

Citizen science as a tool for strengthening the sense of community and sense of place through ecological research on the effect of land uses on biodiversity

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Introduction:

This research aims to address two significant topics in nature conservation. The first is the way citizen science can address the human-wildlife conflict by its possible effects on one's perceptions of the environment. The second is the study of the ecological effect of different land uses on small mammal and passerine communities. The place that a person feels "attached" or "belonging" to and the ways we shape our environment via different land uses, are essential aspects in nature conservation, and have a strong presence in the public discourse.

Human-wildlife conflict and citizen science as a possible solution

Citizen science is a process where citizens are voluntarily involved in a scientific process and is one approach to gathering massive amounts of data about our environment. (Silvertown 2009, Conrad and Hilchey 2011). It is a growing trend in biodiversity monitoring in every sector of the nature conservation community from government initiatives, NGO's programs and academic research (Theobald et al. 2015). Some papers propose citizens science as a method to bridge human-wildlife conflicts and empower participating citizens and the local community as a whole (Adams et al. 2014, Larson et al. 2016).

In the last century, we are experiencing a global and local biodiversity decline (Butchart et al. 2010, Newbold et al. 2015). One of the cultural barriers for the decline in biodiversity conservation refers to the "extinction of experience". That is, people in modern societies experience the declining presence of nature in their life and hence feel less in need for wildlife presence and less obligation or even will to act for its conservation. Some even feel a need to reduce or eradicate natural wildlife or niches when they encounter them. This destructive cycle of the Human-wildlife conflict must be addressed in order to justify biodiversity conservation (Miller 2005, Soga and Gaston 2016). Also, on the local scale, we can see the importance of the cultural heritage of nature conservation. Different communities in the same country can differ in the way they think and act towards biodiversity conservation (Manfredo et al. 2016) and research from diverse Israeli cultures showed that environmental education is a crucial vector that bridges those gaps (Orenstein et al. 2017). We suggest that citizen science may have social and psychological aspect that affects the ways a person and a community perceive

nature in their back yard or in their region. If participating in citizen science does have a significant positive effect on one's sense of belonging to one's natural environment, then encouraging such participation may help to better address the human-wildlife conflict.

The effect of wildlife presence on "sense of place" and "sense of community" in relation to wildlife

The direct and indirect presence of wildlife can affect a wide range of anthropological, cultural and psychological aspects (Schänzel and McIntosh 2000, Smith and Pijanowski 2014). The "sense of place" is a psychological term, which is defined as the cultural and natural properties of the landscape that makes it unique in a person's perception (Shamai 1991, Williams and Stewart 2015). The meaning of a 'place' includes both human and non-human, living and non-living elements, thus, "sense of place" also includes the wildlife community that exists in the place.

"Sense of community" is another psychological term that was described as: being a member, understanding the boundaries, having emotional security, having the possibility to influence and to be influenced, fulfillment of needs, shared emotional connection (McMillan and Chavis 1986). One's sense of community is a factor that we believe can be affected by wildlife presence as a part one's community.

To connect people of western societies to the wildlife dimension, we can use immediate hunter-gatherers' practices such as listening to wildlife acoustics and reading tracks and signs (Barkai, 2017; personal talk). Research from Namibia on tourist ecosystem-experience showed that seeing tracks and signs of wildlife can be satisfying almost like an actual sighting of the animal (Fiedeldey 1994). Also, it is claimed that the calls of the birds are speaking the basic fundamentals of music (Cohen 1983). Anthropological research from the anthropology field showed that modern people could also develop those perceptions during participation in workshops of learning the "language of birds" (Appel 2016). The research group showed how the experiment groups could develop immediate hunter-gatherers perceptions on their environment by seeing a bird as a subject or even a fellow person and not as a mere example of a species or category. They believe that those changing perceptions are linked to the process of moving from nomadic to agriculture economy, where they begin to perceive the animal as a species and not as a person. They suggest that this process is reversible if the person will experience nature without a designated claim (Naveh and Bird-David 2014).

Tracks and Bioacoustics monitoring are also a powerful tool for ecological research. It can verify the presence and reveal the behavior of a variety of species without direct observation (Steyn and Liebenberg 1990, Brosh and Adam 2012). The evolving statistical methods, computerize power and the software to analyze the data from tracks and especially bioacoustics made those fields arising methods in the ecological research of the recent decade (Brandes 2008, Hines et al. 2010, Aing et al. 2011, Keeping and Pelletier 2014, Wa Maina et al. 2016, Campos-Cerqueira and Aide 2016), and even in citizen science programs (Moskowitz 2010, Zilli et al. 2015, Pipek et al. 2018)

Land use patterns effect on biodiversity

With the data of tracks and bioacoustics, this ecological study will evaluate how different land uses may affect passerine and small mammal's communities. This ecological question is essential to developing nature conservation policy in landscape planning committees, and, moreover, to developing an adequate question to address with the tool of citizen science.

It is believed that as the world population increases the extent and quality of natural habitats will decrease due to demand for agricultural lands and urban development. Understanding how to maintain biodiversity in diverse mosaic landscapes is a primary goal in nature conservation (Schneider 2001, Green et al. 2005). It is particularly true in Israel's Mediterranean region where over 40% of the land-cover was already transformed to agriculture, and these numbers will increase in the future (State of Nature Report, Hamaarag, 2016).

The variation in land use (as annual crops, orchards, cattle grazing, nature park roads and buildings) has different consequences for different species. The effect can be summed to a few significant aspects: The first, the change in habitat structure. It can result from lower annual grass or increase the height of the habitat (planting orchards, buildings powerlines, and roads). These changes either increase exposure or create shelters. Environmental agriculture techniques as conservation tillage leave the annual plants on the ground. It creates cover and a food resource for arthropods and rodents (Holland 2004). Also, tree planting and electricity lines can increase nest predation by providing a suitable habitat for nest predators (King et al. 2009, Masoero et al. 2016). Second is the change in food availability or the change in the cost of foraging. Irrigation in the dry season and, planting nonnative plants provides green leaves, nectar, and fruits out of the locale seasonal cycle or form an ecological trap to prey (Baker and Harris 2007). Agriculture and the abundance of food around settlements can increase the mammalian predator community (Hilty et al. 2006, Bino et al. 2010). Food availability can also

change the intensity of birds song and mobbing reaction to predators as shown in a few studies (Duncan Rastogi et al. 2006, Ritschard and Brumm 2012, Batáry et al. 2014)

Those changes to the habitat can affect in predator/prey interactions by changing the efficiency of the prey's flight behavior. For example, grazing can increase psammophilic species abundance in the open habitats due to the low plant cover, which helps them to escape predators more efficiently (Schooley et al. 1996, Shanas et al. 2006). An opposite effect in research from the Mediterranean shrublands showed that in cattle grazed land there was a decrease in Mediterranean Maquis rodents occupancy due to low annual grass height and insufficient shelter (Rosenfeld 2004)

The food availability and the fear effect from predators can also create a change in foraging patterns and new land-use patterns for different species (L. Thomson et al. 2006, Hawlena and Pérez-Mellado 2009) by the increasing number of predators and invasive species near the anthropogenic disturbance. As was demonstrated the way Mountain gazelles (*Gazella gazelle*) do not utilize all the open land because of high predator density in cattle grazing lands and high human presence in the agriculture lands (Shamoon et al. 2017). Road structure can alter the foraging behavior of predators and prey and change the resource of food and prey (Trombulak and Frissell 2000)

We assume that the change in species richness and diversity affects in two ways: the first increase of generalist species proportion should be higher in the edge of the anthropogenic disturbance to increase food availability and complexity of habitat structure (Benton et al. 2003). In the sizeable natural habitat and agriculture patches, we predict to find lower richness, but the community will be composed of more specialist species (Krannitz 2007, Cariveau and Winfree 2015).

The second, fitness change, as the white-breasted hedgehog (*Erinaceus concolor*), shows increased density in populated lands. It also shows a growing trend of scabies infection (*Sarcoptes scabiei*) that leads to spike loss and even death (personal communication, Dr. Rona Valency the wildlife hospital, 2018) or as an effect of behavioral change in the parental behavior in the nesting season due to the need to defend the nest from local invasive species as cats (Haskell et al. 2001, Bonnington et al. 2013).

The cultural, economic, and historical differences between communities can alter the wildlife community structure by using the land in different methods for different needs (Kinzig et al. 2005, Shanas et al. 2006, Fischer et al. 2008).

Knowledge of land-use effects may lead to operational models to preserve the landscape heterogeneity and biodiversity at temporal and spatial levels (Shanas et al. 2006). In that sense, this study will continue the work of Shamooun (2018), who showed the various effects of land use on medium-large size mammals in the Nadiv valley by expanding our knowledge on micro-mammal and passerine response to different land uses in rural, agriculture and urbanized settings (Shamooun 2016).

While nature conservation policy needs to be decided through ecological measurements, it is also influenced by local politics and psychological vectors. In our research, we will conduct a meaningful ecological study with the community, which will assess the effects of land-use patterns on the local wildlife species assemblage while using methods of wildlife track monitoring and bioacoustics sampling. We hope that our program will add critical ecological data and empower the community with quantitative tools to understand the ecological aspects of different land uses.

Our study attempts to evaluate the impact of environmental citizen science using wildlife monitoring at a local and regional scale. We aim to study the means to significantly a) empower one's "sense of place", b) "sense of community" and one's links to wildlife presence in one's "place" or "community", c) assess the effect of varied land use on the small mammal and bird community assemblage. In essence, the study mainly evaluates whether the indirect sensory methods of wildlife monitoring as seeing tracks and hearing bioacoustics calls can assist in perceiving the wildlife presence.

In other words, if citizen science that relates to wildlife can also increase one's sense of place, sense of community, and perception of wildlife as part of one's place or community. Using this method may be a first step toward increasing the will of citizens to invest in biodiversity conservation at a regional or local scale.

Research objectives:

1. To examine the social relevance of a citizen science project by assessing if there are significant changes in the participants "sense of place" and "sense of community" before and after conducting a wildlife citizen science project on a local and regional scale.
2. To examine and assess the effect of varied land uses on the small mammal and bird community assemblage.

Research hypotheses

We hypothesize that participating in one season of data gathering in our citizen science project and the process of knowing the local wildlife would strength the “sense of place” and “sense of community . The main factors that will contribute to the change will be the process of getting to know the local wildlife and acquiring the skills to find their presence near their place of residence in our citizen science project.

For the small mammals, we hypothesize a degradation in species richness and higher presence of the commensal brown rat (*Rattus rattus*) in correlation to distance from the urban landscape and the presence of cats (*Felis silvestris*) as shown in our preliminary test.

We hypothesize that some agriculture practices will be more beneficial to species richness and to individual species than others. For example, hedgehogs may be more common in the cities and the cultivated lands, as our preliminary results show.

The bioacoustics monitoring will differ with a higher rate of mobbing calls and fewer juvenile begging calls in the urbanized landscape. These changes may occur due to the higher presence of nest robbers as Eurasian jays (*Garrulus gladiolas*) and cats.

Methods

Study area:

From Sharon plain to the Nativ Valley in the central- west of Israel, our study area is a mosaic of urbanized landscape, agriculture and rural areas of we have joined to leading organizations of environmental communities. The "partnership for regional sustainability" connects five neighboring regional councils: Alona, Binyamina-Givat Ada, Jasr A-Zarka, Zikhron Ya'akov, and Hof HaCarmel to Pardes Hanna-Karkur environmental department, the Sharon environmental unit, and the NGO Eco-ocean. During the research we will join the local communities' environmental efforts to monitor and preserve the local natural habitats. In each community research area, we will give an adequate representation of the significant parts of the landscape mosaic. Every plot will include gradient of distances from the edge of the urbanized landscape and variety of land uses as: orchards, vineyards, oak forest, shrubland, and open grasslands.

Data gathering software

The everyday use of smartphones, which are full of sensors and computerized tools, facilitates the collection of high-quality environmental data (Zilli et al. 2015). To make the process of data gathering as simple as possible to the participants, we will use a [Telegram messenger chat-bot](#)

application that will be tailored to the research needs. All data will be uploaded through the chat-bot to a specialized database that can be categorized to the different monitoring protocols. The chat-bot will also function as a news platform, community group chat, feedback of the participants on their sightings and as a platform for the psychological questionnaires. A website will be built to show data from the server. It will include a map of the monitored plots, descriptive statistics and multimedia files from the field.

Community work

The research will be conducted during three years with 2-4 monitoring seasons for each year. We will advertise a call for participants three months before each field survey. The chosen participants will participate in a short-dedicated workshop to give technical background, explain the research goals and discuss the outcomes for each community; from the broad community, we will choose leading participants to help coordinate the field samplings. Furthermore, parallel to fieldwork, we will conduct a series of educational and community events to create a meaningful conversation between the research and the citizens (Bonney et al. 2009). We wish to work with two communities that differ in their interests: 1. Local families – for monitoring the urban and the field close to the urbanized lands. 2. Youth movements – for the rural lands and the cultivated lands.

In every survey, the participants will be asked to identify all the species in their site with dedicated field guides and to send the track images and sound files. All the results from the track images and sound files will be analyzed by certified wildlife trackers (Evans et al. 2009) and bioacoustics software (Hafner and Katz 2018). The correct answers will be sent to each participant with descriptive statistics of all the community sampling efforts and data. All files will be managed through amazon web cloud service. The data will be open to the public through a dedicated website based on [AngularJS](#)

Geographical data analysis for the ecological model

Spatial data for each site will be collected through remote sensing and local municipalities mapping services. We will gather spatial data of vegetation, agriculture, buildings, roads. Data on land cover, geomorphology, and connectivity to rural lands will be achieved with the help of the “Hamaarag” and the Open landscape Institute – Deshe from The Steinhardt Museum of Natural History. Light pollution data will be based on the commercial EROS-B satellite (Levin and Phinn 2016).

Questionnaires for "sense of place" and "sense of community."

Each participant will answer questionnaires before and immediately after entering each of the monitoring seasons (see Table 1). The same questionnaires will be answered 3 months after the monitoring season to look at long-term effects. The questionnaires will be built by psychological criteria of Sense of Place (SOP) (Shamai 1991) in relation to the residence and its natural environment and Sense of Community Index (SCI) (Carpiano and Hystad 2011) questionnaires based on Macmillan's work (Mcmillan and Chavis 1986) in relation to the local wildlife in his neighborhood and another questioner in relation to his "local nature". We will also add the short "Nature relatedness NR-6" index (Nisbet and Zelenski 2013) to the questionnaires. It will measure if the person's nature relatedness background correlates to other variables in our study. To focus the questionnaires and to adjust the variables for our questions on the natural environment and the local wildlife, we will build a preliminary ecological survey to investigate the main factors that influence the participant's perception of wildlife through a focus group.

The questionnaires will also be sent to two control groups (150 each). One comprised of citizens who spent time in the same outdoor localities but did not participate in a citizen science project. The second will be a group of citizens who typically do not spend time in nature nor the specific outdoor localities and who did not participate in the citizen science project. With the data of their sightings from the files and the participants' identification, we will be able to analyze the learning curve of the participants in the study.

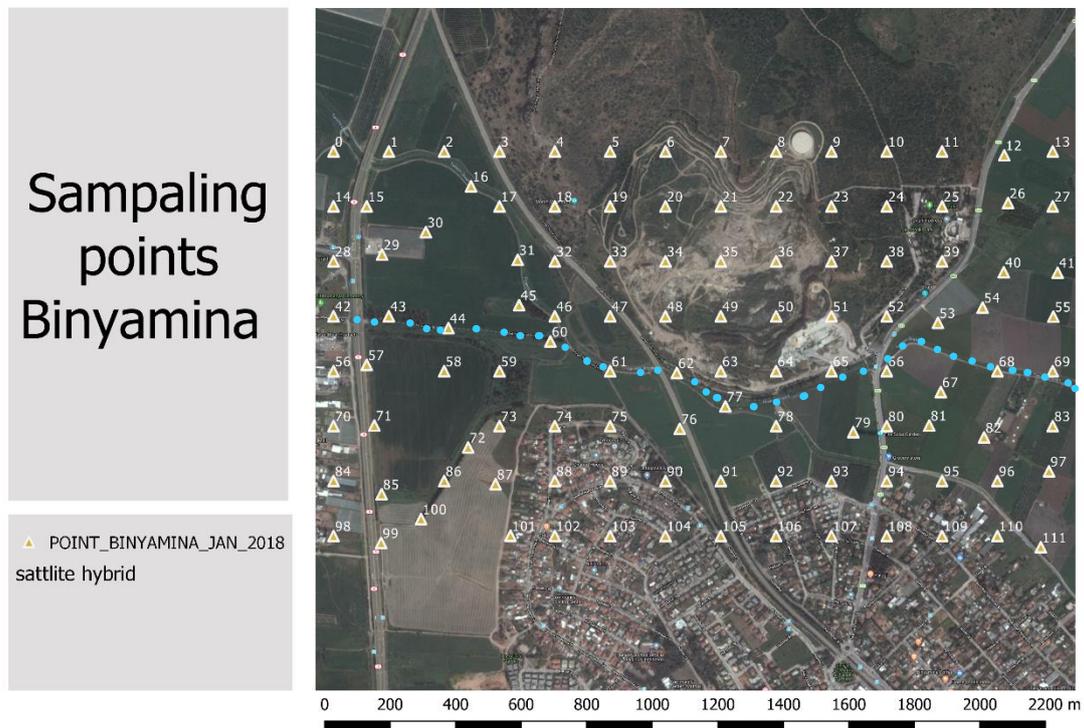
Ecological field sampling

Study design:

For each community, we shall create an online map to guide field monitoring. The map will include a grid of 100-200 points 200 meters apart. Each grid will include points in the urbanized, agriculture and natural landscape. This study design will be sufficient to prevent autocorrelation in the occupancy of rodents (personal talk, Tal Levanony) and Eurasian blackbird (*Turdus merula*) territory – a medium-size passerine (Wysocki et al. 2004).

Each organized community will accept responsibility to monitor 10-40 points in their locale monitoring map. Distant points will be monitored by us. The study design will address the local environmental questions that are relevant to the native community. As seen in Map 1. We chose Binyamina to monitor the Taninim stream at the request of the community that wishes to

develop this area as their natural park. Moreover, it may help to ecologist to evaluate the stream as a possible ecological corridor between Ramat-Hanadiv and Alona hills rural lands.



Map 1: The sampling points array of the research in Binyamina around the narrow corridor of the Taninim stream.

This array of sampling points will be monitored by the community at least one time each monitoring season. In this array we will use two monitoring protocols:

Track-plate monitoring

Track plates is a method that was first developed in the U.S. in the 1940s. It is mostly used with small to medium mammal monitoring around the world (Silveira et al. 2003, Rytwinski and Fahrig 2007, Zielinski and Truex 2016). The method uses an artificial nontoxic colored a sticky plate (transparent wallpaper) inside a tunnel to capture high-quality tracks.

Track plates will be placed in local communities in private and public gardens and fields following appropriate training. In every track plate location, the participant will record the following parameters; time and date, GPS coordinate and surrounding plantations and buildings. All the tracks will be scanned and uploaded to a dedicated chatbot/website. We will also place 50 track plates in the rural areas as control plots. The experiments will be made in the wet (April) and dry (October) seasons for two years.

Soundscape recordings

We will conduct a bioacoustics survey with the community, after a basic course on bird call and soundscape recording practice. During the research months, we will ask the participants to record 10 minutes of Oga sound file through the "chat-bot." Each recording will be tagged with time, date, phone model, and the sounds that the participant can identify. The bioacoustics monitoring will be conducted in three meaningful months for bird activity. October for the fall migration and march for the spring migration and the beginning of the nesting season.

The files will be scanned for four common passerine calls: Sardinian warble (*Sylvia melanecoplea*), graceful piriña (*Prinia gracilis*), great tit (*Parus major*) and Euroasian blackbird (*Turdus merula*). Those species were selected by their abundance, ease of detection by sound, with priority to the group of foliage invertebrates feeding birds who shows a decline from modern practices of agriculture (Wilson et al. 1999, Atkinson et al. 2004). Their calls will be classified by their different acoustic behavior (song, alarm-mobbing, begging). They will be detected through template matching with the "MonitorR" package from annotated libraries (Hafner and Katz 2018). To address the sound level difference between the phone models, we will choose from the database recordings that were made in similar phone models (Murphy & King, 2016).

Statistics

Questioners of SOP and SCI

The SOP and SCI questionnaires (see below, after the reference list) will be analyzed through Spearman correlation, linear discriminate analysis (LDA), and factor analysis models to look at the difference in the three community groups, time frame and the importance of the variables to distinguish between the groups.

Ecological community structure

The track-plate species presence/absent data will be analyzed through nestedness, turnover, beta diversity in the different land uses (Baselga et al. 2018). The acoustic behavior data will be analyzed with occupancy models as the explained variable and NMDS ordination to characterize different land use (Wagner et al. 2016) to understand the effect of the different land use on the birds predation pressure, fledgling abundance and song duration.

Ecological spatial analysis

An occupancy model (MacKenzie 2017) will be built with the correction of the detection probability of the participants. For this analysis we will use a special method to calculate Occupancy with a single-visit which available R package “detect” (Figueredo and Dias 2004) The model will be built using spatial data (from the Maarag, and Deshe institutes) as vegetation type, distance from agriculture, roads and settlements, connectivity to rural areas, camping activity and light pollution to predict the variables that affect the small mammal's community and passerines acoustic activity. The model will be projected on a map using the unmark R package (Chandler 2015).

Expected outcomes

- Test of the effect of community citizen science on empowering one's sense of place and sense of community in relation to the wildlife dimension.
- Map of the community of small-medium mammals and passerine acoustic behavior in correlation to patterns of land use.
- Two protocols for citizen science ecological monitoring.
- Tools for the local community to monitor and assess the influence of land use policy on regional wildlife.

2. אני מרגיש מרוצה במקום שבו אני חי.
3. אני רואה חשיבות בלהיות תושב המקום.
4. אני מרגיש בנוח לחיות במקום.
5. אני רוצה להמשיך לחיות במקום.
6. אני מעדיף לא לספר לאף אחד שאני מהמקום.
7. מידת השילוב במקום גבוהה.
8. יש לי חברים מהמקום.
9. אני מרגיש מחויב למקום.
10. יש לי זכויות מלאות במקום.
11. אני מזהה את עצמי עם המקום.
12. אם תהיה לי ההזדמנות לשרת את המקום אשתמש בה.
13. אם יציעו לי לגור בסביבה אחרת במקום אני אסכים.

ביחס לטבע המקומי: תוספת שאלות "תחושת המקום"

1. אני דואג לסכנות הקיימות לשדות.
2. אני מרגיש מרוצה בשדות לידם אני גר.
3. אני רואה חשיבות בטיולים בשדות.
4. אני מרגיש בנוח לטייל בשדות.
5. אני מרגיש זר בשדות.
6. אני רוצה להמשיך לטייל בשדות.
7. אני מרגיש בטוח בשדות.
8. מידת ההכרות שלי עם השדות גבוהה.
9. אני מרגיש מחויב לשדות.
10. יש לי זכויות מלאות בשדות.
11. אני מזהה את עצמי עם השדות.
12. יש לי תחושת שייכות לשדות.
13. אני גאה לגור ליד השדות.
14. אני מרגיש חלק בלתי נפרד מהשדות.
15. אם תהיה לי ההזדמנות לעשות למען שמירת השדות אעשה זאת.
16. אני יציעו לי לגור בסביבה אחרת אני אסכים.*
17. אני מרגיש בנוח כשאני פוגש חיות בר.
18. אני מרגיש מאוים כשאני פוגש חיות בר.

שאלון אינדקס "תחושת קהילה" עם חיות הבר :

עובד מתוך – "Sense of Community index, Chavis, Lee, & Acosta, 2008"

מסכים מאוד - 5 4 3 2 1 - מתנגד מאוד

1. אני מקבל תשובה לצרכי מחיות הבר בגלל שאני חלק מהם. (1)
2. חיות הבר ואנוכי מערכים דברים דומים. (2)
3. להיות חלק מקהילת מחיות הבר גורם לי להרגיש טוב. (4)
4. כשיש לי בעיה אני יוצא לטיול לחפש את חיות הבר. (5)

5. לי ולחיות הבר צרכים והעדפות דומים(6).
6. אני יכול לבטוח בחיות הבר.(7)
7. אני יכול לזהות את רוב חיות הבר.(8)
8. חיות הבר באזור מכירים אותי.(9)
9. אני משקיע הרבה מאמץ וזמן להיות חלק מעולם חיות הבר. (11)
10. להיות שייך לעולם חלק מחיות הבר זה חלק מהזהות שלי.(12)
11. השתלבות בעולם חיות הבר הוא דבר חשוב בשבילי.(13)
12. חיות הבר יכולים להשפיע על קהילות אנושיות.(14)
13. אכפת לי מהצורה שחיות הבר תופשות אותי.(15)
14. יש לי ההשפעה על צורת ההתנהגות של חיות הבר.(16)
15. אני מרגיש שאם קיים חיכוך עם חיות הבר הוא ניתן לפתרון.(17)
16. מאוד חשוב לי להיות חלק מעולם חיות הבר.(19)
17. אני מבלה הרבה זמן במחיצת חיות הבר ונהנה לבלות איתם.(20)
18. אני מצפה להיות חלק מעולם חיות הבר חלק ניכר מחיי. (21)
19. אני נהנה יותר בזמן אירועים מיוחדים בטבע (גשם ראשון/מעוף כלולות/נדידה).(22)
20. אני מלא תיקווה לגבי עתיד חיות הבר. (23)

יצאו מהשאלון שאלות:

Reinforcement of Needs = Q3

Membership =Q10

Influence =Q18

Shared Emotional Connection =Q24

שאלון קשר לטבע

תורגם מתוך - " The NR-6: a new brief measure of nature relatedness"

Elizabeth K.Nisbet and John M.Zelenski

מסכים מאוד - 5 4 3 2 1 - מתנגד מאוד

1. החופשה האידיאלית שלי תהיה במיקום מרוחק בטבע פראי.
2. אני תמיד חושב כיצד המעשים שלי משפיעים על הסביבה שלי.
3. הקשר שלי עם הטבע והסביבה הינו חלק מעולמי התרבותי/רוחני.
4. אני מחפש חיות בר בכל מקום שבו אני מסתובב.
5. הקשר עם הטבע הינו חלק משמעותי מהזהות שלי.
6. אני מרגיש קשור לכל היצורים החיים בכדור הארץ.

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