MindStreet

# Fishing for Calm – Impact of a Structured Fly-Fishing Program on Veteran Mental Health

## A Pre-post Observational Pilot Study[1]

October 1, 2025


## Abstract

**Importance:** Veterans face unique challenges when transitioning to civilian life. They are statistically at increased risk for mental health conditions such as depression, anxiety, and posttraumatic stress disorder (PTSD) due to the stress of combat, injuries, and the loss of camaraderie. These conditions lead to higher rates of mental health issues and suicide among veterans, compared to the general population, highlighting an urgent need for effective, accessible, and targeted interventions for veterans.

**Objectives:** This pilot study aimed to investigate the impact of a week-long nature-based fly-fishing trip on mental health measures among veterans. The study's objective was to assess the benefits of a structured, nature-based fly-fishing program. A secondary objective was to examine results from potential influencing variables to inform future, more robust research studies and program designs.

**Design, Settings, and Participants:** This pre-post observational study was conducted by MindStreet, Inc. and involved 157 veterans who participated in a week-long, capstone fly-fishing trip organized by Project Healing Waters Fly Fishing, Inc. (PHW) at two locations: Freedom Ranch for Heroes in Wise River, Montana, and Oak Heart Lodge in Newaygo, Michigan. Participants were recruited into 29 cohorts, each comprising 8-10 veterans, between July 8, 2024, and November 23, 2024. Voluntary self-administered mental health assessments were conducted at two time points, approximately one week before the trip, and at approximately four weeks after the trip.

**Experience:** The study involved a week-long fly-fishing trip. The trip is a capstone annual event of an ongoing, structured fly-fishing program for veterans. The fly-fishing program teaches fly-fishing skills, fosters camaraderie, and provides a nature-based therapeutic experience to PHW members. Other than logistical and technical support and motivational encouragement by staff, no other support was included as part of the study.

**Outcomes and Measures:** The primary outcomes measured were pre- and post-trip changes in symptoms of depression (Patient Health Questionnaire-8, PHQ-8), anxiety (Generalized Anxiety Disorder Questionnaire, GAD-7), and PTSD (Computerized Adaptive Testing – Mental Health, CAT-MH), administered by Adaptive Testing Technologies, Inc.

**Results:** Subjects with no or mild pre-trip symptoms remained asymptomatic after the trip. Subjects with moderate to severe pre-trip mental health symptoms (PHQ-8 ≥10, or GAD-7≥10, or CAT-MH PTSD ≥ 47) showed statistically significant reductions in depressive, anxiety, and PTSD symptoms immediately following the fly-fishing trip. Mean PHQ-8 scores decreased from 13.59 to 9.93 ($p < .001$), mean GAD-7 scores decreased from 13.82 to 9.04 ($p < .001$), and mean CAT-MH PTSD scores decreased from 59.50 to 48.20 ($p < .001$).


## Key Points

**Question:** Does a nature-based fly-fishing trip with a cohort of veteran peers have the potential to improve mental health markers in veterans?

**Findings:** In this pre-post observational study of 157 veterans, statistically significant reductions in symptoms associated with depression, anxiety, and PTSD were observed. Mental health indices were recorded pre-trip. Measures were repeated approximately 30 days post the fly-fishing trip.

**Meaning** Study findings support the use of immersive nature experience with peers to assist in veteran mental health care. Future research with larger, randomized controlled trials and additional post-trip monitoring is needed to validate these findings and any potential for durability of improvements.

[1] The study was sponsored by Project Healing Waters Fly Fishing Inc. and conducted by MindStreet, Inc. For further information or any questions, please contact Chris Woodward, VP Operations at chris.woodward@projecthealingwaters.org or Dr. Brian Mayhugh, CEO at dbm@mindstreet.com.

**Conclusions and Relevance:** This pilot study suggests that a nature-based fly-fishing program can produce meaningful short-term improvements in mental health symptoms among veterans. While the fly-fishing trip provided immediate benefit, future research with larger randomized controlled trials and longer-term follow-up is needed to validate these findings and explore the specific mechanisms of action.

## Introduction

Veterans face unique challenges when transitioning back to civilian life and are at increased risk for mental health conditions such as depression, anxiety, and posttraumatic stress disorder (PTSD). The stress of combat, injuries, unique stressors, and the loss of camaraderie post-discharge lead to a higher prevalence of mental health conditions compared to the general population.[1,2,3,9,35,37] The impact of mental health challenges on veterans can be long-lasting. Studies on veterans of past conflicts reveal persistent symptoms even decades after their service concluded.[4] This enduring burden is compounded by the concerningly high rates of suicide among veterans, which significantly exceed those of the civilian population, underscoring the urgent need for effective, accessible and scalable interventions.[1,10,34]

Traditional treatments, while effective, may not fully address the unique needs of this population. Despite the availability of conventional mental health services, many veterans face barriers to accessing and engaging with such care.[7,8,20] Traditional therapy is also expensive, resource-intensive, often inaccessible, and may not fully address the specific needs of veterans. These barriers can include the stigma associated with mental illness within military culture, logistical challenges such as geographical distance and scheduling conflicts, and a preference among some veterans for privacy and self-reliance.[5,10] Consequently, a recognized need exists to explore and evaluate alternative and innovative approaches to support veterans' mental health and well-being.[6,11,12] Experiential and clinically validated therapies, such as outdoor, nature-based activities, and digital cognitive behavioral therapy programs, have shown promise in improving mental health outcomes.[13,14,15] This has led to the rise of tailored veteran mental health programs incorporating unique elements, including shared experiences and connections to nature. [11,12,16] Research has shown that spending time in nature can lower stress, improve one's mood, and enhance feelings of well-being.[7] There is growing recognition of the effectiveness of nature-based therapies for veterans with PTSD and other mental health conditions.[6,16]

Fly fishing has been used as a therapeutic recreation tool for veterans as it offers a unique combination of benefits,[11,12,16,] and can have profound effects on improving veteran mental health. Mastering fly-fishing skills, from understanding the gear and casting techniques to reading the water and tying knots, helps (re)build fine motor skills, provides a calming focus, and a sense of accomplishment. Engaging with nature and the meditative rhythm of casting in the tranquil setting of rivers and lakes provides a refuge from the stresses of daily life, allowing veterans to reconnect with nature.[17] The program also fosters camaraderie among veterans. It creates a supportive community where they can share experiences and find strength in a shared purpose, foster social connections, and enhance emotional well-being through a network of peers and mentors with similar lived experiences.[11,12,16,18,19]

### Purpose

This pilot study aimed to observe the impact of a week-long fly-fishing trip on mental health outcomes, a capstone event of a structured, ongoing fly-fishing program offered by PHW. The primary objectives were to assess the immediate therapeutic benefits of the fly-fishing trip for veterans experiencing symptoms of depression, anxiety, or PTSD. A secondary aim of the pilot study was to explore influencing and predictive variables on outcomes to help inform future program designs and leverage scarce resources to maximize the impact on veterans. MindStreet designed the study to explore changes in anxiety, depression, and PTSD related symptoms across the study period to assess potential signals of effect and inform future study designs.

### Project Healing Waters Fly Fishing, Inc.

Founded in 2005, Project Healing Waters Fly Fishing, Inc. ("PHW") is a Colorado-based non-profit that seeks to physically and emotionally support disabled active duty and veteran personnel through fly fishing-associated activities, including education and trips.[11] Leveraging its large group of volunteers, PHW provides therapeutic recreational experiences to its 7,000+ members with connection, camaraderie, and community. All activities and services, including equipment and materials, are free to its members. By focusing on the art, education, and skills

of fly fishing, PHW aims to enhance the quality of life for its members, fostering a sense of accomplishment and acceptance. In addition to regular activities, several hundred members are proportionately selected annually from its 19 local chapters and sent on a week-long, no-cost fly fishing trip in Montana or Michigan. PHW has provided these week-long fishing trips to its members since its founding and has gathered over 20 years of anecdotal evidence on the positive mental health effects of their nature-based programs on veteran mental health.

### MindStreet, Inc.

MindStreet, Inc. ("MindStreet") is a pioneering digital therapeutics company that develops clinically validated, evidence-based digital cognitive behavior therapy (dCBT) programs to treat mental health disorders, such as depression, anxiety, and chronic pain. Developed on its proprietary computer-assisted CBT (CCBT) platform, these programs are as effective as 1:1 CBT but delivered at a fraction of the cost and time. CBT is a clinically validated protocol used by clinicians for over 50 years to treat a range of mental health conditions. MindStreet develops over-the-counter (self-directed) and prescription (clinician-administered) versions of its dCBT programs. The programs include structured, asynchronous, psychiatrist-led, protocol-compliant CBT content, assessments, exercises, and motivational support, delivered digitally using interactive, multi-media formats. Accessible anytime, anywhere, privately and securely, these programs teach users how to identify, address, and manage maladaptive thoughts, feelings, and behaviors. MindStreet designed, led, and executed the study, working closely with PHW staff and utilizing its Good Days Ahead™ program as the study platform.

#### Adaptive Testing Technologies, Inc.

Adaptive Testing Technologies, Inc. (ATTI) pioneered advanced mental health screening and measurement tools. ATTI developed CAT-MH® and K-CAT®, the first and only validated, comprehensive adaptive assessments based on the science of item response theory. These innovative tools can be delivered asynchronously and provide unprecedented precision and accuracy compared to traditional, fixed-length, in-person mental health assessments. Designed for flexibility, the assessments can be administered digitally anywhere, to any population size, at any frequency, whether in clinical settings or beyond. ATTI's products are widely trusted and used by federal and state government agencies, as well as hospitals and clinics, across the United States. ATTI continues to lead the way in transforming mental health evaluations through cutting-edge technology.

## Methods

### Study Design, Settings, and Subjects

This pilot study employed a fully digital, decentralized, non-blinded, non-randomized, pre-post observational design to compare the mental health markers of subjects who participated in a week-long fly-fishing trip. MindStreet informed subjects and researchers about the study's purpose, intent, and structure. All trip participants were briefed by a PHW trip coordinator about the trip and study before their departures. Potential study subjects were provided with detailed information about the study through a dedicated website, email, and webinars for team leads. The study assessed the impact of fly-fishing on mental health markers of depression, anxiety, and PTSD. Members seek out the trip experience and are made aware of the program during regular monthly local PHW chapter meetings, through alum referrals, and other veteran resource groups. Study subjects were selected by PHW using routine internal processes. MindStreet or its researchers had no influence or input in selecting study subjects. PHW assigns trip participants into 52 cohorts each year for these national trips that run from March to November at the Freedom Ranch for Heroes in Wise River, Montana, or the Oak Heart Lodge in Newaygo, Michigan. Each cohort comprises approximately 8-10 veterans, including a team lead. Selected PHW members were invited to participate in the trips, which were split between the two facilities. After IRB approval and study startup activities, 255 trip participants from 29 cohorts starting on July 8 2024, and ending on November 23, 2024, were eligible for subject recruitment. Following screening and consent, subject mental health assessments were conducted at two points in time, approximately one (1) week prior to the fly-fishing trip (pre-trip), approximately four (4) weeks after the completion of the trip (post-trip).

### Primary Objective

The study's primary objective was to investigate the potential impact of a nature-based fly-fishing program on veteran mental health. Subgroup analysis using exploratory endpoints was used to identify possible changes in protocols required and generate information on relationships to inform the design of future cohorts and research.

The pilot study results will guide a more robust trial to discover influential factors and optimization opportunities to improve short- and long-term mental health outcomes.

### Experience

Nature-based interventions have garnered increasing attention for their potential therapeutic benefits on mental health.[19,15,16,21] Exposure to natural environments has been linked to positive outcomes, including reduced stress, anxiety, depression, and improved mood and cognitive function.[12] These effects are often explained through theoretical frameworks such as Attention Restoration Theory (ART), Stress Reduction Theory (SRT), and Cognitive Behavioral Therapy (CBT), which propose that natural settings can help restore cognitive function and reduce physiological stress.[21,22,23,] Fly-fishing, as a specific type of nature-based activity, has emerged as a promising intervention for veterans struggling with PTSD, anxiety, and depression.[18,19,24,25,26,36] PHW's fly-fishing programs are intended to be a transformative journey where the art of fly fishing meets the science of healing. It is about gaining perspective on life's flowing currents and learning to navigate them with grace and resilience. Fly fishing as a practice embodies dexterity and patience, providing a unique environment for mindfulness, focus, and reflection. The tranquil atmosphere of natural waterways can also induce relaxation and a sense of peace.[19] The rhythmic motion of casting a line, the focus on the present, and the deep connection with nature and peers are peaceful and therapeutic. The experience is not just about learning to fish; it is about discovering a baseline to begin the journey of healing. Trip participants are taught key fly-fishing skills, including casting, rod building, fly selection and rigging, reading the water, knot tying, fish behavior, mending, observation, and strike detection. In addition to recreational and skills education, the trip is designed to help build camaraderie, connectedness, and community within the cohort and the larger PHW membership, which are crucial to the healing process

### Outcome Measures

Following a structured awareness campaign (including a website, webinars, and email), and upon enrollment, study subjects were administered a series of digital baseline mental health assessments. Assessments included self-reported standard and clinical assessments, including i) a single-item self-reported rating for depression (0 = not at all, 10 = severe), ii) a single-item self-reported rating for anxiety (0 = not at all, 10 = severe), iii) the Patient Health Questionnaire-8 (PHQ-8)[27] screening tool for depressive symptoms, iv) the Generalized Anxiety Disorder Questionnaire (GAD-7)[28] screening tool for anxiety symptoms, and the v) Computerized Adaptive Testing - Mental Health (CAT-MH),[29] a clinical-grade assessment for depression, anxiety, and PTSD created by Adaptive Testing Technologies, Inc.. Subjects were instructed to complete the pre-trip assessments within seven (7) days before their trip departure date and scheduled to complete post-trip assessments at least four (4) weeks after returning from the trip.

### Participant Selection

Study subjects were recruited from eligible PHW veterans aged 18 or older, representing diverse genders, ethnicities, races, and geographies. Study subjects were invited to attend the no-cost, week-long fly-fishing trip. Each weekly trip cohort consisted of 8 to 10 veterans and PHW leadership staff on-site. Local PHW chapters nominate trip participants using long-standing, internal criteria, including funding, logistics, availability, previous participation, and disability status unrelated to the study.

### Inclusion and Exclusion Criteria

Subjects with a Veterans Administration disability rating of 0% or greater were eligible for the study. Subjects had to be willing to adhere to study procedures and participate in moderate outdoor physical activity. Additionally, subjects were required to reside in the US, be capable of providing voluntary consent, have access to an internet-enabled device (such as a mobile phone, laptop, or desktop) during the assessment periods, and understand and follow directions in English. Exclusion criteria were utilized to ensure subject safety and program effectiveness. Due to access limitations, including wilderness, terrain, streams, weather, etc., subjects with uncontrolled medical conditions or those who were immobile or wheelchair-bound were excluded from the trip.

### Experience Fidelity and Program Compliance

Specific criteria for dropout, completion, and compliance with protocol fidelity were established before the study, and relevant subgroups were identified for analysis. Pre- and post-trip assessments were self-administered by all enrolled study participants. Any subject who did not complete a pre- or post-trip assessment was considered a dropout. Excluding subjects for known exclusion criteria, e.g., PHW Staff, cohort team leads, resulted in the "All Subjects" subgroup. Those with no mental health symptoms before the trip ("Sub-clinical") were identified and

excluded from the sub-analysis. Subjects with a PHQ-8 or GAD-7 score of 10 or greater, or a CAT-MH PTSD score of 47 (moderate) or greater, were identified as the "Symptomatics" subgroup.

**Adverse Events**

No adverse events were reported during the study. An adverse event (AE) was defined as any unfavorable or unintended sign, symptom, or illness associated with the study. PHW was responsible for the physical safety and well-being of all trip participants and ensured the implementation of adequate safety measures, including access to medical care.

## Statistical Analysis

Due to the pilot nature of this observational study, lack of randomization and blinding, the study results are deemed directional. The focus of the analysis was to corroborate anecdotal evidence, identify trends and potential outcomes of the fly-fishing trip and inform and design future research with additional controls, larger sample sizes, and randomization. Statistical tests have been interpreted cautiously, acknowledging the potential for Type I and Type II errors. Descriptive statistics were calculated for all measures and all subgroups at baseline and post-trip assessment. Paired t-tests were used to compare pre-and post-trip differences in depression, anxiety, and PTSD measures. Categorical analyses were performed to understand directional trends in the paired t-tests, where the sample size did not reach statistical or clinical significance. These statistics help evaluate exploratory outcomes related to the experience's potential effects on subgroups and inform the assembly of future cohorts.

### Sample Size

PHW selects approximately 360 members each year to participate in a no-cost, week-long fly-fishing trip from March through November. By the time the study design was finalized, approved by the IRB, and initiated, 255 potential subjects across 29 cohorts were eligible to participate. PHW staff and cohort team leads were excluded from the study analysis. As shown in Figure 1, of the 255 invitees, 98 were deemed ineligible to participate in the study due to their status as PHW staff, trip leads, unwillingness to enroll, or incomplete pre- or post-trip assessments. The remaining 157 subjects (62%, "N") were eligible for inclusion in the study, representing those who enrolled and completed the pre- and post-trip assessments. Of the 157 study subjects, 81 subjects were subclinical and had none or mild baseline mental health symptoms pre-trip, namely, PHQ-8 and GDA-7 scores below 10 and a CAT-MH PTSD score below 47. The group used for statistical analysis comprised the remaining 76 subjects with one or more pre-trip symptoms.

### Statistical Testing

This study utilized a mixed-methods, non-randomized quasi-experimental statistical testing design. This included paired samples t-tests on the mental health markers of subjects before and after the week-long fly-fishing trip. Two-tailed tests were used at a .05 significance level. Common clinical categories included both ordinal hierarchical levels of severity and clinical or subclinical levels of depression, anxiety, and PTSD. At the same time, the percentage of responders was determined by a reduction in clinical acuity on post-trip.

### Missing Data

To ensure analytical rigor and reduce bias, missing data were addressed systematically using structural and case-wise cleaning methods, per best practices for transparent reporting. Columns with no observed values (100% missingness) were removed (e.g., uncollected CAT-MH). We used listwise deletion to exclude cases with missing values in required fields for all subject-level analyses (e.g., pre/post comparisons, trajectory clustering, and responder modeling). This included paired clinical assessments (e.g., PHQ-8 pre- and post-) and outcome variables. Only complete cases were retained for each specific analysis to preserve statistical validity. We did not apply imputation (e.g. mean substitution, regression, or multiple imputation) to fill in the missing data. Given the observational nature of this pilot study, we prioritized data integrity over artificial completion.

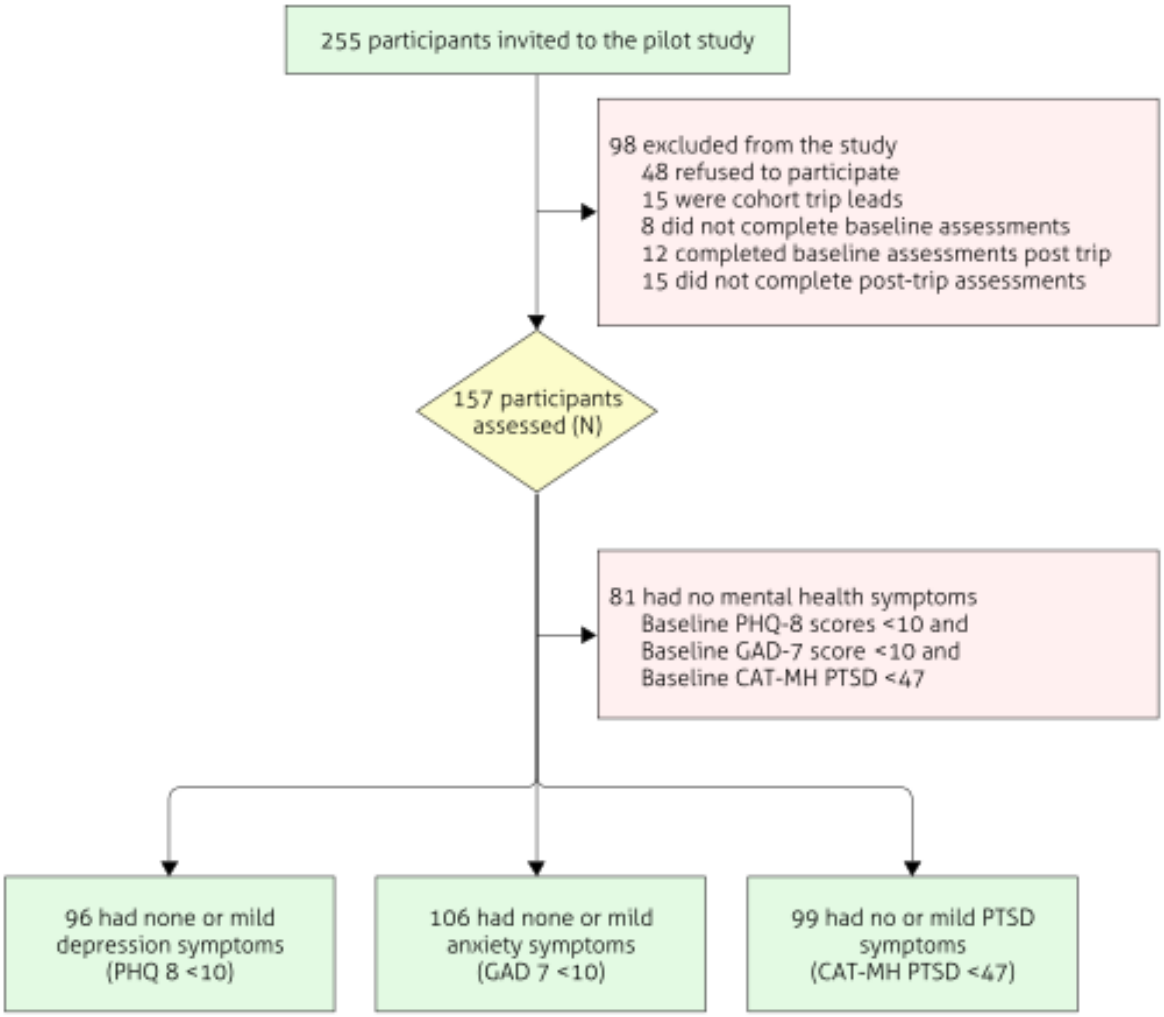


Figure 1: Study Flow and Sample Size

## Results

This analysis evaluated the observed effects of the fly-fishing trip on mental health outcomes among veterans, using validated scales: PHQ-8 (depression), GAD-7 (anxiety), and a condition acuity measure for PTSD (CAT-MH PTSD-E). Data were analyzed for all subjects and those above clinical thresholds (Symptomatics) at baseline.

### Participant Characteristics

As shown in Table 1, the study population comprised 157 subjects with a mean (SD) age of 57.1 (12.0) years. The majority identified as male (141, 89.8%) and White (133, 84.7%), with smaller proportions identifying as Hispanic or Latino (6, 3.8%), Black or African American (5, 3.2%), Asian (3, 1.9%), American Indian (2, 1.3%), or of mixed ethnicity (6, 3.8%), which generally reflects the population distribution within the PHW membership base. Most subjects were married (123, 78.3%), had a mean (SD) of 14.3 (4.7) years of education, and a mean (SD) of 15.8 (10.2) years of military service. Service branches included Army (76, 48.4%), Air Force (32, 20.4%), Navy (24, 15.3%), Marines (15, 9.6%), National Guard (9, 5.7%), and Coast Guard (1, 1.9%). Two-thirds (105, 66.9%) were combat veterans, with a mean (SD) duration of combat deployment of 19.7 (21.3) months. Notably, 37 (23.6%) had engaged in cognitive behavioral therapy within the past year, and 54 (34.4%) were currently on psychiatric medications.

| Characteristic | Count | % | Average | Std Dev |
|---|---|---|---|---|
| Age | 157 | | 57.1 | 12 |
| Sex | | | | |
| Male | 141 | 89.8% | | |
| Female | 16 | 10.2% | | |
| Ethnicity | | | | |
| White | 133 | 84.7% | | |
| Hispanic/Latino | 8 | 5.1% | | |
| Mixed | 6 | 3.8% | | |
| African American | 5 | 3.2% | | |
| Asian | 3 | 1.9% | | |
| American Indian | 2 | 1.3% | | |
| Marital Status | | % | | |
| Married | 123 | 78.3% | | |
| Divorced | 14 | 8.9% | | |
| Single | 11 | 7.0% | | |
| Undiscosed | 5 | 3.2% | | |
| Widowed | 4 | 2.5% | | |
| Years of Education | | | 14.3 | 4.7 |
| Years of Military Service | | | 15.8 | 10.2 |
| Service | | | | |
| Army | 76 | 48.4% | | |
| Airforce | 32 | 20.4% | | |
| Navy | 22 | 14.0% | | |
| Marines | 15 | 9.6% | | |
| National Guard | 9 | 5.7% | | |
| Coast Guard | 3 | 1.9% | | |
| Combat Veterans | 105 | 66.9% | | |
| Combat Deployments Months | | | 19.7 | 21.3 |
| History of CBT/CCBT (Last 12 Months) | 37 | 23.6% | | |
| Currently on Psychiatric Medications | 54 | 34.4% | | |

Table 1: Baseline Demographic Characteristics of Participant Population

**Primary Outcomes**

This pilot study employed a pre-post within-subjects comparison to assess the short-term impact of the trip. Across depression, anxiety, and PTSD, veterans in this study showed considerably higher symptom incidence than is typically found in the general U.S. population.[1,2,3] The naturalistic and voluntary nature of the study presented an opportunity to evaluate the subjects across multiple clinical dimensions, representing real-world conditions. Given MindStreet's extensive, automated digital platform, including measurements and data collection by the software, depression, anxiety, and PTSD could be evaluated concurrently across the study population. Each clinical outcome was analyzed separately across two subgroups: all subjects and symptomatic subjects. Across all conditions, study subjects demonstrated clinically and statistically significant improvements in the short term.

**Depression**

Participation in the fly-fishing trip resulted in significant reductions in depressive symptoms. As a group, the mean (SD) PHQ-8 scores of all subjects (N=157) decreased from 7.7 (5.64) at baseline to 5.98 (5.19) immediately after the trip, a statistically significant improvement ($t(157) = 4.94$, $p < .001$, Cohen's $d = 0.39$), with a small to moderate

effect size. Figure 2 illustrates the change in PHQ-8 score across the entire group and a subgroup of individuals with no clinical symptoms of depression before the trip.

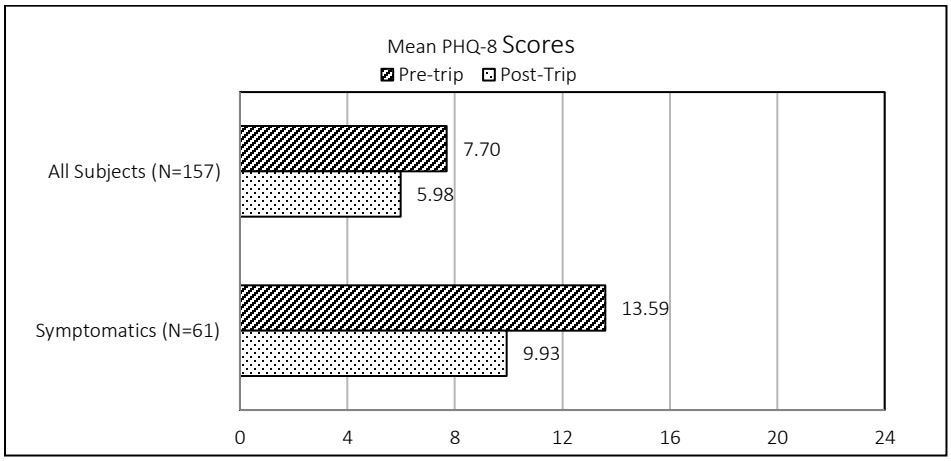


Figure 2: PHQ-8 Change Pre-Post by Subgroup

The improvements in depression symptoms (PHQ-8) scores were also statistically and clinically meaningful across the subgroups, as shown in Table 2. Among subjects with clinically significant depressive symptoms at baseline (PHQ-8 ≥10), the effect was more pronounced. This symptomatic subgroup mean (SD) score dropped from 13.59 (3.05) to 9.93 (5.08) post-trip ($t(61) = 5.26$, $p < .001$, Cohen's d = 0.67), representing a statistically significant and moderate to large effect.

| | Pre-Trip | | | Post-Trip | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depression (PHQ-8) | N | Mean | SD | Mean | SD | Mean Diff | t-Test | Cohens d | *p* |
| All Subjects | 157 | 7.7 | 5.64 | 5.98 | 5.19 | 1.72 | 4.94 | 0.39 | <0.001 |
| Symptomatics | 61 | 13.59 | 3.05 | 9.93 | 5.08 | 3.66 | 5.26 | 0.67 | <0.001 |

Table 2: PHQ-8 Score Improvements by Subgroup

Contingency analysis using the chi-square independent test of association further supports the reduction in mean symptom levels and a meaningful shift in clinical acuity of the study subjects. As shown in Table 3, among subjects with at least moderate symptoms of depression (PHQ-8⩾10) pre-trip (N=61), there was a statistically significant shift in symptom severity following the fly-fishing trip ($\chi^2$=22.3, df=8, p=0.004). Notably, 56% of those initially classified as moderately depressed improved to either the "None" (18%) or "Mild" (38%) categories post-trip. Similarly, 47% of those with moderately severe depression transitioned to "None" (12%) or "Mild" (35%) symptom levels. Among subjects with severe depression at baseline, 50% improved to "None" or "Mild" following the trip.

| Pre Trip | | Post Trip | | | | |
|---|---|---|---|---|---|---|
| Depression, N=61 | | None | Mild | Moderate | Mod Severe | Severe |
| Moderate | 40 | 7 | 15 | 13 | 5 | 0 |
| | 100% | 18% | 38% | 33% | 13% | 0% |
| Mod Severe | 17 | 2 | 6 | 4 | 4 | 1 |
| | 100% | 12% | 35% | 24% | 24% | 6% |
| Severe | 4 | 1 | 1 | 0 | 0 | 2 |
| | 100% | 25% | 25% | 0% | 0% | 50% |
| Total | 61 | 10 | 22 | 17 | 9 | 3 |

$X^2$ = 22.3, df = 8, *p=0.004*

Table 3: Depression Category Analysis, Pre to Post Trip

**Anxiety**

As a group, all study subjects experienced substantial reductions in anxiety (GAD-7) scores following the fly-fishing trip. The change in anxiety symptoms differed significantly across groups at the two assessment time points, as

shown in Figure 3. Among subjects with symptomatic baseline anxiety (GAD-7⩾10), groups experienced a greater reduction in symptoms following the fly-fishing trip.

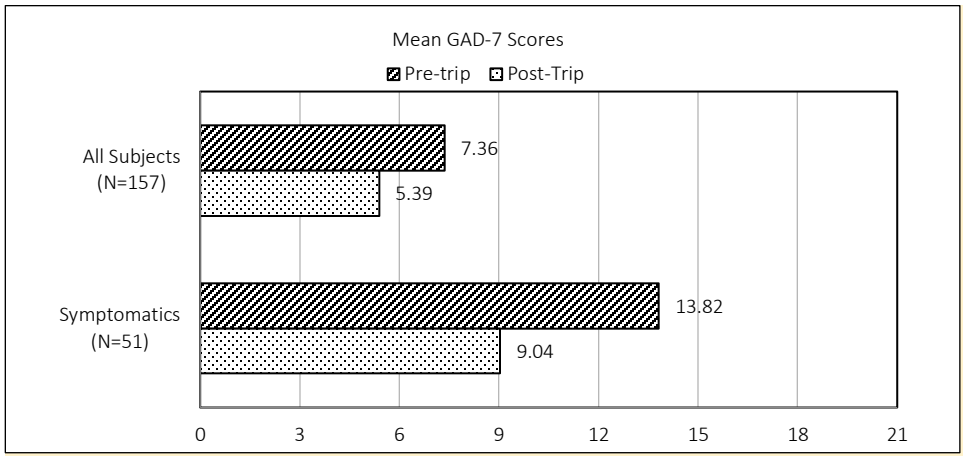


Figure 3: GAD-7 Change Pre-Post by Subgroup

The improvements in anxiety symptoms were also statistically and clinically significant across the subgroup, as shown in Table 4. For all subjects (N=157), regardless of baseline mental health status, mean (SD) GAD-7 scores decreased from 7.36 (5.55) to 5.39 (4.91) post-trip, representing a statistically significant reduction with medium effect size (t (157) = 5.86, p < .001, Cohen's d = 0.47). Among pre-trip symptomatic subjects (GAD-7 ≥ 10) (N = 51), the improvements were even more meaningful. Mean (SD) scores in this subgroup dropped from 13.82 (3.34) to 9.04 (5.23) post-trip with a large effect size (t (51) = 7.77, p < 0.001, Cohen's d = 1.09).

| | Pre-Trip | | | Post-Trip | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Anxiety (GAD-7) | N | Mean | SD | Mean | SD | Mean Diff | t-Test | Cohens d | *p* |
| All Subjects | 157 | 7.36 | 5.55 | 5.39 | 4.91 | 1.97 | 5.86 | 0.47 | <0.001 |
| Symptomatics | 51 | 13.82 | 3.34 | 9.04 | 5.23 | 4.78 | 7.77 | 1.09 | <0.001 |

Table 4: GAD-7 Score Improvements by Subgroup

Categorical analyses further supported the above findings and showed a significant reduction in the proportion of subjects above the clinical threshold for anxiety post-trip, with these improvements shown in Table 5, among symptomatic (GAD-7⩾10) subjects (N=51), 72% demonstrated at least a one-category improvement from anxiety severity following the fly-fishing trip ($\chi^2$=10, df=2, p=0.007). Specifically, those with moderate anxiety improved to either "None" (31%) or "Mild" (41%) levels, and 27% of those with severe anxiety improved to "None" or "Mild." Notably, no subjects remained in the "Severe" category post-trip.

| Pre Trip | | Post Trip | | | |
|---|---|---|---|---|---|
| Anxiety, N=51 | | None | Mild | Moderate | Severe |
| Moderate | 32 | 10 | 13 | 9 | 0 |
| | 100% | 31% | 41% | 28% | 0% |
| Severe | 19 | 2 | 3 | 14 | 0 |
| | 100% | 11% | 16% | 74% | 0% |
| Total | 51 | 12 | 16 | 23 | 0 |

$X^2$ = 10, df =82 *p=0.007*

Table 5: Category Analysis, Anxiety Pre to Post Trip

**PTSD**

The post-fly-fishing assessments also evidenced significant reductions in PTSD symptoms among subjects, as measured by the PTSD-E module of the CAT-MH assessment. Subjects with none to mild symptoms (CAT-MH PTSD <47) maintained consistently low PTSD severity across the timepoints.

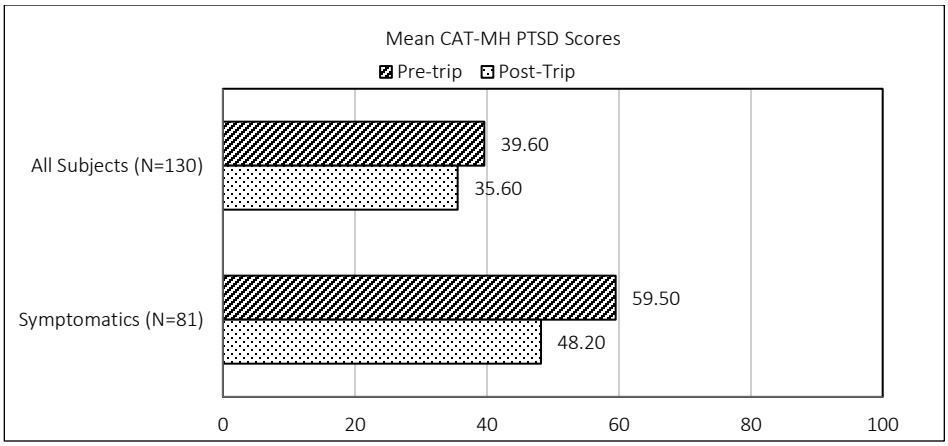

Figure 4: CAT-MH PTSD Change Pre-Post by Subgroup

Corroborating the above trends, and as shown in Table 6, clinically meaningful reductions in PTSD symptom severity were observed across all participant groups and the symptomatic subgroup following the fly-fishing trip. Among all subjects (N=130), mean (SD) CAT-MH PTSD scores decreased from 39.6 (18.30) pre-trip to 35.60 (17.10) post-trip (t= 4.04, p<0.001, Cohen's d=0.29) with a small effect size. Symptomatic subjects (N=45) with PTSD experienced mean (SD) symptom reductions from 59.50 (9.55) to 48.20 (13.53) post-trip with a significant but medium effect (p<0.001, Cohen's d=0.85).

| | Pre-Trip | | | Post-Trip | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PTSD (CAT-MH) | N | Mean | SD | Mean | SD | Mean Diff | t-Test | Cohens d | *p* |
| All Subjects | 130 | 39.6 | 18.3 | 35.6 | 17.1 | 4 | 4.04 | 0.29 | <0.001 |
| Symptomatics | 45 | 59.5 | 9.55 | 48.2 | 13.5 | 11.3 | 5.68 | 0.85 | <0.001 |

Table 6: CAT-MH PTSD Scores by Subgroup

Categorical analyses of the CAT-MH PTSD scores also support the above findings at statistically significant levels ($\chi^2$=23, df=6, p<0.001). As indicated in Table 7, among subjects (N=81) with any PTSD clinical symptom severity (CAT-MH PTSD >=35, mild to severe) pre-trip, there was a statistically significant reduction in severity following the fly-fishing trip ($\chi^2$=23, df=6, p<0.001). Of those with mild PTSD (CAT-MH score between 35 and 46) at baseline (N=39), 39% improved to the "None" category, while 13% and 5% of subjects, respectively, regressed to "Moderate" and "Severe" categories post-trip. Similarly, 14 (64%) of subjects (N=22) with moderate PTSD (CAT-MH score between 47 and 59) improved by at least one category, while 7 (32%) did not experience symptom improvement and 1 (5%) regressed to the "Severe" category. Approximately 13 (65%) of subjects (N=20) with severe PTSD (CAT-MH score >=60) improved at least one category, while 7 (35%) remained unchanged.

| Pre Trip | | Post Trip | | | |
|---|---|---|---|---|---|
| PTSD, N=81 | | None | Mild | Moderate | Severe |
| MIld | 39 | 15 | 17 | 5 | 2 |
| | 100% | 39% | 44% | 13% | 5% |
| Moderate | 22 | 5 | 9 | 7 | 1 |
| | 100% | 23% | 41% | 32% | 5% |
| Severe | 20 | 2 | 3 | 8 | 7 |
| | 100% | 10% | 15% | 40% | 35% |
| Total | 81 | 22 | 29 | 20 | 10 |

$X^2$= 23, df =6, *p<0.001*

Table 7: PTSD Category Analysis, Pre to Post Trip

## Discussion

The pilot study demonstrates that a nature-based fly-fishing program yields meaningful immediate improvements in depression, anxiety, and PTSD symptoms among veterans. These findings align with the growing evidence supporting multi-modal approaches to veteran mental health care.

**Key Findings and Mechanisms**

The immediate post-trip reductions in PHQ-8, GAD-7, and CAT-MH PTSD scores demonstrate the therapeutic benefits of PHW's fly-fishing program on veteran mental health. While depression, anxiety, and PTSD symptoms improved post-trip, longer-term results and durability of response will need to be addressed in future research. These results are consistent with the literature linking nature-based programs, skill-building, and social connection to improvements in mood and trauma-related symptoms.[13,30,31,32] Prior studies of outdoor programs for veterans reported significant reductions in PTSD symptoms, depression, and perceived stress, alongside increased leisure satisfaction.[3] Similarly, a 10-week Danish nature-based therapy (NBT) program highlighted qualitative improvements in veterans' ability to manage stress and PTSD symptoms, with subjects describing nature as a "safe place" that lowered hypervigilance and provided mental relaxation.[6,33] These mechanisms align with this pilot study's findings, where veterans experienced reduced anxiety and improved emotional regulation post-intervention.

### Influencing and Predictive Factors

The most influential predictor of symptom improvements across the three mental health markers was baseline anxiety severity as measured by the GAD-7 pre-trip score, suggesting that higher initial anxiety severity was strongly associated with the likelihood of greater intervention response. The results of a random forest prediction model, as shown in Figure 5, indicate that baseline GAD-7 contributed over 30% to the model's predictive accuracy. Age and years of service also demonstrated significant influence, followed by education level and post-intervention GAD-7 scores. In contrast, demographic and life course variables, such as marital status and gender, had a relatively minor predictive influence. These variables underscore the predictive value of pre-treatment symptom severity on therapeutic response, which could help inform the construction of future trip cohorts.

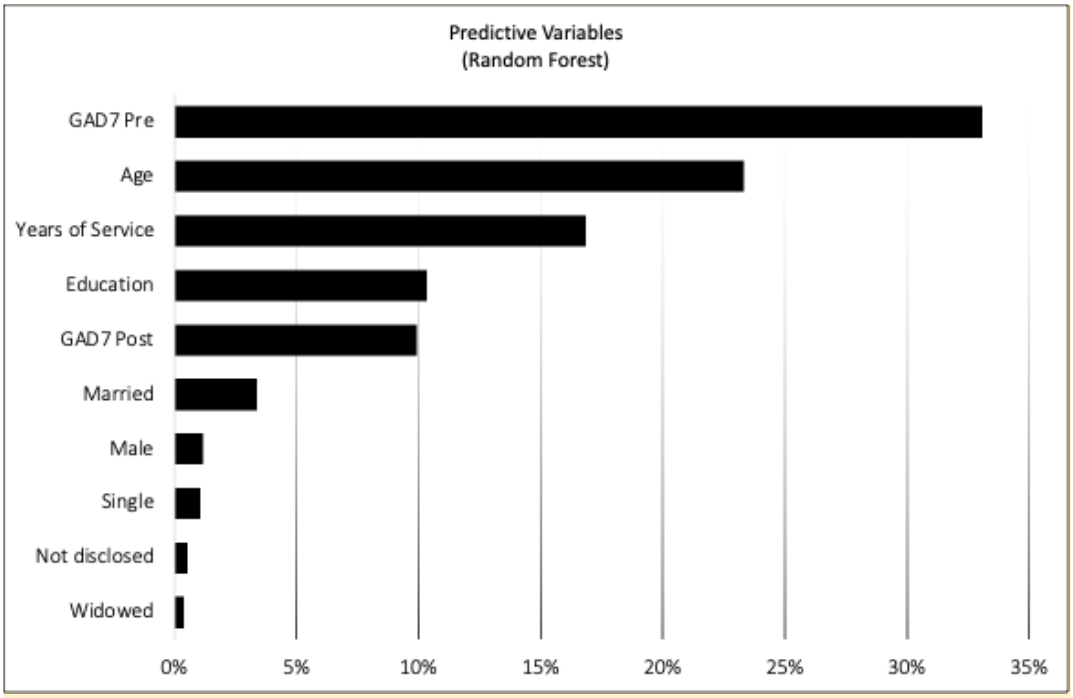


Figure 5: Influencing and Predictive Variables on Experience Response

### Study Limitations

This pilot study evaluated the real-world impact of a nature-based intervention with a long history of providing week-long fly-fishing trips for veteran populations. While the findings suggest meaningful reductions in symptoms of depression, anxiety, and PTSD, several limitations must be acknowledged to contextualize these results and inform future studies.

The primary limitation of this study is its modest sample size, due to budget and logistic limitations and the voluntary nature of the study design, which restricts statistical power and limits the detection of subtle or subgroup-specific effects. The small cohort also constrains the generalizability of findings, particularly for underrepresented groups such as women, minority veterans, or those with complex comorbidities. Larger studies will be necessary to validate these preliminary findings and to enable more robust subgroup analyses.

Another notable study limitation is the absence of a randomized control group or an active comparator. Without randomization or an alternative intervention arm, it is impossible to attribute observed improvements solely to the experience, as natural recovery, regression to the mean, or placebo effects may have contributed to the gains. Additionally, the lack of blinding introduces the potential for response and social desirability biases in self-reported outcomes, which may overestimate the efficacy of the experience.

The study's follow-up period was relatively short, precluding assessment of the long-term durability of symptom reduction or the risk of relapse. Attrition bias further complicates interpretation. An extended follow-up is necessary to assess the sustainability of gains in mental health markers and their impact on functional outcomes, such as quality of life and social reintegration.

The study also relied exclusively on digital, asynchronous self-reported measures for the primary outcomes, susceptible to recall and reporting biases. The absence of clinician-administered assessments, objective behavioral data, or qualitative insights limits the depth of understanding regarding the nature experience's actual impact and mechanisms of action. Future studies should incorporate a broader range of assessment modalities to triangulate findings and provide a more comprehensive evaluation of participant outcomes.

To address these limitations, future research should prioritize larger, more diverse samples, randomized controlled designs with active comparators, extended follow-up periods, and the inclusion of both subjective and objective outcome measures. Through these methodological enhancements, subsequent studies can provide more definitive, generalizable, and actionable conclusions regarding the efficacy and mechanisms of combined nature-based and digital interventions for veterans with mental health conditions.

## Recommendations

### Future Research

Future research should employ larger, more diverse samples and randomized controlled designs with active comparators to establish causal efficacy and generalizability. An extended follow-up will also be necessary to assess the durability of effects. Expanding outcome measurements to include clinician-administered assessments, objective behavioral data, and qualitative feedback will provide a more comprehensive understanding of the experience's impact. Efforts should also be made to recruit underrepresented groups, including women, minority veterans, and those with comorbidities. Finally, studies should employ designs that enable the isolation of specific intervention components to better understand their individual and combined effects. Addressing these methodological priorities will yield more robust, generalizable, and clinically actionable evidence for the use of combined nature-based programs in veteran mental health care.

## Conclusions

This study contributes to the evidence that immersive, nature-based experiences can offer short-term relief and brief symptom management for this population. Future implementations should prioritize accessibility, engagement, and equity while refining and fine-tuning protocols through rigorous, component-specific research.

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