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WP 1 Development of cross-border participative strategies in waste reduction

D1.5.1. Methodology for the implementation of meta-analysis and state of the art analysis of human behavior

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Document description	The Wastereduce project activities include the production of a systematic review and meta-analysis on the effectiveness of informative and behavioral interventions aimed at promoting waste-related pro-environmental behaviors in natural and protected areas. This document describes the methodology that will be followed to prepare the systematic review and meta-analysis, adopting a step-by-step specification. The methodology follows the PRISMA 2020 (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines and previous work in the field.			

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Executive Summary

The Wastereduce project activities include the production of a systematic review and meta-analysis on the effectiveness of informative and behavioral interventions aimed at promoting waste-related pro-environmental behaviors in natural and protected areas. This document describes the methodology that will be followed to prepare the systematic review and meta-analysis. The methodology follows the PRISMA 2020 (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines and previous work in the field.

Given the limited number of studies on the effectiveness of informative and behavioral interventions aimed at promoting waste-related pro-environmental behaviors in natural and protected areas, the systematic review will focus not only on studies targeting actual or self-reported behaviors, but also on investigations aiming to change behavioral intentions, which are moderately related with actual behaviors and considered as a proximal predictor of behavior by main theories of the field. The inclusion of intentions will allow obtaining more robust results. However, given the intention-behavior gap and potential biases in self-reports, the type of criterion variable (observed behavior vs. self-reported behavior vs. intentions) will be included as a moderator in the presentation of the results and/or in the analyses. Moreover, to appraise the generalizability of the effectiveness of the interventions, we will also include studies on waste-related behavior in *public urban spaces*, considering the type of environment (natural vs. urban) as a moderator in the presentation of the results and/or in the analyses.

Following previous work in this field, we will include the following types of interventions: (1) making behaviors easier to do, such as moving recycling bins to a more convenient location; (2) providing reminders of the appropriate actions, like “put litter in the appropriate bin”; (3) providing reasons for performing a specific behavior, such as explaining that recycling is important for avoiding waste of resources and pollution; (4) providing instructions on how to perform a specific behavior, such as recycling; (5) providing feedback about a past behavior, such as errors made in sorting waste; (6) providing rewards or incentives for appropriate behaviors; (7) showing others engaged in a behavior, such as community members recycling waste; (8) appealing to preexisting beliefs to make participants behave in belief-consistent ways; (9) asking people to make a commitment to engage in a behavior, for instance by signing a pledge card; (10) asking people to reach a given goal; for instance carry home the waste they produced during a visit; (11) informing people that the environment is monitored, for instance via cameras or local officers; (12) combined interventions; (13) other types of interventions.

The behaviors and intentions considered will include the following ones: reusing containers, binning, recycling, taking your own’s litter away, picking up litter produced by others, signaling litter, other behaviors.

The report specifies: (1) the objectives and rationale of the systematic review; (2) its methods (including reports’ eligibility criteria, information sources, search strategy, selection process, effect measures, synthesis methods); (3) the results that will be

reported (planned syntheses of results and analyses on reporting biases and certainty of evidence); and (4) the planned discussion of the results (including general interpretation, analysis of the limitations of evidence and of the review process, discussion of the theoretical and applied implications).

The systematic review will provide an empirical-driven guidance on the effectiveness of different kinds of informative and behavioral interventions to promote waste reduction and appropriate binning behavior at the individual level in natural and protected areas.

1. Introduction

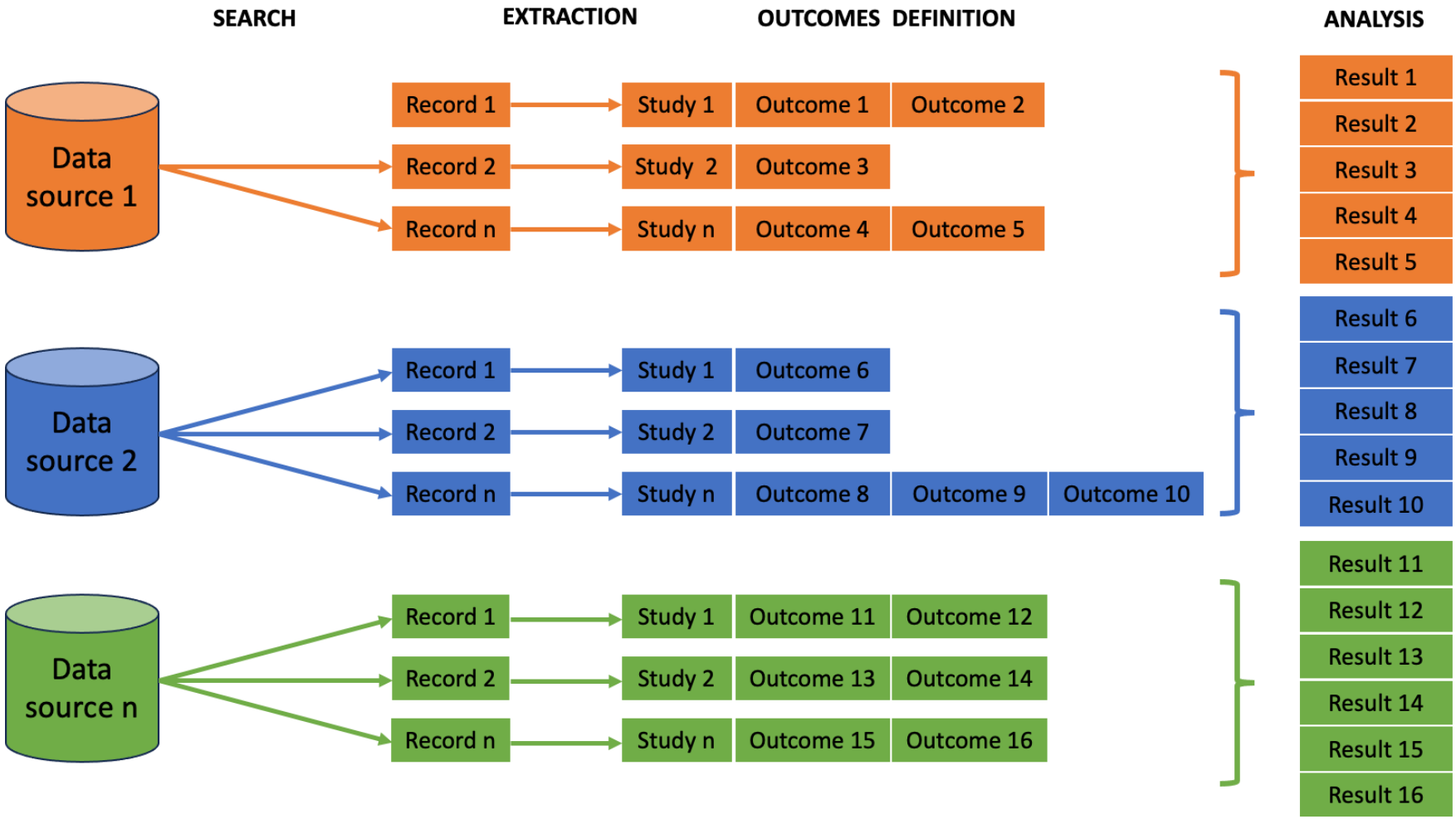
Project Activity 1.5 in WP1 consists in the *specification of the methodology for literature review on the effectiveness of behavioral interventions and communication policies aimed at waste reduction and human behavior related to waste disposal/reduction strategies*. The methodology we adopt follows the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines (Page et al., 2021) and previous work in the field.

A **systematic review** is a review that uses explicit, systematic methods to collect and synthesize findings of studies that address a clearly formulated question. The findings of the results of quantitative studies can be statistically synthesized in various way in a meta-analysis: estimating the mean effect sizes, combining *p* values, calculating the range and distribution of observed effects, and counting the direction of the effects (McKenzie & Brennan, 2019).

A **study** may include the results of multiple experiments, in which a manipulation or a treatment is applied, and its effects are appraised. A **result** in a systematic review, is "the combination of a point estimate (such as a mean difference, risk ratio, or proportion) and a measure of its precision (such as a confidence/credible interval) for a particular outcome", where the outcome is an "event or measurement collected for participants in a study (such as quality of life, mortality)" (Page et al., 2021). For instance, a result of an intervention in the context of our systematic review may be represented by the mean difference in the number of correctly recycled items between a group of participants who received a message highlighting the social norm of recycling vs. a control group who received a control message, with the associated confidence interval. In this case, the **outcome** is the number of correctly recycled items, which is also the dependent variable. A single intervention within an experiment may be assessed by multiple outcomes. In our example, the effectiveness of the social norm intervention may be measured both by the number of correctly recycled items and by asking participants how strong their intention to recycle in the future is. In the case of multiple outcomes of the same intervention, the statistical combination of the results may need to be corrected for their intercorrelation (Borenstein et al., 2009), to avoid possible biases related to common methods, investigators, and settings.

Thus, a systematic review is based on the systematic analysis of studies that produced results assessed via their outcomes. Each study is examined by considering its **report,** which is a document describing it, such as an article, a preprint, a conference abstract, a technical report, a dissertation, an unpublished manuscript. Reports are found by searching data sources, such as scientific databases (e.g., Scopus or Web of Science), repositories, websites, and other researchers. Searches in data bases produce **records**, which are made of the title and the abstract (or both) of a report. Two records referring to the same report are **duplicates**, but if they are merely similar, they should be considered unique. **Figure 1** graphically summarizes the basic elements of a systematic review.

Figure 1. *The basic elements of a systematic review*.



2. General methodological aspects

Following the PRISMA 2020 guidelines (Page et al., 2021), we will systematically report the following elements in our systematic review:

1. **Abstract**[1]
2. **Introduction** (rationale and objectives);
3. **Methods** (eligibility criteria, information sources, search strategy, selection process, data collection process, data items, study risk of bias assessment, effect measures, synthesis methods);
4. **Results** (study selection, study characteristics, risk of bias in studies, results of individual studies, results of syntheses, reporting biases, certainty of evidence)
5. **Discussion** (general interpretation, limitations of evidence and of the review process, theoretical and applied implications)
6. **Other information** (protocol accessibility, support, conflicts of interests, availability of data, code and other materials).

Table 1 from Page et al. (2021) fully displays the elements that will be reported.

[1] Following PRISMA 2020, the abstract of the systematic review will report the following elements: (1) title identifying the report as a systematic review; (2) explicit statement of main objectives and inclusion and exclusion criteria; (3) specification of the information sources, of the methods used to assess risk of bias, and of the methods used to present and synthesize results; (4) specification of the included studies and of their features; (5) presentation of the main outcomes; (6) summary estimate and confidence/credible interval of the meta-analysis (if conducted) and indication of the direction of the effect of group comparison; (7) brief summary of the limitations of the evidence included in the review; (8) general interpretation of the results and important implications.

Table 1. *PRISMA 2020 checklist (from Page et al., 2021).*

Section and Topic	Item #	Checklist item
TITLE		
Title	1	Identify the report as a systematic review.
ABSTRACT		
Abstract	2	See the PRISMA 2020 for Abstracts checklist.
INTRODUCTION		
Rationale	3	Describe the rationale for the review in the context of existing knowledge.
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.
METHODS		
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.
	10b	List and define all other variables for which data were sought (e.g., participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.
Effect measures	12	Specify for each outcome the effect measure(s) (e.g., risk ratio, mean difference) used in the synthesis or presentation of results.

Table 1. *PRISMA 2020 checklist (from Page et al., 2021).*

Section and Topic	Item #	Checklist item
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g., tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.
RESULTS		
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.
Study characteristics	17	Cite each included study and present its characteristics.
Risk of bias in studies	18	Present assessments of risk of bias for each included study.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g., confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.

Table 1. *PRISMA 2020 checklist (from Page et al., 2021).*

Section and Topic	Item #	Checklist item
	20c	Present results of all investigations of possible causes of heterogeneity among study results.
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.
DISCUSSION		
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.
	23b	Discuss any limitations of the evidence included in the review.
	23c	Discuss any limitations of the review processes used.
	23d	Discuss implications of the results for practice, policy, and future research.
OTHER INFORMATION		
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.
	24c	Describe and explain any amendments to information provided at registration or in the protocol.
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.
Competing interests	26	Declare any competing interests of review authors.
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.

In section 2.1, we will specify the rationale and objectives of our review. In section 2.2, we will present the methodology that we will follow in the preparation of the systematic review at a general level. Then, in the next sections of this deliverable, we will specify in more detail the methods that we will use to select, evaluate, and summarize the studies (3), how we will analyze and present the results of the review (4), what aspects will be considered in the discussion of the results (5), other information that will be provided (6).

2.1 Rationale and objectives

The main aim of our systematic review is to appraise the **effectiveness of informative and behavioral interventions** aimed at **promoting waste-related pro-environmental behaviors** in **natural and protected areas**. To this aim, we will try to answer three main questions (see also Osbaldiston and Schott, 2012):

(1) What interventions have been tested in natural and protected areas?
(2) What is the relative average efficacy of each intervention?
(3) Does the relative average efficacy of each intervention differ between natural and urban public places?
(4) Are certain treatments more effective for promoting certain types of behaviors in natural and protected areas?

Interventions will be classified following previous work in the field. We will expand an influential classification proposed by Osbaldiston and Schott (2012) in the context of a meta-analysis of various observed pro-environmental behaviors (including recycling). This classification includes the following 10 types of interventions, which we present here with slight rephrases of the authors definitions to make them explicitly applicable in the context of our systematic review:

(1) *Making it easy* involves changing situational conditions and making behaviors easier to do, such as moving recycling bins to a more convenient location;
(2) *Prompts* are noninformational reminders of a specific action, like a sign “put recyclables in the appropriate container” near to sorted waste containers;
(3) *Justifications* are reasons (why-to information) provided for performing a specific behavior, such as explaining that recycling is important to avoid wasting resources and polluting by dumping in landfills;
(4) *Instructions* indicate how to perform a specific behavior (how-to information), such as what items to put in the carton/paper bin;
(5) *Feedback* involves providing information about the extent to which a behavior has been performed by people earlier and/or about the correctness of such behavior, such as the amount of waste correctly recycled and errors made in sorting waste;
(6) *Rewards or incentives* include any kind of monetary gain that people receive as a result of participating in the intervention, such as cash, coupons, rebates, bus passes, gifts, prizes, and so on;

(7) *Social modeling and norms* include any kind of passing of information via demonstration or discussion in which the initiators indicate that they personally engage in the behavior, such as community members showing how to recycle waste; in this category we will also include messages that make appeal to social norm to affect behavior;
(8) *Cognitive dissonance* refers to interventions accessing (or appealing to) preexisting beliefs or attitudes to make people behave in ways consistent with those beliefs or attitudes; such as making appeal to people's desire to protect the environment to have them deploying waste in the appropriate way; this intervention type includes "foot in the door" treatments where people are asked to engage in a small act first and subsequently in a larger act;
(9) *Commitment* involves asking people to make some verbal or written commitment to engage in a behavior, for instance by signing a pledge card;
(10) *Goal setting* consists of asking people to aim for a predetermined goal; for instance, to carry home all the waste they produced while being in a natural area.

According to Osbaldiston and Schott (2012), these ten types of interventions can be also grouped in five higher-order classes: *convenience* (make it easy, prompts), *information* (justifications, instructions), *monitoring* (feedback, rewards), *social-psychological* (social modeling, cognitive dissonance, commitment, goal setting). The analysis of intervention efficacy is made more complex by the fact that often more than one intervention type is applied in the same experiment. Osbaldiston and Schott addressed this problem by classifying each intervention in relation to its importance in the study with a 4-point scale coding system "such that a value of 3 indicated the treatment was of primary importance and a central focus of the intervention, a 2 indicated it was of secondary importance, a 1 indicated that it was a minor factor but still a difference from the control condition, and a 0 indicated it was not a factor." (p. 269).

Varotto and Spagnolli (2017) revised Osbaldiston and Schott's classification in their meta-analysis on strategies to promote household recycling and used the following categories: environmental alterations; prompts and information; feedback; incentives; social modeling; commitment; and combined interventions. In their meta-analysis, *combined interventions* were grouped in a separate category, and this is the approach we will follow in our systematic review when more than one intervention is applied at the same time in a study.

In our systematic review, we plan to use Osbaldiston and Schott's taxonomy of interventions. Education interventions and campaigns will be included in the information or justification category, depending on their prevailing stated contents. We will add to the classification a new *environment monitoring* category, which will include interventions in which forms of control are exerted on what happens in the environment, for instance via cameras or local officers, and participants are made aware that this is happening. Additionally, we will add a new category for interventions not fitting with our classification (*other interventions*). However, the classification may need to be revised after considering the search results.

Following and expanding previous work in natural areas (see e.g., Esfandiar et al., 2020, 2022), behaviors and intentions considered will include *reusing containers*, *binning* (putting waste in a generic bin), *recycling*, *taking own's litter away*, *picking up litter produced by others*, *signaling the presence litter*, *other*. We will also include outcome measures referring to the direct consequences of these behaviors (e.g., amount of waste collected or recycled in the control vs. experimental group).

Considering the rather limited number of existing studies on waste-related behavior on natural areas (see e.g., Esfandiar et al., 2022), the systematic review will focus not only on studies targeting actual pro-environmental behaviors, but also on studies appraising self-reported behavior and investigations aiming to change behavioral intentions. Behavioral intentions are moderately related with actual behaviors (Bamberg & Möser, 2007) and considered as a proximal predictor of behavior by main theories of the field, such as the theory of planned behavior (Ajzen, 1991). The inclusion of a higher number of studies will allow obtaining more robust results. However, considering the potential biases in self-reported pro-environmental behaviors (Lange, 2024) and the intention-behavior gap (Sheeran, 2002; Sheeran & Webb, 2016), the type of criterion variable (observed behavior vs. self-reported behavior vs. intentions) will be included as a moderator in the presentation of the results and/or in the analyses.

For the same reason, we will include in our systematic review both protected natural environments and nonprotected ones. Protected areas will include six categories identified by the International Union for Conservation of Nature (2008): strict nature reserve; wilderness area; national park; natural monument or feature; habitat/species management area; protected landscape/seascape; and protected area with sustainable use of natural resources. In addition, following Esfandiar et al. (2022), we will also include studies in other protected natural areas, such as provincial or territorial parks, nature reserves, indigenous protected areas, and privately-owned reserves. To include unprotected natural areas, a more generic search term ("natural") will be used. Moreover, to appraise the generalizability of the effectiveness of the interventions, we also include studies on waste-related behavior in *public urban spaces*, including the type of environment (natural protected vs. natural unprotected vs. public urban) as a moderator in the presentation of the results and/or in the analyses[2]. **Figure 2** summarizes the main aspects considered in our review.

Figure 2. *Aspects considered in the systematic review*.

[2] Public parks in urban areas could be considered as an additional category between natural environments and urban environments when the type of environment will be used as a moderator to present or analyze the results.

TYPE OF ENVIRONMENT
- Natural protected
- Natural unprotected
- Urban (public space)

TYPE OF INTERVENTION
- Making it easy
- Prompts
- Justifications
- Instructions
- Feedback
- Rewards or incentives
- Social modeling and norms
- Cognitive dissonance
- Commitment
- Goal setting
- Environmental Monitoring
- Other
- Combined interventions

TYPE OF MEASURE
- Observed behavior
- Consequence of behavior
- Self-reported behavior
- Behavioral intention

TYPE OF BEHAVIOR
- Reusing containers
- Binning (in a generic bin)
- Recycling
- Taking own's litter away
- Picking up litter
- Signaling litter presence
- Other

3. Methods

3.1 Eligibility criteria

We will include in the systematic review only empirical studies in which an intervention or treatment aiming to affect the target waste-related behaviors/intentions is applied to a real-world natural or urban setting. Moreover, a control group, condition, or baseline assessment should be present. This comprises across time design designs (ABA, pre/post test, baseline-intervention), between-participants designs, and mixed designs (Osbaldiston & Schott; 2012; Varotto & Spagnolli, 2017). Laboratory experiments, simulations, or real-world studies without appropriate control or sufficient statistics for the computation or extraction of effect sizes will be excluded. Considering that the systematic review includes public urban settings, studies on private urban settings, such as household recycling will be excluded, as well as studies in work settings. Following Varotto and Spagnolli (2017), we will include only studies conducted in developed countries and reported in English. Although this could limit the generalizability of the results, it could also avoid the predictably high heterogeneity of the results related to very different waste management systems and socio-economic aspects. Finally, we will include only studies published in the last 40 years (thus after 1984), because these are the most useful for designing programs going forward, considering possible changes over time of socio-cultural, environmental, and technical conditions (for a similar but more restrictive approach see Osbaldiston and Schott, 2012). Research on educational interventions will be included only if satisfying the conditions previously specified.

3.2 Information sources, search strategy, and selection process

The information sources for the literature review will include:

- Scientific databases: PsychInfo, Scopus, Web of Science, Google Scholar, EconLit, ACM Digital Library, GreenFILE;
- Website of relevant journals (e.g., Environment and Behavior, Journal of Environmental Psychology, Resources, Conservation and Recycling, Journal of Cleaner Production, Journal of Sustainable Tourism, Sustainability, Review of Environmental Economics and Policy, Biological Conservation, Landscape Ecology and Urban Planning, Nature Sustainability, Ecology Letters, etc.);
- Leading authors of included studies and project partners, who will be emailed to obtain indications of further published or unpublished studies as well as of relevant grey literature;
- Backward literature search from the references contained in the included articles and forward literature search from the studies citing the included articles (via Scopus and Scholar);
- Previous systematic reviews and meta-analyses on interventions targeting waste-related pro-environmental behaviors (e.g., Allison et al., 2022; Esfandiar et al., 2022; Heidbreder et al., 2019; Hines et al., 1987; Hornik et al., 1995; Osbaldiston & Schott, 2012; Porter et al., 1995; Schultz, et al., 1995).

Additional information sources could be added after an initial assessment of the search results if this could allow a more comprehensive assessment of the relevant literature.

3.3 Data collection process, data items, risk of bias assessment

The data bases will be searched by using the terms specified in **Table 2**. We will add filters to exclude reports in languages different than English and published before 1985. Additional queries could be added after an initial assessment of the results if this could allow a more comprehensive assessment of the relevant literature. We will report the initial and final date of the search.

Table 2. *Search query*.

Source	Query
Adapted and expanded from Esfandiar et al. (2022) and Osbaldiston & Schott (2012)	TITLE-ABS-KEY (“human* behav*” OR “visitor* behav*” OR “tourist* behav*” OR “traveler* behav*” OR “pro-environmental behav*” OR “environmental behav*” OR “PEB*” OR “sustainable behav*” OR “responsible behav*” OR “ecological behav*”) OR TITLE-ABS-KEY (“behav* intentio*” OR “pro-environment*” OR “non-compliance” OR “litter*” OR “bin*” OR “recycl*” OR “reuse” OR “waste” OR “disposal”)

	AND TITLE-ABS-KEY (“national park*” OR “protected are*” OR “provincial park*” OR “territorial park*” OR “nature reserve*” OR “indigen* protected area*” OR “privately owned reserve*” OR “marine protected*” OR “natural” OR “public” OR “park*” OR “public garden*” OR “urban”)

We will examine the records returned by the search queries to remove duplicate entries. In the next step, two experienced researchers of our team will examine the abstracts of the reports associated to the collected records to appraise eligibility. They will examine independently 40% of the records each to assess if they meet the inclusion criteria or not, and, in case of doubts, they will decide together after a discussion. A subset of 20% of the records will be examined by both researchers to compute the inter-rater agreement. In case of diverging evaluations on these common items, the decision will be taken after a discussion and joint evaluation.

The two researchers will then examine the reports associated with the included records to further appraise their eligibility and obtain the following information (see Crocetti, 2015; Varotto & Spagnolli, 2017):

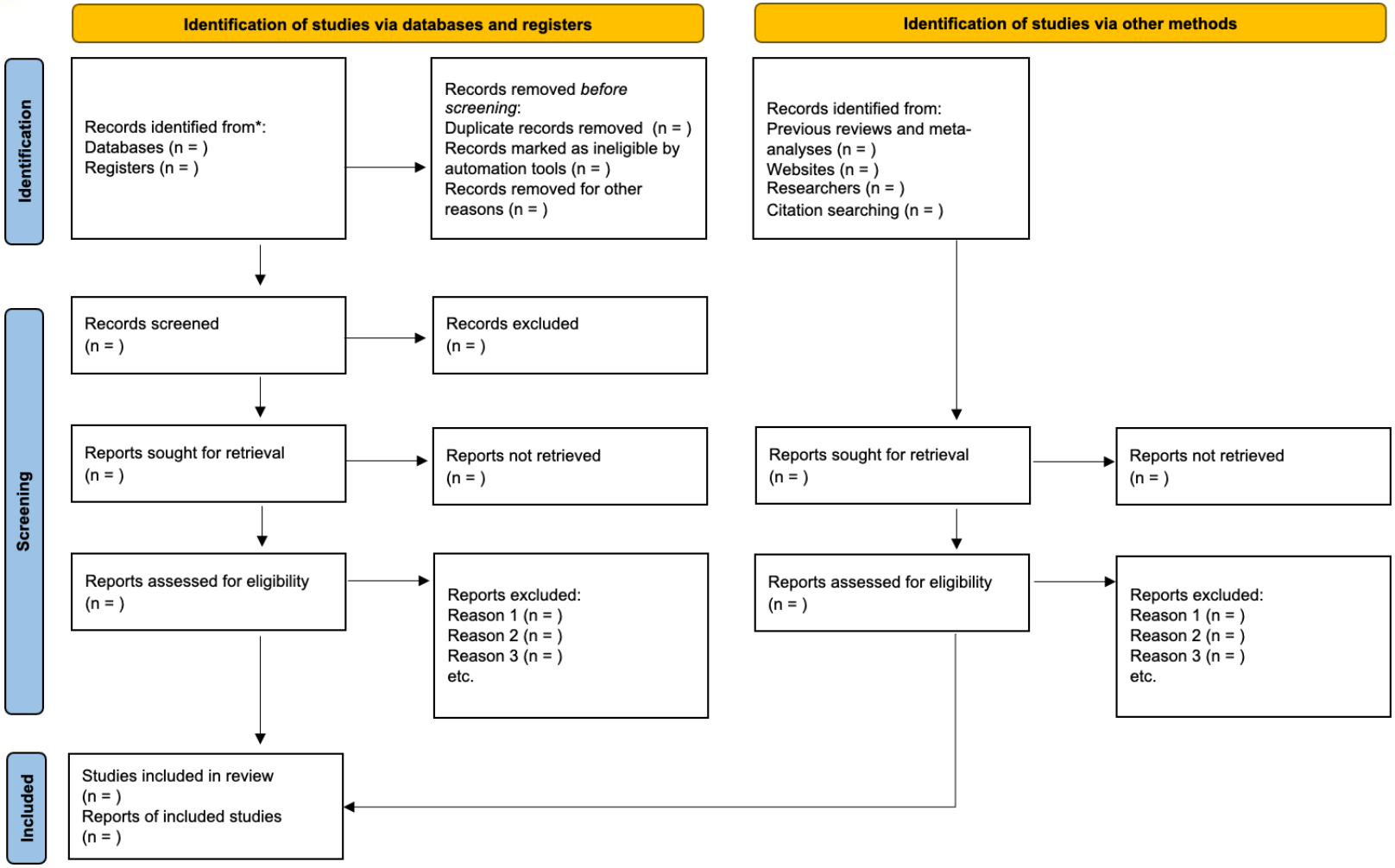
- *publication-related information*: authors; publication year; publication type (journal, conference paper);
- *study-related information*: type of study (empirical, review); purpose and hypotheses; participants (number and type); type of intervention; duration and phases of the intervention; type of activity under examination (e.g., reuse, recycling); type of environment (e.g., urban, urban park, marine reserve, national park); type of measure (observed behavior, self-reported behavior, behavioral intention, consequence of behavior); type of behavior; outcome variable(s);
- *data for effect sizes computation*, such as means, SDs, sample size, counts/frequencies, F and t statistics, Chi square, p values.

In the case of missing information (e.g., necessary statistics), an attempt to contact the authors of the study to obtain it will be made. If this fails, the study will be excluded. To be eligible a study should satisfy the following criteria:

- empirical study with a control group, condition, or baseline assessment;
- reporting an intervention or treatment aiming at affecting a waste-related behavior/intention;
- being conducted in a real-world natural or urban public setting;
- making available sufficient statistics available for the computation/extraction of effect sizes;
- being conducted in developed countries;
- being reported in English;
- being published in the last 40 years (after 1984);
- with full text available.

All the outcomes of the studies included in the systematic review will be explicitly reported. **Figure 3**, adapted from Page et al. (2021), shows the flow of the search and selection process.

Figure 3. *PRISMA 2020 flow diagram for new systematic reviews (adapted from Page et al., 2021).*



3.4 Effect measures and synthesis methods

If the number of outcomes obtained by search will be lower than 15, we will summarize the results in a narrative review and will not aggregate the results in a meta-analysis. If more than 15 outcomes will be obtained, the effect size for each outcome will be assessed with Hedge's g, which represents the standardized mean difference between the intervention and control condition (Osbaldiston & Schott, 2012; Varotto & Spagnolli, 2017). Effect sizes for single interventions will be computed using the appropriate methods in relation to the type of design (Morris & DeShon, 2002). When needed, the effect size will be computed using appropriate meta-analysis software from reported counts/frequencies, t, F, r, and p statistics. Reports of nonsignificant results without additional information, such as statistical values and related probabilities, will be considered as associated with a zero effect size (Osbaldiston & Schott, 2012).

A random-effect model will be used to estimate the overall effect size, thus considering between-study variability (Borenstein et al., 2009). In the case of multiple outcomes of the same intervention, the average effect size will be computed controlling for the correlation among outcome measures (Borenstein et al., 2009) to avoid possible biases related to common methods, investigators, and settings, and we will avoid double counting of participants (see Varotto & Spagnolli, 2017). In case of effect sizes outside of the range of ±2.50 standard deviation units, a sensitivity analysis will be performed to appraise the robustness of the findings by substituting the outlier values with boundary range values (Osbaldiston & Schott, 2012). Heterogeneity between studies will be appraised with the Q and I^2 statistics. Moderator analysis will be performed in the case of significant heterogeneity.

Publication bias will be assessed by using two tests for asymmetry of the funnel plot: Egger's linear regression method (Egger, Smith, Schneider, & Minder, 1997) and Begg and Mazumdar's rank correlation method (Begg & Mazumdar, 1994). Moreover, a trim and fill analysis will be conducted to assess the severity of the publication bias and to estimate the adjusted effect size (Duval & Tweedie, 2000). Finally, the Rosenthal's fail-safe N will be computed (Rosenthal, 1991) and evaluated according to Rosenthal (1979). This procedure follows the one used by Varotto and Spagnolli (2017).

4. Results

We will present the number of removed duplicates, the number of excluded records and reports and the motivation for their exclusion, also using a flow diagram (see **Figure 3**). The information collected for each study, as specified in section 3.3 of this deliverable, will be also reported.

The results of single studies will be briefly discussed in a descriptive manner. If the number of outcomes will be sufficient to carry out a meta-analysis, the results of individual studies will be presented using Hedge's g and associated 95% confidence intervals, also using a forest plot. Moreover, the average effect size, computed with a random-effect model, will be presented with its associated 95% confidence interval, making clear what the direction of the effect is in the forest plot. We will present the measures of statistical heterogeneity (see section 3.3) and the results of the analysis on publication bias (see section 3.4). If significant heterogeneity among study results will be found, we will report the results of moderator analysis, along the lines followed by Osbaldiston and Schott (2012, see also Cooper, 2010), and the results of investigations of other possible causes of heterogeneity.

Results disaggregated by type of environment, type of intervention, type of measure, and type of behavior (**Figure 2**) will be presented and discussed (see also Osbaldiston & Schott, 2012; Varotto & Spagnolli, 2017), trying to understand which intervention is more effective in relation with the type of environment and with specific behaviors.

We will also present the results of the sensitivity analysis conducted to assess the robustness of the synthesized results in relation to possible outliers. Other sensitivity analyses could be performed in relation to aspects of data that may appear potentially problematic for their impact on the overall results.

Considering the limited time available for producing the literature review and meta-analysis, the appraisal of the risk of bias in single studies will depend on the number of studies identified by search. In particular, if less than 30 studies will be identified, we will use the Cochrane Risk of Bias 2 method (Sterne et al., 2019). With a number of studies between 31 and 50, we will use the Jadad Scale, which is a simpler method (Jadad et al., 1996). In both cases, two raters will evaluate 20% of the studies and their agreement will be computed by the correlation between evaluations. With more than 50 studies, the risk of bias at the level of single studies will not be assessed and this will be acknowledged as a limitation.

5. Discussion

As suggested by PRISMA 2020 guidelines, we will try to provide a general interpretation of the findings and discuss the results disaggregated by type of environment, type of intervention, type of measure, and type of behavior. We will draw the theoretical and applied implications of the findings. Further, we will discuss the limitations of the evidence, in terms of the number and quality of studies included, but also in relation to the variability of the results. We will additionally consider the

limitations related to geographical and language inclusion criteria and discuss any methodological limitation emerging from the analysis of the results and their aggregation.

6. Other information

We will provide information about the accessibility of the protocol used, which has been described in this deliverable, and possibly pre-register the protocol in a public repository. We will also specify the financial support from the Wastereduce project and declare the absence of any conflict of interests. Data and data analyses files will be made available on a public online repository.

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