Early Exposure to Nature and Willingness-To-Pay for It: The Value of Tallgrass Prairie Grassland Restoration

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Abstract

Widespread global grassland destruction motivates restoration efforts. However, little research on public preferences exists to inform restoration decisions, and reduced exposure to nature, such as grasslands, could diminish public willingness-to-pay (WTP) for it. We conduct a choice experiment to estimate preferences over Tallgrass Prairie grassland restorations and quantify how those preferences are correlated with childhood experiences. We find that WTP for grassland restoration can be large, especially with recreational opportunities. Furthermore, people who participated in outdoor activities or grew up near grasslands during their childhood would place a higher value on grassland restoration than people who did not.

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1. Introduction

Urbanization, agricultural intensification, and climate change have led to a rapid conversion and degradation of nature around the globe (Grimm et al., 2008). This crisis has prompted governments around the world to intensify nature conservation and restoration (Showstack, 2020), for those losses can harm biodiversity and reduce the provision of many ecosystem services including recreation. One type of habitat, iconic Tallgrass Prairie in the U.S., has almost completely disappeared; however, investments can be made to restore prairie habitat, and added expense can produce recreation opportunities on the sites. This paper informs prairie restorations by providing the first estimates of the values people place on recreational opportunities in such restored areas. We also explore preference heterogeneity in the context of growing concern that children have less exposure to nature (Cox et al., 2018; Pergams and Zaradic, 2008; Larson et al., 2011) and such a change in exposure to and interaction with nature could affect the value that today's children have for nature when they are adults. This paper cannot identify causal impacts of childhood experience on adult preferences. However, we document correlations between an individual's early-life proximity to and experiences with nature and their adult willingness to pay (WTP) for habitat restoration in the context of grasslands.

Grasslands are open land areas dominated by grass, legumes, and flower plant species and with little tree or shrub cover. Grasslands can contribute vital environmental benefits and services such as water supply and flow regulation, carbon storage, soil protection, and climate mitigation (Kemp et al., 2013; Bengtsson et al., 2019). They also provide

other valuable services to humans, including scenic values and recreational opportunities (Bagne, 2012). However, grasslands are heavily degraded by human land use. In the past few decades, more than 40% of grasslands have been converted to croplands in the Great Plains area in the U.S. (WWF, 2018). In Europe, more than 50% of grassland has been destroyed in the past 30 years (Dixon et al., 2014). The loss of grassland has contributed to a widespread and ongoing decline of bird and other animal populations that have affinities to grassland habitats (With et al., 2008).

Grassland restoration can halt the decline of these ecosystems. However, grasslands have been less well studied than other habitats (Török et al., 2021). There is some evidence that people value grasslands (Dallimer et al., 2015; Dissanayake and Ando, 2014), but current restoration decisions are still made with limited information about public preferences regarding grassland restoration. In particular, research has done little to explore how the value of a grassland restoration project is affected by providing a suite of possible recreation opportunities, even though recreation has been found to be an important element of the values people place on nature sites such as wetlands and beaches (Pienaar et al., 2019; Nguyen et al., 2022).

To fill this gap, we conduct a discrete choice experiment (DCE) study of the value of grassland restoration to advance our understanding of how people would value different types of recreation – hiking, bird watching, fishing, and camping – in restored grasslands. We estimate the average values people in the region have for restored prairie sites and recreation within them. We also advance inquiry into preference formation by exploring correlations between an individual's preferences for grasslands and outdoor recreation and their personal history with those environmental goods.

Research suggests that preferences for environmental goods can be shaped by active experience (Delaney et al., 2019). People's experiences with natural resources can influence both the level and the precision of non-market valuation estimates of the values they place on those resources (Cameron and Englin, 1997; Czajkowski et al., 2015; Tu and Abildtrup, 2016). Preferences might also be shaped by passive exposure to a form of nature; Faccioli et al. (2020) explore the role that place identity has on people's preferences for environmental goods and conservation.

In particular, environmental psychologists suggest that both active and passive experience with nature during childhood may play a particularly important role in forming their preferences over natural amenities (Ewert et al., 2005; Thompson et al., 2008; Miller, 2005; Soga et al., 2016). Active childhood experience with nature may help children build up nature-related human capital in the form of skills and knowledge specific to nature appreciation and recreation. Such "amenity capital" (Krupka, 2009) might help them enjoy and value nature more as adults. For example, people who participated in forest recreation in their childhood have been found to visit forests more frequently in adulthood (Taye et al., 2019). Jensen and Olsen (2019) find a positive relationship between nature visits in childhood and WTP for water quality improvement in adulthood estimated using a DCE. Passive childhood exposure to nature itself can also play a vital role in people's preference for environmental goods, separate from making it easier for people to have active experiences. Some work finds that people who lived near a wilderness environment in their childhood have more positive perceptions of natural environments and show a greater affinity for nature (Kals et al., 1999; Bixler et al., 2002). Sato et al. (2017) use a contingent valuation (CV) study to examine the effect of

respondents' personal history and beliefs on the value they place on the preserved area of Mt. Rokko in Kobe, Japan. However, the CV method cannot provide evidence on the relationship between peoples' childhood experience and their values for different attributes of a nature area.

Overall, some valuation research has studied the influence of experience on preferences, little work by economists has focused on how preferences are affected by experiences people have as children rather than as adults. Furthermore, research in environmental economics on the role of passive exposure to nature on preference heterogeneity remains limited. We advance this body of work by testing for correlations between early life activities in and passive exposure to nature and a person's individual WTP for a grassland restoration. In particular, we define a person's passive exposure as the proximity of nature to their childhood home(s), and test whether there is a particularly strong correlation with a person's proximity to grassland (instead of any type of nature) and their WTP to restore that specific kind of habitat as an adult.

We carry out a choice experiment survey in three-state Tallgrass Prairie region comprised of Illinois, Iowa, and Minnesota to examine people's WTP for a restored grassland and its relationship with their early-life experience with nature. We quantify people's marginal WTP (MWTP) for different features of restored grasslands in this area to pro- vide insights on which recreational activities should be prioritized. A mixed multinomial logit (MMNL) model in WTP-space and an equality-constrained latent class (ECLC) model are applied to estimate an individual's MWTP for different attributes of a hypothetically restored grassland while accounting for attribute non-attendance (ANA).

To explore the relationship between early-life experience with nature and grassland valuation, we categorize and measure respondents' early-life experiences in two dimensions: active experience and passive experience. First, we measure an individual's active childhood experience as the frequency with which they visited nature, spent time out- doors, engaged in specific nature-related recreational activities, or received environmental education. Second, we measure an individual's passive childhood experiences with nature by the proximity of nature in general and grasslands in particular to their childhood home(s). We use two methods to analyze the relationship between childhood experiences with nature and MWTP for features of a grassland restoration. First, we regress the individual-specific MWTP for attributes of restoration on their childhood experiences with nature and socioeconomic characteristic control variables. Second, we use a la- tent class model to quantify the differences in MWTP for grassland restoration between groups of people that are classified by their childhood experiences with nature and current demographics.

This research yields two major findings. First, people place economically significant value on having a restored grassland nearby, and that value is increased by recreational attributes. For example, people are willing to pay an average of at least $12 per house- hold per year to have a 100-acre grassland restored nearby with no particular recreational amenities. People are also willing to pay $14 per household per year to have the experiences of catch and release fishing and $20 per year per household to have campgrounds available onsite. Second, people who had early-life experiences with nature, either active or passive, tend to have higher MWTP for associated attributes in a restored grassland. Values for grassland restoration are especially high for people who

could have developed a place identity for grassland by living within walking distance of a grassland as a child and for people who had immersive nature experiences like camping and environmental education.

2. Choice Experiment Survey Design

We carry out a choice experiment survey in three states in three-state Tallgrass Prairie region - Illinois, Iowa, and Minnesota - to estimate individual's MWTP for different features, including recreational activities, of a hypothetical restored grassland.[1] We design the choice questions to estimate the values people have for grassland restoration itself, and for the kinds of nature-based recreation that can be made available in a restored grassland.

We survey people in all three states of the Tallgrass Prairies region to enhance our research's external validity. This area has lost most of its original tallgrass prairies, where vegetation can grow four to six feet tall. In Minnesota and Iowa, there are only about 300,000 acres of the original tallgrass prairies remaining, while the historical range of tallgrass prairies was about 25 million acres (Fish et al., 1998). Illinois has lost 99 percent of its original prairies since the early 1800s.[2] Governments and non-profit groups are working actively to restore and conserve native tallgrass prairies in these states.

The survey instrument includes background information, descriptions of choice-scenario attributes, a set of discrete-choice questions, and a set of questions that collect respondents' demographic information and early-life experiences with nature. A full sample survey is available in the Appendix. By gathering data on respondents' childhood

experiences, we can estimate the correlations between a person's present-day responses to the choice questions and how they experienced nature as children.

Background information and choice question attributes

The survey begins with background information about grasslands, outlining the ecosystem services such areas provide and showing representative photographs to help respondents envision what they are being asked to evaluate. The survey frames the choice questions by explaining that the state has proposed restoring a new grassland area near them, but such a restoration project could have different outcomes depending on how it is designed; the purpose of the survey is to learn how much the respondent would support such a project as a function of its features.

The survey describes the fixed attributes of the hypothetical restoration scenarios the respondent will choose between to ensure all respondents have the same features in mind when making choices. In all cases, the state government would use unused marginal farmland to restore a 100-acre grassland that is 40 miles away from the respondent's home, and the project would be paid for by an annual property tax paid by homeowners or passed on to renters. Other fixed attributes of the hypothetical restored grasslands include the presence of wildflowers, deer, and butterflies. All grasslands would have picnic tables, informational signage, and a pond with some fish but no visitor center.

Next, the survey describes the variable attributes of the choice scenarios. We chose attributes related to recreational activities that are commonly available in existing restored grasslands so the results can usefully inform actual agents making choices about

how to design a restoration project. The variable attributes are the annual payment the household would have to make if that project were chosen and a set of amenities: bird species richness (which enriches birdwatching), length of biking and hiking trails, availability of fishing, and availability of camping. Table 1 describes each attribute and its levels, specifying the status quo level that prevails when there is no grassland restoration. The survey clearly states that in the status quo scenario with no restored grassland, the site would have a minimal number of bird species (specifically 10 species) and no amenities (trails, fishing, and camping) would be available at the site. The attribute levels of each attribute are chosen based on relevant literature and advice from biologists to ensure attribute levels are reasonable in the survey. The exact list of grassland attributes was refined after analyzing the results from the focus groups.

[[Insert Table 1 here]]

Choice cards and experimental design

A single choice question is posted on a "card" that includes a set of scenarios. Respondents are asked to choose the scenario they prefer among the options of that choice card. In our survey, choice questions are generated based on the five attributes and varying levels mentioned above using the D-efficient experimental design in Stata, which minimizes the generalized variance of the parameter estimates (Zwerina et al., 1996). All attributes are coded as categorical variables in the experimental design, but the attributes "bird species richness", "length of biking and hiking trails," and the payment vehicle are treated as continuous variables in the data analysis.[3] To limit respondents' cognitive

burden while maintaining statistical power for WTP estimation (Caussade et al., 2005), we produce 18 unique choice questions and divide them into three blocks of choice profiles to generate three unique versions of the survey.

Respondents are randomly assigned to answer one of three versions of six choice questions. Each question offers three options: two different options of a restored grassland and a status quo option. The status quo option indicates that there will be no restoration project, which means there will be no new grassland, and what would have been the restoration site will have minimal bird species and no multi-use trails, fishing, or camping. An example of a choice question is shown in Figure 1.

[[Insert Figure 1 here]]

Information on individual characteristics

The final part of the survey collects standard demographic characteristics such as gender, income, education, and age. In order to estimate the relationships between an individual's childhood experiences and the values they place on grasslands and recreational amenities, we also collect data on respondents' childhood proximity to and experiences with grasslands and nature as well as respondents' current proximity to grasslands. Following research in psychology, we define childhood experience as an individual's life experience before thirteen years old (Collado and Corraliza, 2015). Features of respondents' childhood hometown locations are certainly exogenous to their own intrinsic affinity for grasslands because children do not choose where they live. The extent of a person's childhood activities in nature is also likely to be heavily influenced

by their parents' exogenous decisions to do (or not do) things like sign them up for nature classes and take them fishing or camping.

Specifically, the survey asks respondents to categorize how much they did the following things before they were 13 years old: visited nature, spent time outdoors, received environmental education, engaged in hiking or biking, bird watching, fishing, and camping, as well as had any negative experience with nature. Respondents are also asked questions about whether they lived as children near any grassland or other nature areas. Self-reported childhood experiences may be imprecise due to recall bias that can occur when the accuracy of memories may be influenced by subsequent events and experiences. To address this concern, we use measures of childhood experiences that are fairly simple for adults to remember. Rather than asking exactly how many times they engaged in an activity, we ask respondents to categorize whether they did the activity often, sometimes, or never; our main results use only dichotomous information on whether the respondent ever did an activity. As a robustness check, we use objective measures of childhood proximity to grasslands based on respondent's childhood zip-codes. Results are discussed in Appendix B.

Hypothetical bias

One common concern in stated preference valuation is hypothetical bias, which arises when respondents report a WTP that exceeds what they would actually pay using their own money. We apply three survey features that are widely applied in the literature to mitigate such bias. First, we include a script based on Tonsor and Shupp (2011) and Aadland and

Caplan (2006) in the survey instruction section to remind our respondents their budget constraint and the trade-off they face between paying for grassland restoration and other household expenses (Cummings and Taylor, 1999). Second, we include an opt-out reminder on each choice card to reduce hypothetical bias (Ladenburg and Olsen, 2014).[4] Third, we include a certainty follow-up question after each choice card to ask how sure the respondent was that they would choose the option they indicated with a one to ten point scale from "very uncertain" to "very certain"- a method used to mitigate the influence of hypothetical bias on value estimates (Ready et al., 2010). Following this method, the regressions in the main paper use data in which responses that opt for restoration but have certainty below seven are re-coded to the status quo (Penn and Hu, 2020).

Focus group and survey administration

We held four focus groups in Illinois from the general population, with the participation of 9-10 people per group and a total duration of 60 minutes each. The participants replied to advertisements posted on a campus-wide email list and Craigslist and were rewarded with $20 cash. In each focus group, participants were given 15-20 minutes to answer a completed survey. Then they were asked to discuss aspects of the survey such as descriptions of attribute levels and salience of the payment vehicle. In general, participants reported that the survey was easy to understand and answer, the survey language was not biased or too technical, and the payment vehicle used in the survey was believable. Participants also reported that it was easy for them to recall and answer questions about their childhood experiences with nature.

We made several adjustments based on suggestions from the focus group participants. First, we added more pictures in the background information section to help them better understand the hypothetical scenarios. Second, we stated the distance between the restored grassland and respondents' home more precisely. Third, we added two fixed attributes to the description of the hypothetical restored grasslands, making clear that some butterflies and birds would always be present in a restored area and any features like trails would always be accessible to people with disabilities.

We launched a pilot version of the survey in mid-September through Qualtrics and checked the sample of 90 complete and usable surveys for anomalies. We then distributed the survey online through a Qualtrics panel in October 2019. An online survey can prevent respondents from reading ahead or going back and changing responses. We also randomized the order of the presentation of choice sets to avoid learning and ordering effects. Data from all choices are used in the analyses. We obtained 1018 usable surveys in total (330 in Illinois, 338 in Iowa, and 350 in Minnesota), which generated 6108 choice question observations.

3. Econometric Framework

Estimating Values

This paper uses choice experiment methodology (Hanley et al., 1998) to estimate an individual's WTP for different attributes of a hypothetically restored grassland and

examines the relationship between individuals' early-life experiences with nature and WTP for restoration. We analyze the responses collected by the choice experiment survey based on the random utility maximization (RUM) model (Louviere et al., 2000). Individuals choose from a set of grassland restoration scenarios with varying attributes to maximize their utility. The utility of individual *n* choosing alternative *i* in choice card *t* can be written as:

$$U_{nit} = -\alpha_n P_{it} + \beta' \boldsymbol{X_{nit}} + \epsilon_{nit} \quad (1)$$

where **X** is a vector of variable attributes, p is the price (cost) of the choice scenario and ϵ_{nit} is an unobserved random component that captures an individual's idiosyncratic tastes and is i.i.d extreme value type-one distributed (Louviere et al., 2000). The vector β represents a vector of individual-specific random coefficients, and α is the individual-specific coefficient on cost in the random parameter logit model.

We define k_n as the scale parameter for a respondent *n* as the variance of the error term can vary across respondents. Dividing Equation (1) by the scale parameter to achieve a specification that has the same variance across all respondents:

$$U_{nit} = -\left(\frac{\alpha_n}{k_n}\right) p_{it} + \left(\frac{\beta_n'}{k_n}\right) X_{nit} + \epsilon_{nit} \rightarrow$$

$$U_{nit} = -\lambda_n p_{it} + c_n' X_{nit} + \epsilon_{nit} \quad (2)$$

The specification in Equation (2) is a mixed multinomial logit (MMNL) model in preference space (Train and Weeks, 2005). To take the advantage of directly specifying the distribution of WTP instead of deriving WTP indirectly based on the distribution of coefficients in the utility space, we estimate our model in the WTP space directly

(Carson and Czajkowski, 2019). Since the WTP for an attribute is calculated as $wtp_n = \frac{c_n}{\lambda_n}$, we re-parameterize Equation (2) to get the model estimated in WTP-space (Train and Weeks, 2005):

$$U_{nit} = -\lambda_n p_{it} + \lambda_n \mathbf{wtp}' \boldsymbol{X_{nit}} + \epsilon_{nit} \quad (3)$$

We use the MMNL model estimated in WTP-space with fully correlated distributions of the random parameters to estimate individual's WTP for each attribute of a restored grassland. We assume the coefficient for the attribute cost *p* to be log-normally distributed, while the ***wtp*** for all each attribute is specified to be normally distributed. The model is estimated using maximum simulated likelihood (Scarpa et al., 2008; Train and Weeks, 2005).[5]

We also check for the presence of attribute non-attendance (ANA) behavior in our survey. ANA in stated preference choice experiments occurs when respondents ignore one or more attributes in a choice experiment question. Estimated MWTP can be biased if ANA issue exists but is not addressed. The stated and inferred ANA approaches are the two common methods to identify and address the presence of ANA behavior in a choice experiment. The stated ANA approach requires respondents to report the attributes they have ignored or given less than full attention in a survey. As we do not ask for such information in our survey questions, we use inferred ANA approach to examine and account for the existence of ANA behavior in our survey.

To account for inferred ANA, we follow Scarpa et al. (2009) and use an equality-constrained latent class (ECLC) model with ANA. Instead of using latent classes for accounting for respondents' heterogeneous preferences, the ECLC model with ANA classifies

respondents into latent classes based on ANA behavior. We impose two constraints on the class coefficients so that each latent class represents an attribute attendance pattern: (1) The coefficients of attributes that are assigned zero if the attributes are unattended. (2) All coefficients for attended attributes are constrained to be equal across classes. We categorize the attributes in the survey into two types (price and grassland) and follow Petrolia and Hwang (2020) to classify respondents into four classes: all attributes attended, price non-attended, grassland attributes non-attended, and none attributed attended. The grassland attributes include bird species, the length of trails, and options for fishing and camping, while the price attribute is the annual cost for grassland restoration each household needs to pay.

Values and Early-childhood Experience

Two methods are applied in the paper to quantify how people's WTP for grassland restoration is related to their childhood experiences. In the first method, we recover the conditional individual-specific means of MWTP for every respondent in our sample (Greene et al., 2005). We then regress an individual's MWTP for each attribute on their childhood experiences with nature and other current socioeconomic characteristics in an Ordinary Least Squares (OLS) model. The estimated results can be interpreted as the differences in WTPs for attributes between people with and without childhood experiences.

In the second method, we use a latent class model to examine how heterogeneity in people's MWTP for grassland restoration is associated with their childhood experiences

with nature. The latent class model models unobserved preference heterogeneity across respondents as a discrete distribution (Boxall and Adamowicz, 2002; Greene and Hensher, 2003). The respondents are divided into **C** preference classes. People within a class have relatively homogeneous preferences, while respondents' preferences vary between classes. The probability of observing a particular sequence of choices for an individual *n* is:

$$P_n = \sum_{c=1}^{C} \pi_{cn}(\theta) \prod_{t=1}^{T} \prod_{i=1}^{I} \left[\frac{exp(x'_{nit}\beta_c)}{\sum_{i=1}^{I} exp(x'_{nit}\beta_c)} \right]^{y_{nit}} \quad (4)$$

where x_{nit} represents is a vector of alternative-specific attributes and y_{nit} is a binary variable that equals (1) if respondent *n* chooses alternative *i* in card *t* and equals 0 otherwise. $\pi_{cn}(\theta)$ in Equation (4) represents the population share of class *c* and is given as:

$$\pi_{cn}(\theta) = \frac{exp(\theta_c z_n)}{1 + \sum_{c=1}^{C} \theta_c \, z_n} \quad (5)$$

where θ represents class membership model parameters and z_n is a constant.[6] The log-likelihood of the model is given as:

$$lnL(\beta, \theta) = \sum_{n=1}^{N} P_n(\beta_c) \quad (6)$$

We estimate β and θ by indirectly maximizing the expression above via the expectation-maximization algorithm (Train, 2008).[7] We calculate the MWTP for an attribute in each class by taking the ratio of the attribute's class-specific coefficient to the price coefficient. We run the latent-class model for a range of possible numbers of classes and evaluate fit using the Bayesian information criterion (BIC) and the corrected-Akaike's information criterion (CAIC) as shown in Table A1 of the Appendix. Based on the information

criterion, the optimal number of classes would be three classes. Thus, we focus discussion on the latent-class model results in which respondents map into three classes.

4. Results

Table 2 compares the mean of respondents' demographic characteristics to each state's average demographic characteristics based on data from the 2010 US Census, with standard deviations (where available) indicated within parenthesis. Table 2 shows that respondents are more likely to be female and more educated.[8] However, all of the state averages fall within one standard deviation of the sample means, showing our sample can be considered as reasonable representative of adults in each state.[9] Figure A2 in Appendix shows respondents' early-life experience in terms of nature-related activities (hiking, fishing, bird watching, and camping) and childhood location proximity. Sufficient variations exist in respondents' childhood experiences with nature. For instance, 53%, 12%, 26%, and 25% of respondents frequently hiked, watched birds, went fishing, and camped out in their childhood, while 13%, 53%, 27%, and 32% of respondents never did these four activities in their childhood, respectively.[10] Moreover, 45% and 34% of respondents lived near a grassland that they could visit on a day trip and within a 20-minute walking distance respectively.

[[Insert Table 2 here]]

We might expect strong correlations between these measures of experience would limit our ability to separately explore the roles played by different kinds of activities. Figure

A3 in Appendix does show that there are some moderate positive correlations; for example, people who "visited nature" often are understandably likely to have camped, fished, and hiked often, and we see that people who visited grasslands often tended to live near them. However, the correlations among many of the elements of individual experience are very small, so multicollinearity should not be a serious issue in our analyses that explore the relationship between MWTP and childhood experiences.

MWTP for grassland restoration

Table 3 Column (1) presents the main regression results, estimating equation 3 (WTP-space) with certainty adjustment to mitigate hypothetical bias. We recode any choices with follow-up certainty level less than seven to the status quo option. All mean MWTP coefficients in Column (1) are statistically significant at the 1% level. The coefficient on the status quo (no grassland restoration) option is large and negative, suggesting respondents would be willing on average to pay over $34 to have a restored grassland instead of the status quo even with none of the variable attributes in the choice scenarios present. The coefficients on all amenity attributes are positive and significant, which suggests that people would gain positive value from having recreational opportunities in a restored grassland. Estimated MWTP with and without different levels of certainty adjustment are presented in Table A3 in the Appendix. The degree of certainty adjustment has little impact on the nature of the findings except the size of the status quo coefficient.

To explore the impact of ANA on our results, we followed Glenk et al. (2015) to com-

pare the MWTP estimates from the MMNL model in WTP-space and the ECLC model estimates that infer ANA. Table 3 Column (2) and (3) show the estimated coefficients and MWTP for each attribute using the ECLC ANA model on the data with the same certainty adjustment. Model fit does not change much in the ECLC ANA model. AIC favors the MMNL model slightly, while BIC favors the latent class model slightly. The "price non-attended" class has the largest class share (40%), and the "all attendance" class is estimated to include 35% of the population. Though the probability of ANA is considerable, it is within the range of ANA probabilities reported in the literature.[11] Since the MWTP is the ratio of the marginal utility of a grassland attribute and the marginal utility of cost attribute, price non-attendance can bias estimates of MWTP upward; such bias is apparent in the comparison of Columns (1) and (3). The MWTP for any restoration instead of the status quo falls from $34 to $13, and while the MWTP for bird species is stable, the average MWTP values for the recreational attributes fall by 38-49% after accounting for ANA behavior.

Policy-relevant valuation must control for sources of hypothetical bias; thus, we discuss the actual average values of these environmental goods focusing on the estimates from Table 3 Column (3) that account for ANA and do a certainty adjustment. Even with those controls, the marginal values of grassland restoration and its recreational amenities are considerable. People would be willing to pay about $1 per year to have just one additional species of birds in the restored grassland.[12] People would gain utility from having recreational amenities in the grassland, with an average annual MWTP of about $9 for an additional mile of trails, $22 for camping, and $14 and $20 for having catch-and-release or unlimited fishing, respectively.[13]

[[Insert Table 3 here]]

Heterogeneity in MWTP by early life experience

Do the average values reported above vary among people with different childhood experiences with grasslands and outdoor recreation? Here we report the results of two types of analyses outlined in the previous section that shed light on the answer to that question.

Individual-specific MWTP and OLS estimates

In the first method, we regress the conditional individual-specific means of MWTP for each attribute on individuals' childhood experiences with and exposure to nature and socioeconomic characteristics. The self-reported childhood experiences may be un-intentionally affected by respondents' adulthood preferences. Respondents may provide answers of sufficient quality if less detail is expected from them (Nieuwenhuijsen, 2005). Thus, in the main analysis we focus on dichotomous information on whether the respondent ever did a nature-related activity.[14] One group of explanatory variables we include in the analysis is a set of dummies for activities (camping, hiking, bird-watching, fishing, visiting nature, visiting grasslands, spending time outdoors, receiving environmental education) coded as one if an individual did an activity frequently or occasionally in childhood and zero if an individual never did such activity. The second group of variables captures other features of their childhood. We include dummies for

whether they lived near any grassland that could be visited on a day trip or was within a 20-minute walk of their home, as well as dummies for whether they had negative childhood experiences with nature or learned how to ride a bike. The third group of variables controls for demographic features of the respondents: age, gender, income, race, education, and the number of children currently in the household. Finally, the fourth group of variables controls for features of respondents' present home locations to separate the impact of childhood and current nature exposures on the preferences for grassland restoration. We include whether they are currently living near any grassland that could be visited on a day trip or is within a 20-minute walk of their home.

Table 4 presents the estimation results when the conditional individual-specific MWTP for each of the attributes including the status quo variable is recovered using the MMNL results from Table 3 Column (1) to create the dependent variables of the regressions in Columns (1) through (6). We find strong evidence of correlations between features of people's childhoods and the preferences they have today.[15]

Some direct experiences seem related. People who had fishing or bird-watching experience as children have higher MWTP for all attributes of a restored grassland. In addition, people who camped out at least once as children have higher MWTP for fishing and camping attributes of a restored grassland; for example, they would be willing to pay over $4 more for having catch-and-release fishing, and nearly $6 more to be able to set up camp. Additionally, respondents who received environmental education, spent time outdoors, or visited grasslands have higher MWTPs for all attributes of a restored grassland.

People's childhood location itself seems related to their current MWTP for grassland

restoration. Respondents have higher MWTP for grassland restoration if they lived a short walk to a grassland. In contrast, growing up within day-trip distance of a grassland is not associated with any increased MWTP for a new grassland project. Similar to childhood location, currently living within day-trip distance of a grassland is not correlated with people's MWTP for grassland restoration. However, respondents actually have lower MWTP for C&R fishing and camping if they are currently living within a short walk of a grassland; the presence of a substitute may lower demand for a new site. People's childhood experience with nature appears related to the value they place on restoring new grasslands. Respondents are willing to pay more to avoid the no-restoration status quo in the absence of the other attributes listed in the survey if they grew up with a lot of camping, fishing, bird-watching, environmental education, and grassland visits or if they simply lived near a grassland.

[[Insert Table 4 here]]

We explore whether results change if we alter how we define the dichotomous representation of whether someone had an experience. In this treatment, we narrowly defined childhood experience and code someone as having had an experience only if they did an activity frequently and zero otherwise. The results are in Table A5 in the Appendix. Results are similar to the results presented in Table 4 above in that people did camping and environmental education and lived close to a grassland have larger MWTP for many attributes of a grassland restoration (including avoiding the no-restoration status quo).

Latent class model

In the second method, we use a latent class model to examine the links between childhood experiences and adult preference through a different lens. As explained more formally in Section 3, this model has two components: a regression that identifies the likelihood that a respondent is in each class, and a regression that estimates preferences over scenario attributes for each class from which average class-specific MWTP values are derived.

Table 5 shows how individual characteristics affect which group a respondent is most likely to be in. An individual's nature-related experience is coded as one if an individual did this activity frequently or occasionally and zero if an individual never did a such activity in their childhood. The analysis is performed using data with certainty adjustment. Looking at the results in Column (1), we see that respondents in class 1 are more likely than those in class 3 to have lived within walking distance of a grassland. Results in Column (2) suggest that respondents in class 2 are more likely than those in class 3 to have had active experiences with nature in their childhood. More specifically, they are more likely to have camping, fishing, and bird watching experience at least once in their childhood. They are also more likely to have received environmental education and spent time outdoors. Compared to respondents in class 3, both respondents in class 1 and 2 are more likely to have had negative experiences with nature in their childhood, perhaps exposure to nature simply increases the chances of having negative experiences with it. In terms of respondents' demographics, people in class 2 are more likely to have more children in the household.[16]

[[Insert Table 5 here]]

Table 6 presents respondents' MWTP for each attribute from class 1 (more passive experience with nature), class 2 (more active experience with nature), and class 3 (less experience with nature) with 95% confidence intervals under certainty adjustment. We can observe very striking differences in MWTP among people in the three groups. Respondents with either passive or active childhood experience with nature have positive MWTPs for different attributes of a restored grassland. In contrast, respondents in class 3 who tended to have neither type of experience have MWTPs for grassland amenities that are not significantly different from zero. MWTPs between respondents with passive and active experiences with nature are consistently different from each other. Respondents in the passive-experience class would be willing to pay only $8 for having the option of camping, while the respondents with active childhood nature experience would be willing to pay $100. Likewise, passive-experience respondents would be willing to pay nothing and $12 for C&R or unlimited fishing (respectively), while people in the active-experience group would be willing to pay $80 and $92 for these two fishing options. Active-experience class 2 respondents are willing to pay $24 more for a mile of trails and $5 more for an additional bird species in a restored grassland than passive-experience class 1 respondents. Overall, the results suggest that the MWTP of grassland attributes for people who actively interacted with nature in their childhood can be around three to ten times higher than those who lived within walking distance of grassland in their child- hood. Note that we observe similar findings if we narrowly defined childhood experience and code someone as having had an experience only if they did an activity frequently and zero otherwise (Table A6).

[[Insert Table 6 here]]

Results from both methods discussed above illustrate that people's MWTP for grassland restoration is affected by their childhood experiences. Specific childhood experiences that can positively affect an individual's WTP include whether people went camping, received environmental education, and lived near a grassland within walking distance in their childhood. The differences in MWTP for grassland restoration between people with and without childhood nature experience can be large.

5. Conclusion and Discussion

We carried out a choice experiment survey in Illinois, Iowa, and Minnesota to estimate people's WTP for tallgrass prairie grassland restoration and analyze the correlations between individuals' childhood experiences with nature and WTP for grassland restoration. This paper yields several findings that can have important implications for restoration and conservation planning.

Our research helps conservation groups plan efforts at grassland restoration in particular by estimating grassland restoration values and how those values are affected by the recreational amenities included in restoration efforts. We find that the average individual in the Tallgrass Prairie region of Illinois, Minnesota, and Iowa places positive values on bird diversity, trails for recreation, ponds with unrestricted fishing, and campgrounds for camping in a restored grassland. Thus, the value of grassland restoration with extensive recreational attributes can be large – as much as $61 per household per year.[17] The agencies and non-profits involved in grassland restoration can

use these results in conjunction with their knowledge of the costs of different features of grassland projects to shape plans for providing recreational activities in restored grassland to maximize the net benefits such areas produce.

Our results also show that people's adult WTP for grassland restorations and amenities within them is correlated with both their passive and active childhood experiences with nature, and the differences are large. People with neither type of childhood experience have values for grassland restorations that are not significantly different from zero. The passive experience of living close to a grassland in childhood is associated with positive WTP, and people who actively engaged with nature in childhood value a hypothetically restored grassland about three to ten times more than those who just lived near grasslands. At the same, WTP for people without both types of childhood experiences with nature is not significantly different from zero. These findings advance the limited research in economics on the relationship of childhood experience with adult WTP for nature in some interesting ways. We find that individuals have higher MWTP for grassland restoration even if they only occasionally did nature-related activities such as fishing. Even more striking, we find that growing up near grasslands – not just nature in general – has a large correlation with an adult willingness to pay to restore that kind of habitat, even controlling for childhood nature activities.

We cannot claim to have identified causal impacts of childhood experiences on adult preferences, though a child's innate preferences are unlikely to be able to determine where they live and thus their passive exposure to grasslands. It would, however, be valuable for future work to unpack the mechanisms underlying the correlations we find, for these

results could have several important implications.

First, it could be that passive experience plays an essential role in forming people's preferences for nature. In that case, climate change could result in a spatial mismatch between the locations of species and ecosystems and the people who value them. Ecologists have already documented shifts in growth zones (Kelly and Goulden, 2008) and predict large-scale changes in species ranges spurred by climate change (Walther et al., 2002; Forister et al., 2010)). If a site changes to host a different set of species and type of natural landscape, people there may have limited appetite for protecting the species that now share their space.

Second, these results could suggest that trends limiting how much children interact with nature may indeed undermine future net public demand for conservation and restoration. In neoclassical economics, the marginal value of nature theoretically increases with its scarcity so that when people have fewer chances to visit nature because of limited sup- ply, they may value nature more. However, if early-life exposure and interaction increase a person's value for nature, then the marginal value people place on nature could actually decrease with growing scarcity over time. Some of our findings are also consistent with a pattern in which programs promoting nature education and activities for children could mitigate a decline in public demand for conservation; experimental or quasi-experimental research could help confirm whether such programs have impact.

Third, differential acquisition of childhood amenity capital could even be an element in the system dynamics that yield persistent patterns of environmental injustice in access to nature and green space. People choose where to live based at least in part on their

budget constraint and WTP for environmental amenities (Tiebout, 1956; Banzhaf et al., 2019), and our findings could imply that people's WTP for nature is affected by their childhood exposure. If people in poor and minority groups live in neighborhoods with fewer green spaces in their childhood because of budget constraints and structural racism in housing markets, they may have lower WTP for nature as adults and may be less willing to pay a premium to live near nature even if budget constraints and barriers to mobility are relaxed. Scholars of environmental justice could further explore whether this kind of feedback really does play a role in entrenching patterns of unjust access to nature in the U.S. This paper alone makes clear that investments in U.S. Tallgrass Prairie habitat produces large benefits to the public that will be enhanced by adding recreational amenities. These findings also make clear that there is a correlation between the benefits current adults would gain from investments in nature and their exposure to natural areas in their youth. We recognize that we do not have clean identification of causal relations and cannot fully separate the impacts of childhood and adulthood experiences on preferences for grassland restoration. Future work could do more to control for the effects of current outdoor activities on preferences and unpack the mechanisms driving the correlations we have found between WTP for restoration and recreation and childhood exposure to and experience with nature. Those mechanisms have implications for the how society's willingness to steward nature will evolve with climate change and increasingly scarce access to nature and could play a role in some of the dynamics that influence environmental justice.

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6. Tables

Table 1: Survey Attributes and Levels

Attribute	Levels	Description
Number of species	(10 species)	The number of different bird species in the restored grassland.
	20 species	A higher number means you are more likely to see different kinds of
	30 species	birds in the grassland.
Multi-use trails	(0 mile)	Length of multi-use, marked trails in the restored grassland.
	1 mile	Trails allow visitors to experience the tallgrass prairie by
	2 miles	walking or biking. No motorized vehicle allowed.
	3 miles	All trails are open 24 hours
Fishing	(No fishing)	At least one lake or pond on the restored grassland has fish.
	Catch and release only	Different levels of fishing on the restored grassland may
	Unlimited fishing	be allowed. A current state fishing license is required
Camping	(Camping is not allowed)	Different levels of camping in the restored grassland
	Camping is allowed	may be allowed.
Annual cost to household	(0)	The amount of money your household will have to
	$10	pay every year to restore and maintain the grassland.
	$55	The money will be paid through an increase in
	$100	annual property tax.

Note: Status quo levels for each attribute are presented in parentheses.

Table 2: Comparison of State Population and Sample

State		Income ($1000)	Education (% of adults with bachelor's degree or above)	Female (% female over age 18)
Illinois	State Mean	54	30	51
	Sample Mean[b]	50-75	52(50)	66(47)
Iowa	State Mean	58	28.9	50
	Sample Mean[b]	50-75	38 (49)	71(45)
Minnesota	State Mean	65	34	50
	Sample Mean[b]	50-75	49(50)	65(48)

Note:

[a] Sample mean represents median income range for survey respondents.

[b] Values in parentheses indicate standard deviations

Table 3: MWTP to Restore Grassland

	MMNL	ECLC-ANA	
	(1)	(2)	(3)
	MWTP	Coef	MWTP
Status quo	-34.2	-0.305***	-12.6
	[-42.3, -26.2]	(0.098)	[-20.5, -4.7]
Species	1.0	0.022***	0.9
	[0.6,1.3]	(0.002)	[0.7,1.1]
Trails	15.9	0.219***	9.1
	[13.4,18.4]	(0.018)	[7.4,10.8]
C&R fishing	25.2	0.345***	14.3
	[19,31.5]	(0.045)	[10.4,18.1]
Unlimited fishing	37.4	0.473***	19.6
	[31.1,43.7]	(0.045)	[15.3,23.8]
Camping	32.2	0.520***	21.5
	[26.2,38.1]	(0.036)	[18.2,24.9]
Cost coefficient	-3.6	-0.024***	
		(0.001)	
Class shares			
All Attended		0.35	
Price Non-attended		0.4	
Grassland Attributes Non-attended		0.14	
No Attribute attended		0.11	
AIC	10054	10060	
BIC	10328	10124	
LL	-4992	-5017	
N	18324	18324	

Note: Column (1) shows the MWTP for each grassland restoration attribute

with 95% confidence intervals estimated in the MMNL model in WTP-space with certainty adjustment. The Column (2) and (3) show the estimated coefficients and MWTP for each attribute using the ECLC ANA model with certainty adjustment. For certainty adjustment, we recode any follow-up questions with a certainty level less than 7 to the status quo option.

Table 4: Relationship between Childhood Experience and WTP for Grassland Restoration

	(1) Species	(2) Trails	(3) C&R fishing	(4) Unlimited fishing	(5) Camping	(6) Status quo
Camping exp	0.144	0.489	3.757**	2.404*	5.648**	-4.531
	(0.111)	(0.488)	(1.669)	(1.427)	(2.238)	(3.098)
Fishing exp	0.374***	0.977*	5.483***	4.414***	6.643***	-10.412***
	(0.114)	(0.501)	(1.712)	(1.464)	(2.296)	(3.179)
Brid-watching exp	0.313***	1.042**	2.936*	3.139**	3.783*	-8.423***
	(0.102)	(0.450)	(1.540)	(1.317)	(2.065)	(2.859)
Hiking exp	0.135	0.940	0.082	1.235	0.271	-3.665
	(0.160)	(0.704)	(2.409)	(2.060)	(3.230)	(4.472)
Visited nature	0.142	0.403	2.306	1.913	3.351	-4.048
	(0.193)	(0.848)	(2.898)	(2.478)	(3.886)	(5.381)
Env education	0.312***	1.105**	3.456**	3.264**	4.188*	-8.568***
	(0.112)	(0.494)	(1.689)	(1.444)	(2.265)	(3.136)
Outdoor	0.552**	2.275**	8.006**	6.207**	9.601*	-15.855**
	(0.244)	(1.073)	(3.668)	(3.136)	(4.918)	(6.810)
Visited grassland	0.204*	1.092**	3.271*	3.171**	3.919	-6.204*
	(0.124)	(0.543)	(1.857)	(1.587)	(2.489)	(3.447)
Lived near grassland(1day)	0.018	-0.308	1.167	-0.209	1.692	-0.414
	(0.123)	(0.539)	(1.842)	(1.575)	(2.469)	(3.419)
Lived near grassland(20min)	0.317**	1.157**	3.464*	3.491**	4.214*	-8.754**
	(0.126)	(0.553)	(1.893)	(1.618)	(2.538)	(3.514)
Living near grassland(1day)	0.054	0.530	1.739	1.280	2.475	-2.045
	(0.107)	(0.470)	(1.609)	(1.376)	(2.157)	(2.987)
Living near grassland(20min)	-0.081	-0.759	-4.569**	-3.466**	-6.137**	3.691
	(0.134)	(0.590)	(2.017)	(1.724)	(2.704)	(3.744)
Learned biking	0.085	-0.180	0.559	0.753	-0.044	-1.940
	(0.192)	(0.844)	(2.886)	(2.467)	(3.869)	(5.357)
Negative exp	0.052	-0.720	-1.841	-2.706*	-2.623	0.117
	(0.127)	(0.558)	(1.908)	(1.632)	(2.559)	(3.543)
Constant	-0.899***	10.600***	3.849	20.358***	5.116	15.799*
	(0.321)	(1.411)	(4.824)	(4.125)	(6.468)	(8.956)

Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1017	1017	1017	1017	1017	1017

Standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, *** $p < 0.01$

Note: In an OLS model, we regress respondents' MWTP for each attribute on their childhood experiences with nature while controlling for their socio-demographics information. We recover the conditional individual-specific MWTP for each attribute using the primary specification in our analysis (Table 3 Column (1)). An individual's nature-related experience is coded as one if an individual did this activity frequently or occasionally and zero if an individual never did such activity in their childhood. A full table is available in the Appendix (Table A4).

Table 5: Latent Class Model: Class Membership for All Variables

	(1) Class 1	(2) Class 2
Camping exp	0.383	0.411*
	(0.244)	(0.236)
Fishing exp	0.162	0.712***
	(0.245)	(0.241)
Bird-watching exp	-0.021	0.405*
	(0.252)	(0.234)
Hiking exp	-0.158	0.180
	(0.334)	(0.336)
Lived near grassland(1day)	-0.117	0.193
	(0.251)	(0.244)
Lived near grassland(20min)	0.801**	0.035
	(0.316)	(0.290)
Visited nature	0.202	0.065
	(0.394)	(0.381)
Env education	0.359	0.631***
	(0.257)	(0.244)
Outdoor	0.481	1.069**
	(0.476)	(0.483)
Visited grassland	0.183	0.358
	(0.277)	(0.265)
Living near grassland(1day)	0.377	0.371
	(0.305)	(0.289)
Living near grassland(20min)	-0.384	0.196
	(0.324)	(0.298)
Learned biking	0.164	0.104
	(0.428)	(0.402)
Negative exp	1.122***	0.492*
	(0.314)	(0.264)
Female	-0.116	-0.023
	(0.237)	(0.226)
Hispanic	-0.112	-0.198
	(0.483)	(0.449)
Black	-0.379	0.380
	(0.641)	(0.576)
White	-0.226	-0.020
	(0.446)	(0.428)
# children	0.080	0.175*
	(0.115)	(0.106)
High education	0.166	0.182
	(0.315)	(0.307)

High income	-0.126	-0.341
	(0.273)	(0.268)
Constant.	-1.697**	-2.464***
	(0.665)	(0.691)

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We perform the latent class model analysis with certainty adjustment. Using class 3 as the reference class, the class membership above shows that compared to people in class 3, respondents in class 2 are more likely to have active childhood experiences with nature, and respondents in class 1 are more likely to have lived near a grassland in their childhood. An individual's nature-related experience is coded as one if an individual did this activity frequently or occasionally and zero if an individual never did such activity in their childhood.

Table 6: Latent Class Model: MWTP to Restore Grassland

	(1) Class 1 (Passive Exp)	(2) Class 2 (Active Exp)	(3) Class 3 (Less Exp)
ASC	-11.6	-141.1	534.2
	[-18.4, -4.9]	[-192.1, -90.1]	[-128.4, 1196.8]
Species	0	4.7	-1.9
	[-0.3,0.3]	[3.1,6.4]	[-7.1,3.3]
Trails	10.1	35	16
	[8,12.2]	[24.6,45.5]	[-26.7,58.7]
C&R fishing	4.5	79.5	2.3
	[-0.8,9.8]	[50,108.9]	[-114.1,118.7]
Unlimited fishing	11.9	92.3	124.4
	[5.4,18.3]	[62.3,122.4]	[-37.7,286.6]
Camping	8.3	100.3	132.5
	[4,12.6]	[70.3,130.3]	[-42.8,307.9]
Class shares	34.9%	49.5%	15.6%

Note: The results described above classify respondents into three classes based on childhood experiences and demographics. An individual's nature-related experience is coded as one if an individual did this activity frequently or occasionally and zero if an individual

never did such activity in their childhood. Results show the MWTP for each attribute from class 1 (passive experience with nature), class 2 (active experience with nature), and class 3 (less experience with nature) with 95% confidence interval.

7. Figures

Figure 1: Sample Choice Question

[1] Three main types of grasslands ecosystems are available in the U.S., which are the short-grass ecosystem, the mid-grass ecosystem, and the tallgrass ecosystem. Figure A1 shows the grassland ecosystems in the U.S.
[2] https://www.fs.usda.gov/main/midewin/learning/nature-science
[3] An advantage of coding attributes as categorical variables is that they allow researchers to test and examine a variety of continuous specifications after data have been collected (Johnson et al., 2013).
[4] On each choice card, we remind respondents they have the option to choose the status quo: If you do not like either option A or option B, then please choose the box market "No Restoration Project".
[5] All specifications and analyses are estimated in Stata using the *mixlogitwtp* package (Hole, 2016).
[6] θ_1 is normalized to 0 for identification purpose.
[7] The latent class model is estimated in Stata using lclogit2.
[8] Past research has showed that less-educated individuals are more likely to be under-represented in internet surveys due to limited access to the internet (Manfreda and Vehovar, 2008).
[9] More detailed information of summary statistics for respondents characteristics can be found in Table A2 in Appendix.
[10] In the survey, respondents choose "Frequently" if they did an activity frequently in a specific season, every week, or every month before 13 years old. Respondents choose "occasionally if they did an activity once or twice a year or at least once ever before 13 years old.
[11] For example, Glenk et al. (2015) find the percentage of respondents that non-attendance to cost varies between 25% and 58% and Hensher and Greene (2010) find 5% and 30% of respondents ignored cost. Moreover, Campbell et al. (2008) indicate that 70% of respondents ignored the cost attribute, and Scarpa et al. (2009) report that the share of cost non-attendance can be higher than 90%.
[12] The magnitude of MWTP for bird species is consistent with findings in Dissanayake and Ando (2014).
[13] The baseline attribute level for the fishing attribute is "no fishing," and for the camping attribute is "no camping."
[14] We also explore the possibility of recall bias by using geographic information data to measure features of people's actual childhood locations. More detailed discussion is available in Appendix B.
[15] We evaluate whether these quantitative results are robust if the conditional individual-specific MWTP for each of

the attributes are recovered using the MMNL results from Table A3 Column (1) and (3) (original sample and sample with heavy certainty adjustment). In general, the relationships between childhood experiences and their adult preferences for restoration are reasonably stable to certainty adjustments.

[16] To evaluate robustness, we re-perform the latent class model analysis with unadjusted data and find broadly consistent results. Results are available upon request.

[17] For a restored grassland with 10 bird species, one mile of trail, and the availability of camping and unlimited fishing options.

Choice Question 1

Suppose Option A and Option B are the **only** grassland projects you could choose. Which **one** would you choose? Please read **all** the features of **each** option and then **check the box that represents your choice**. If you do not like either option A or option B, then please choose the box marked "No Restoration project" which is Option C.

Attribute	Number of Bird Species	Biking and Hiking Trails	Fishing	Camping	Cost to your household every year	I would Choose
Option A	30 different species 	1-mile trial 	No restriction 	No camping 	$100	❒ A
Option B	10 different species 	No Trail	No Fishing 	Designated campground 	$10	❒ B
Option C	No Restoration Project： No grasslands, minimum level of different birds species (10 species), no trails, no fishing, no Camping				No cost	❒ C