Figure 2).

Field operational actions: along the coastline of the 'Torre Flavia' site, about 800 m of fences demarcated dunes to mitigate people trampling on halo-psammophilous plants and plover nests; moreover, we located six cages on active plover nests; we also built and located occasional shelters in dunes to protect nest sites and clutches; finally, from December 2020 to February 2021, we actively manually removed 5122 litter items stranded on the beach, among them, 106 (2%) were potentially entrapping materials (i.e., fishing lines and hooks); however, although these standardized clean-ups [51] removed a large amount of entrapping litter, these materials were continuously deposited after sea-storms and by fishermen, making a total clean-up of the sand dunes difficult.

Field surveillance and control: Seventy volunteers have been trained with a course conducted by professional ornithologists with a background in plovers (about 20 h of frontal lessons in a series of YouTube videos explaining the Plover's biology and techniques to approach people, improving their awareness; and providing a kit with an identification card, information leaflets for bathers (>5000 printed copies), and the Municipal Ordinances).

Communication (locally promoted or via social- and mass-media): We involved fishermen, dog owners, bathing people, and scholar students (five primary and secondary schools of Cerveteri and Ladispoli), explaining information about the nesting ecology of the two bird plovers, and the attentions to be kept at the dunes; to this purpose, we sent messages to the local radio (Radio Centro Mare), and mass- and social media (local TV and magazines: Il Messaggero, L'Ortica, Baraonda, and Terzo Binario), reporting information on small and large panels (n = 150) along park paths, and distributing information leaflets to bathers.

Alliances with Institutions and Associations aimed at providing some strategic actions: We blocked the mechanical grooming (i.e., cleaning) of beaches carried out by an alliance between ONGs (LIPU—Bird Life International; MareVivo, WWF—Italy) and the Municipality of Ladispoli. In this regard, the Municipality helps with change toward good dune management.

3.3. Threat Reduction Assessment

After the projects, a panel of experts carried out the TRA procedure, the assessing area, the severity and urgency of each threat, and obtaining the mean values (and standard deviation) for any attribute. The attributes were ranked and summed: domestic dogs and beach trampling showed the highest total rank (Table 2). Finally, experts assessed the percentage in threat reduction following the project. Experts assessed as mechanical beach grooming (>80%), dune trampling, and synanthropic predators (both >60%) showed the highest averaged percentage of impact reduction; fishing lines and hooks showed the lowest percentage of impact reduction (Table 2).

Table 2. Threat Reduction Assessment (TRA) procedure. Regime attributes of area, intensity, and urgency, and related ranks for the SPA 'Torre Flavia' Special Protection Area. Threat Reduction Assessment and procedure to calculate the TRA-I index. (1): Sum of ranking of area, intensity, and urgency. (2): Estimated percentage of threat mitigation over assessment period. TRA-I index = Σ (raw score/total ranking) × 100 = 63.08%.

Threats	Area	Rank	Intensity	Rank	Urgency	Rank
9.4—Fishing lines and hooks	2.1 (±0.88)	2	2.6 (±0.97)	1	2.8 (±1.03)	1
1.3—Dune trampling	3.4 (±0.70)	3	3.7 (±0.48)	3	3.9 (±0.32)	5
8.2—Domestic dogs	3.8 (±0.63)	5	3.7 (±0.48)	3	3.9 (±0.32)	5
2.2—Synanthropic predators	3.7 (±0.68)	4	3 (±0.94)	2	3.1 (±1.45)	2
4.1—Mechanical beach grooming	1.9 (±1.20)	1	4 (0)	5	3.5 (±0.85)	3

Threats	Criteria Ranking			Total Ranking [1]	Percent Threat Reduced [2]	Raw Score
	Area	Intensity	Urgency			
9.4—Fishing lines and hooks	2	1	1	4	49.5	1.98
1.3—Dune trampling	3	3	5	11	69.0	7.59
8.2—Domestic dogs	5	3	5	13	49.0	6.37
2.2—Synanthropic predators	4	2	2	8	60.5	4.84
4.1—Mechanical beach grooming	1	5	3	9	84.5	7.61
				45		28.39

The procedure showed a total TRA-I that was equal to 63.08%, considering all of the threats affecting the target birds. Domestic dogs and dune trampling appeared as the threats that were most urgent to solve.

4. Discussion

Our study highlighted how the anthropogenic threats on the selected target species (plover birds) were due to three main categories of social actors (i.e., fishermen, bathing people, and dog owners), all acting as driving forces.

Moreover, domestic dogs and people trampling represented the human-induced threats with the highest magnitude on plovers, consequent to the high pressure of bathing people on these fragile ecosystems. The disturbance from the uncontrolled frequentation of beaches by people may impact on halo-psammophilous dunal plants [24,54], important resources (shading, shelters, and nesting materials) for nesting plovers, and therefore, on their behavior and breeding ecology [35], also leading to the destruction of nests and eggs [55–58].

Domestic dogs also constitute a stress factor, since they act as predators on eggs and chicks, or they disturb the hatching adults. In this last case, when dogs are present near the nests (approximately < 15 m), plovers can move away from the nest, exposing it to the predation of eggs/chicks or to sun exposure, and compromising the hatching success [59].

To mitigate dune trampling and the presence of domestic dogs, the project team developed a set of actions that have greatly reduced the impacts of these threats (communication for dog owners, fences, and cages on nests), as observed using the expert-based TRA procedure. We assumed that our efforts mitigated the magnitude of these threats. However, to confirm this assumption, a sampling design using 'control' areas (where plovers are present, but where no conservation actions have been implemented) should be carried out as a before–after control-impact (BACI) design [60]. Indeed, in our case, no comparable 'controls' were available within the surroundings.

The frequentation of fishermen is at the origin of the accumulation of fishing lines and hooks on the beaches, a type of litter entrapping birds [50]. We actively removed this litter before the nesting period of plovers (December–February periods [61]). Nevertheless, since the continuous deposition of litter by sea-storm events, and the presence of fishermen that abandon fishing lines and hooks in situ, experts evaluated these removal actions as being poorly effective.

Natural predators (crows, gulls, rats, and foxes) constitute a further threat that is assessed by experts as being relevant. However, the presence of these animals is largely and indirectly linked to the frequentation of bathing people: indeed, abandoned waste locally attracts scavengers and synanthropic generalist species. Particularly, rats (*Rattus rattus*) represented the only species that were able to enter the cages to prey on the eggs, therefore explaining the predation, even in the presence of cages. Excluding these rodents could be a further improvement of the project, allowing for an increase in the hatching success of the plovers.

Finally, mechanical cleaning is another threat that is linked to the need to keep beaches aesthetically attractive for bathing people, but impacting on coastal biodiversity [62,63]. In our case, an alliance between the Park Agency and the Municipality of Ladispoli allowed for obtaining effective outputs, locally blocking the mechanical cleaning.

Once the project was implemented, a panel of experts assessed how effective this may have been on the target species, using the TRA procedure. The value obtained (>60%) suggests how these actions had a relatively high level of success, although experts assessed differently the level of effectiveness in impact reduction for any single threat. However, the results obtained by monitoring using the TRA-I index make aware to the experts that the project needs further adaption. More particularly, measures aimed at reducing people trampling (fences, ropes, and signs) and synanthropic predators (cages) were assessed with the highest scores (i.e., showing the highest level of effectiveness). Differently, fishing lines/hooks and domestic dogs appeared to be the threats with lowest reduced impact (<50% in effectiveness). The removal of fishing lines/hooks from the beach appeared difficult due to the low detectability of this litter, and for the continuous stranding to sea-storms [61]. In the second case, the opposition of dog owners (who do not comply with the Municipal regulations: Ordinance n. 5 of 22 February 2022, issued by the

Municipality of Cerveteri, and Regulation n. 14 of 1 April 2014, issued by the Municipality of Ladispoli) appeared to be difficult to overcome, and further communication aimed at improving the awareness of these stakeholders will be necessary to reduce polarization and conflicts. Instead, mechanical beach grooming showed a marked reduction thanks to the Municipalities of Ladispoli, who participated in actively blocking any mechanical impact on beaches and dunes (a high effectiveness in the alliance between NGOs and the Municipality).

The use of the TRA approach made it possible to obtain a percentage value (TRA-I), thanks to the involvement of a panel of expert evaluators. This evaluation has been used by the Public Agency for adapting and improving the local SPA management.

However, these expert-based procedures show some weaknesses. Indeed, a lack of analytical data may affect the general judgement [12]. Second, an assessment has been conducted by experts that are involved in projects, with all showing a high degree of local knowledge of the threat regimes (extent, intensity, and magnitude) and status of conservation targets: although it allows for a reliable expert-based assessment by scores, this fact could produce a bias towards the individual perception of these threats. When available, a 'control' team (showing a high degree of knowledge on local threats and targets) could independently assess the project, and the data between the groups could be compared. Third, breeding plovers are very rare on a regional scale: consequently, the data are very limited for statistical analyses. Indeed, in Latium (>5000 km^2 with a coastline of 361 km), considering a total amount of 36 eggs laid by the Kentish Plover, only three chicks fledged (8.3%) in 2016 [46], and in 2020, only six chicks fledged from 59 eggs (10.2% [45]). At the local level (SPA Torre Flavia), before our project (2020), we recorded only two pairs breeding (one of each species), with only one chick fledging from the Little Ringed Plover. After the project (2021), we recorded three eggs laid (two chicks fledged) of the Kentish Plover, and 18 eggs laid, with five hatched eggs and one chick fledged of the Little Ringed Plover. Therefore, as yet suggested by Salafsky et al. [2], in this case study, we carried out a quantification focusing on the results (i.e., the outputs in threat reduction due to project efforts), without a direct quantification of the outcomes on the target species.

Expert-based TAN and TRA approaches may show some points of strengths [64]. Moreover, in particular, (i) when time budget and economic resources are limited, (ii) where analytical measurements are impossible or difficult to carry out (and also due to the rarity of the targets; see previous), and (iii) where threats are difficult to compare among them, the use of expert-based approaches may provide first arrangements ([65], example in [11]), selecting the priorities for action, and facilitating the decision-making process in crisis operational contexts [1]. Moreover, with the TRA approach, we obtained first indications on the threats needing further effort, therefore facilitating the process of adaptive management [66]; in our case, this was carried out on focal targets inhabiting these highly sensitive conservation front lines [67,68].

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