PUBLIC HEALTH CENTER
OF THE MOH OF UKRAINE

Study on the prevalence of *Francisella tularensis*, the causative agent of tularemia, in Ukraine

Implemented by the State Institution "Public Health Center of the Ministry of Health of Ukraine" within the framework of the project "Epidemiologic and Molecular Characterization of Francisella tularensis in the countries of Black Sea region (Georgia, Turkey, Ukraine)".

With the support of the Defense Threat Reduction Agency of the US Defense Department (DTRA).

Kyiv, 2026

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Abbreviations

MoH – Ministry of Health of Ukraine

PHC – State Institution "Public Health Center of the MoH of Ukraine"

RCDCPs – Regional Centers for Disease Control and Prevention

Anti-Plague Institute – Branch "I.I.Mechnikov Anti-Plague Institute" of the PHC

Reference Laboratory – the Public Health Center's Reference Laboratory for the diagnosis of tuberculosis, bacterial, parasitic, and especially dangerous pathogens

DTRA – Defense Threat Reduction Agency of the US Department of Defence

ACURO – Animal Care and Use Review Office

OHRO – Office of Human Research Oversight

EDGE – Empowering the Development of Genomic Epidemiology

F. tularensis – *Francisella tularensis* pathogen

PPE – personal protective equipment

PCR – polymerase chain reaction

ELISA – enzyme-linked immunosorbent assay

IgG – immunoglobulin G

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Project description

This project was aimed to strengthen Ukraine's national capacity in the detection, laboratory diagnosis, and epidemiological surveillance of *F. tularensis*, the causative agent of tularemia, within One Health approach. The work was focused on integrating field epizootiological surveillance, clinical component preparation, laboratory testing, and training specialists involved in detecting, diagnosing, and responding to tularemia cases.

The project was implemented to establish a sustainable foundation for tularemia monitoring in Ukraine by collecting field data in regions with potential or known natural foci of the pathogen, examining biological samples from small mammals and arthropod vectors, as well as strengthening coordination between various levels of the public health system in the field of epidemiological surveillance. An important project focus was also the development of a methodological basis for further studies on tularemia seroprevalence in the population and the assessment of infection risk factors.

The project activities included the following tasks:

- Field epizootiological study in Odesa, Zakarpattia, and Volyn regions with sampling specimens from small mammals and collection of ixodid ticks for subsequent laboratory analysis.
- Laboratory diagnosis (PCR) of collected field samples to detect *Francisella tularensis* specific DNA fragments.
- Preparation of study clinical component, including protocol development, data collection tools, analysis of retrospective data on endemic areas, and preparation of documentation for ethical approval.
- Training for public health specialists (PHC and rCDCPs), laboratory personnel, and Anti-Plague Institute's staff on conducting tularemia surveillance, laboratory diagnostics, biosafety, epidemiological investigation, and outbreak response.
- Building capacity for tularemia surveillance, including strengthening laboratory, field, and bioinformatics capabilities.

As part of the field component, the Anti-Plague Institute's team collected and submitted to the laboratory a total of 888 samples, including 619 organ samples from 155 small mammals, 259 pools of ixodid ticks comprising 2,023 individual ticks, and 10 blood samples from small mammals. The Reference Laboratory specialists conducted testing of samples for *Francisella tularensis* presence.

The project was carried out under conditions of active wartime and was completed prematurely, which resulted in logistical and organizational constraints, including the inability to fully implement the clinical and ecological components of the study. At the same time, the implemented activities allowed to strengthen Ukraine's readiness for detecting and responding to zoonotic threats, generated baseline field and laboratory data on tularemia, and laid the foundation for the continued surveillance of *Francisella tularensis* in the future.

Study relevance

Tularemia is a natural focal zoonotic infection caused by the bacterium *F. tularensis*. It is characterized by complex epidemiology, a wide range of reservoirs and vectors, and diverse routes of transmission, including contact, vector-borne, alimentary (ingestion), and aerosol. The pathogen can survive in environmental reservoirs (in soil and water) for a long time, ensuring its persistence in natural foci and complicating infection control efforts. In addition, *F. tularensis* belongs to the highly virulent pathogen of the highest priority (Category A), underscoring its significance as a potential biological threat agent.[1]

In Ukraine, natural foci of tularemia of varying activity have been registered throughout the country. Their distribution is uneven and depends on climatic, landscape, and ecological factors that determine the biocenotic relationships between the pathogen, reservoir species, and vectors. Small mammals are the primary natural reservoir of the pathogen which play a key role in sustaining the epizootic process.

According to the results of ecological and geographical studies, natural foci of tularemia are unevenly distributed across the landscape zones of Ukraine: the largest proportion of foci (53.5%) actually occurs in the Polissia zone, 32.7% - in the forest-steppe zone, and 14.1% - in the steppe zone. The most epizootically active are floodplain and wetland foci associated with aquatic ecosystems, where the infection is transmitted both via ticks (transmissive way) and through water.

Historically, tularemia was a significant public health problem in Ukraine, particularly, major outbreaks of the disease were recorded in the mid-20th century. The highest incidence rates of tularemia in Ukraine were registered in 1948 and 1949, with 47,620 and 16,102 cases respectively - with more than 50% of cases occurred in the steppe zone. In 1997-1998, a significant outbreak of tularemia was recorded in the Odesa and Mykolaiv regions, during which 100 people became ill, including 70 cases in Odesa region and 30 cases in Mykolaiv region[2]. Over the last few decades, a downward trend in the incidence of tularemia among the population has been observed. Only sporadic cases have been reported: 1 case in 2017, 2 cases in 2018, 3 cases in 2020, 1 case in 2021, 2 cases in 2022, and 1 case in 2023. At the same time, the pathogen continues to circulate in natural foci.

For the epizootiological study, Odesa, Volyn, and Zakarpattia regions were selected, as they are characterized by the presence of natural foci of tularemia or by environmental conditions favorable for their formation. In particular, in Odesa region, which has the highest number of such foci, circulation of the pathogen among background species of small mammals has been confirmed. In Volyn region, there is a significant number of enzootic areas where antibodies to the pathogen are regularly detected among animals. In Zakarpattia region, despite the limited number of officially registered foci, there are prerequisites for epizootics development due to reservoirs and vectors presence, as well as proximity to enzootic territories in other regions.

At the same time, current data on *F. tularensis* distribution, the role of different species of small mammals and arthropod vectors, as well as the impact of environmental changes on the functioning of natural foci remain limited. Existing studies indicate the genetic heterogeneity of the pathogen and varying virulence of strains; however, these issues require further investigation. This reinforces the need to develop systems for early detection, monitoring, and response.

Field epizootiological study

The project field component (epizootiological study) was aimed at determining the presence, prevalence, and ecological characteristics of *F. tularensis* circulation among reservoir species and vectors in natural foci of tularemia.

Field works have been conducted from 6 March to 19 September 2025 on the territories of Odesa, Zakarpattia, and Volyn regions.

The field team made trips to:

- Odesa region – in March, April, May and September of 2025;
- Zakarpattia region – in June, July and August of 2025;
- Volyn region – in September 2025.

The selection of regions was based on a retrospective analysis of epidemiological data regarding the presence of tularemia natural foci, favorable ecological conditions for pathogen circulation, and a high density of potential reservoirs and vectors.

The study covered the following areas: in Odesa region – Podilskyi, Odeskyi, Berezivkskyi, Bilhorod-Dnistrovskyi, and Izmailskyi districts; in Zakarpattia region – Mukachevskyi, Uzhhorodskyi, and Khustskyi districts; in Volyn region – Lutskyi and Kovelskyi districts (Fig. 1-3).

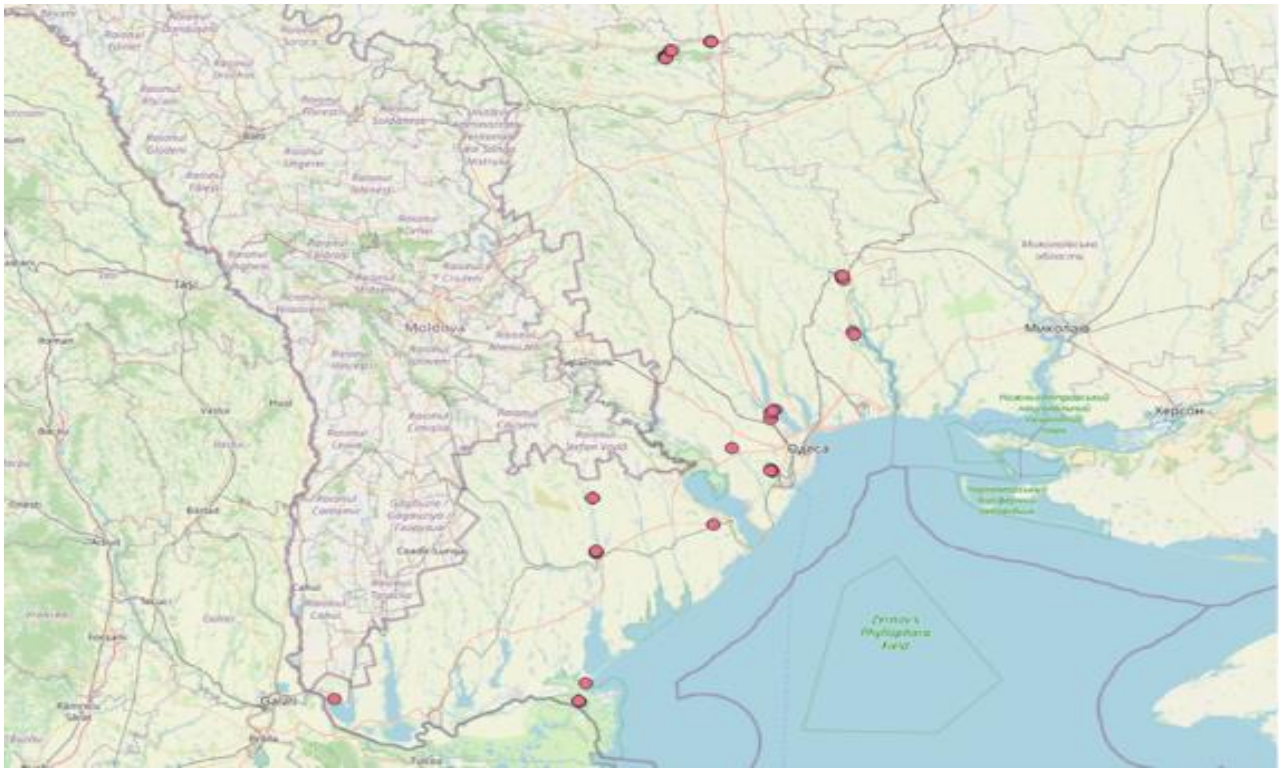

Figure 1. Sites of biological sample collection in Odesa region (Podilskyi, Odeskyi, Berezivskyi, Bilhorod-Dnistrovskyi and Izmailskyi districts)

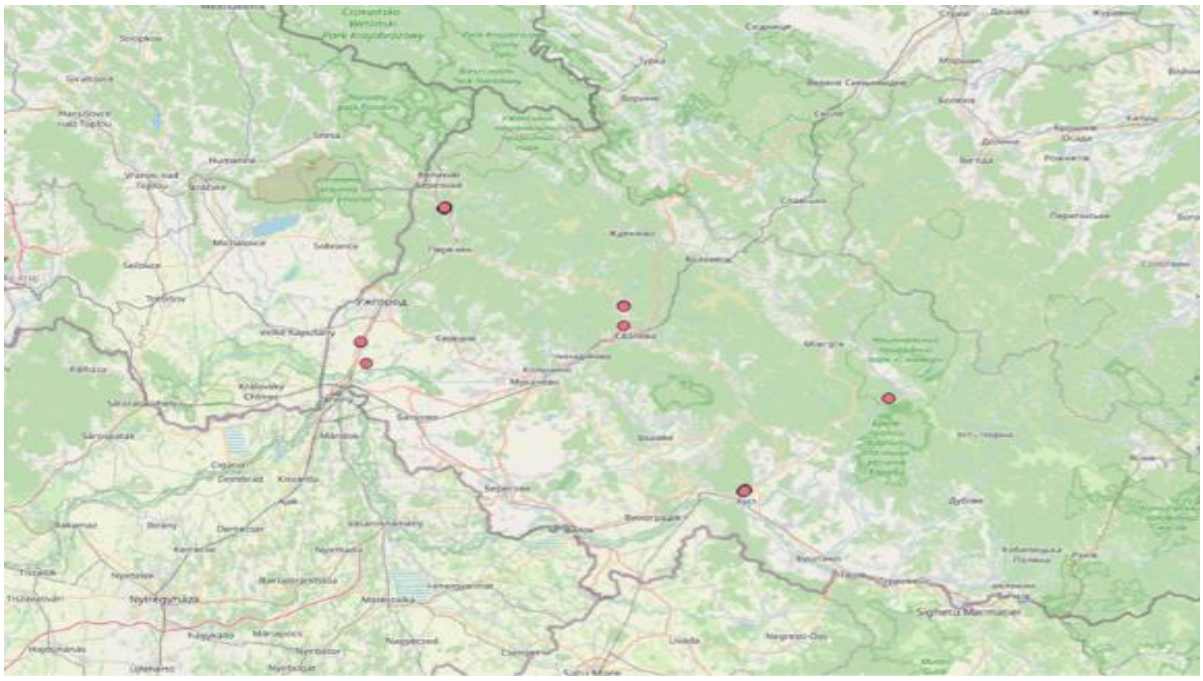

Figure 2. Sites of biological sample collection in Zakarpattia region (Mukachivskyi, Uzhgorodskyi and Khustskyi districts)

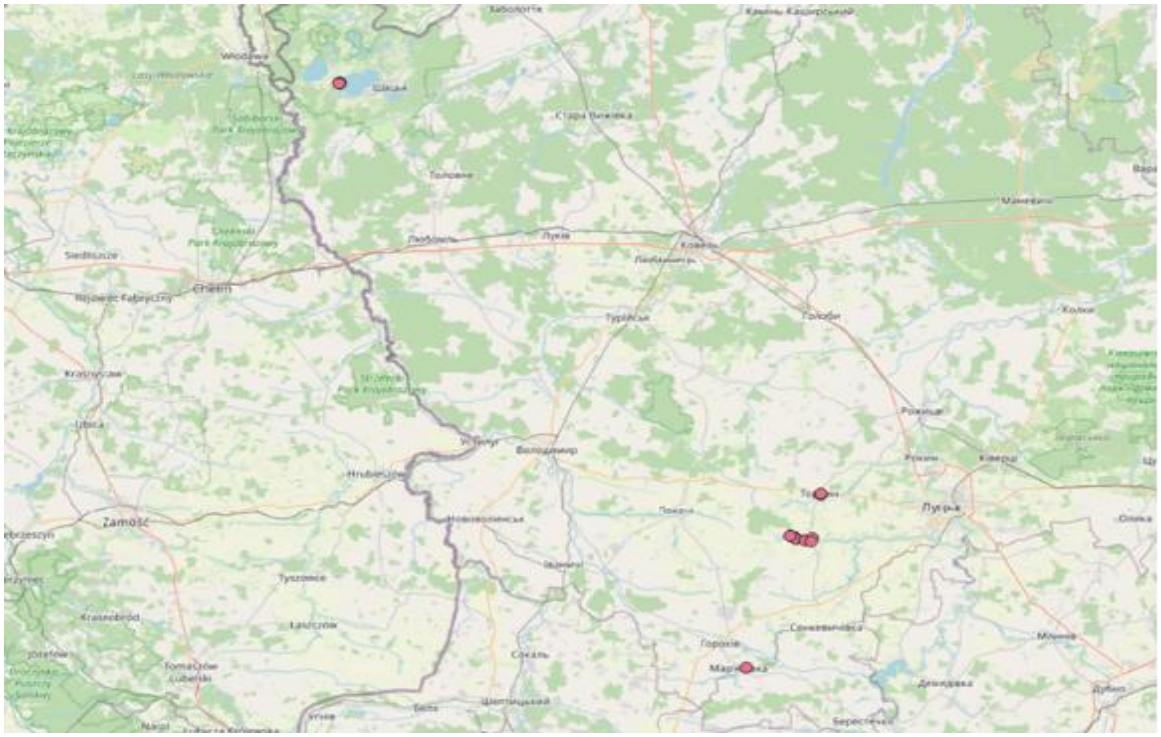

Figure 3. Sites of biological sample collection in Volyn region (Lutskyi and Kovelskyi districts)

Methodology for collecting small mammal samples

Biological material from small mammals was collected as part of an epizootiological study of natural habitats to detect *F. tularensis* circulation in reservoir species. Primary attention was focused on mammal species classified as highly and moderately susceptible to the pathogen, which play a key role in maintaining the epizootic process.

During the epizootiological study, it was planned to capture of 200 small mammal specimens, including the following potential species: *Sylvaemus sylvaticus*, *Sylvaemus tauricus*, *Sylvaemus uralensis*, *Mus musculus*, *Mus spicilegus*, *Microtus arvalis*, *Microtus levis*, *Myodes glareolus*, *Apodemus agrarius*, *Neomys anomalus*, *Neomys fodiens*, *Crocidura suaveolens*, *Crocidura leucodon*, *Micromys minutus*, *Sorex minutus*, *Sorex Araneus*, *Neomys anomalus*. It was not possible to predefine the number of specimens for each species.

If any endangered species and listed in the Red Book (including gray hamster (*Cricetulus migratorius*)) were trapped, their immediate release was envisaged without conducting any additional manipulations.

Epizootiological surveys were conducted in various types of natural biotopes (forests, meadows and fields, floodplains and wetlands, and agrocenoses), taking into account the seasonal behavioral patterns of small mammals. Specifically:

- in spring – trapping was carried out in areas of winter aggregations (forests, forest plantations, etc.);
- in autumn – in agrocenosis fields, orchards, and other sites;
- in floodplain and foothill ecosystems – in the zones of increased humidity and high concentrations of hygrophilous species.

Live traps were used for capture, ensuring that the animals were caught without immediate death. Live traps were set up within each biotope in one or two lines, with 25-50 traps per line, spaced 4-5 m apart, and at least 50 m between lines (Fig. 4). The start and end points of each line were recorded using GPS.

Figure 4. Live traps for capturing small mammals

Traps were set in the afternoon and checked the following morning, or more frequently depending on temperature conditions (up to every 2 hours during hot periods), in order to minimize animals stress and mortality. Potential risks (overheating, precipitation, insects) were taken into account when placing the traps, and the number of traps was monitored before and after trapping.

Captured animals were transported to the field laboratory within a limited time frame (up to 60 minutes), ensuring safety conditions and minimizing stress.

Before the manipulations, the animals were subjected to inhalation anesthesia using isoflurane or sevoflurane. Anesthesia was performed by placing the trap with animal inside a sealed bag containing an anesthetic source, without direct contact between the animal and the substance.

After achieving the required level of anesthesia, the following procedures were performed:

- animal registration;

- species identification;
- sex determination;
- recording of the capture location and time.

At the initial stage of the study, blood samples were collected from small mammals, followed by the release of the animals back into their natural environment after recovery.

Following the study protocol updated, a method of sampling organs was introduced, which involved euthanizing animals using a lethal dose of inhaled anesthetic. This change in approach was driven by the need to improve the sensitivity of laboratory diagnostics, since *F. tularensis* is predominantly localized in internal organs (specifically in spleen, liver, and lymph nodes), and its detection in blood may be limited or transient.

After confirmation of euthanasia (absence of cardiac activity), necropsy was performed in field conditions using sterile instruments (scissors, forceps).

The collected material included the tissues of lungs, liver, spleen, and lymph nodes. Dissection was performed by sequential opening of the abdominal and thoracic cavities under aseptic conditions. Each collected sample was placed in a separate cryotube.

The unique identification number was assigned to each biological specimen, specifying: the sample type, individual number, and capture date. The samples were stored in cryotubes and immediately placed into Dewar vessels containing liquid nitrogen to ensure the biological material preservation.

The samples collection, transportation to the Reference Laboratory, and storage were carried out in accordance with the State Sanitary Rules (SSR) 9.9.5.035-99 “Safety of Work with Microorganisms of Pathogenicity Groups I-II.”.

All data regarding the collected samples were entered into a general table on a cloud-based platform.

Ethical considerations of small mammal sample collection

The collection of samples from small mammals (at the initial stage – blood samples, and after the methodology updating – organ tissue samples) was conducted in accordance with national and international bioethical requirements.

A favorable decision was granted by the Bioethics Commission of the National University of Life and Environmental Sciences of Ukraine (No. 026/2024, 30 December 2024), and following amendments to the study methodology, an additional approval (No. 033/2025, 28 April 2025) was obtained, allowing the trapping of small mammals in natural habitats and the collection of organ samples for tularemia testing.

In addition, upon approval by the national commission and given that the collection of mammalian samples for *F. tularensis* testing is envisaged as a part of routine epidemiological surveillance, confirmation has been received from ACURO representatives regarding the applicability of an exemption from the international ethical review procedure.

Methodology for collecting ixodid tick samples

The collection of ixodid ticks was carried as a part of the epizootiological study (zooentomological component) aiming to detect potential arthropod vectors of *F. tularensis* in natural foci of infection.

Tick sampling in natural habitats was performed using the flagging method across various types of open biotopes (forest, meadow, and agrocenosis) during the warm season, when tick activity is at its peak.

The flagging method involved dragging a piece of fabric (a flag) attached to a handle over the vegetation surface, followed by the collection of ticks that attached to it. Surveys were performed in selected sites characterized by favorable conditions for vector survival, including the areas with high humidity, dense vegetation, and the presence of potential reservoir hosts (Fig. 5).

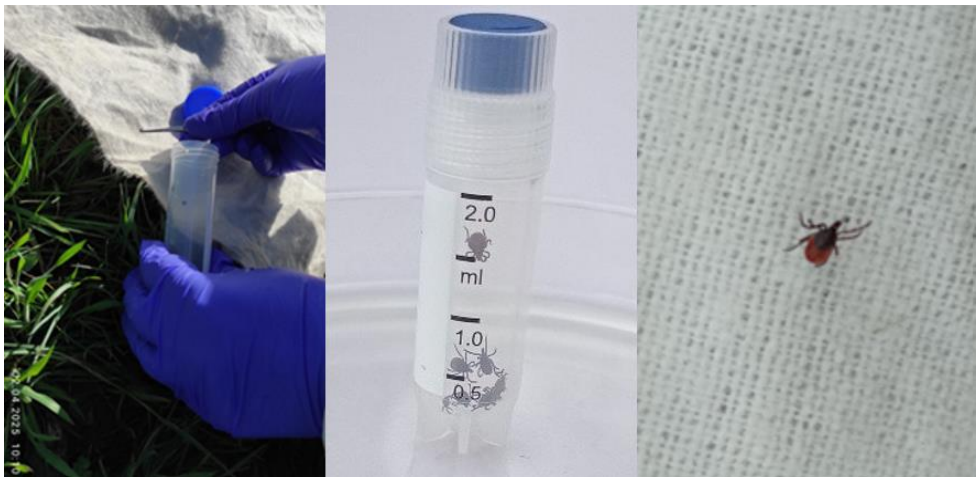

Figure 5. The procedure for collecting ixodid ticks using the flagging method.

Collected tick samples were sorted directly in field conditions. For each sample or group of samples, the following procedures were performed:

- species identification based on morphological characteristics;
- determination of developmental stage (larva, nymph, imago);
- sex determination for adult specimens.

The obtained data were recorded along with the collection site, date, and biotope type.

Collected ticks were pooled according to the sampling site, species, developmental stage, and morphological characteristics. Pool formation enabled the optimization of further laboratory investigations and ensured the representativeness of the analysis for assessing pathogen circulation in the study areas.

Following collection and initial processing, tick samples were placed into cryovials and stored at low temperatures. In the field, the samples were kept in liquid nitrogen in Dewar vessels, ensuring the preservation of pathogen DNA for subsequent molecular analysis.

The samples were transported to the reference laboratory, where further studies were performed using PCR.

Similar to the data on small mammals, the obtained data on ixodid ticks were entered into general table on a cloud-based platform.

Laboratory diagnostics of field-collected specimens

All biological samples obtained as part of the field epizootiological study (small mammal organ tissues, blood samples, and pools of ixodid ticks) were tested in the Reference Laboratory using molecular genetic methods to detect *F. tularensis* DNA.

All samples underwent pre-analytical preparation before molecular analysis. Tissue samples of organs (lungs, liver, spleen, lymph nodes) and tick pools were subjected to homogenization using standard laboratory procedures. Afterwards, the material was aliquoted to ensure the possibility of re-analysis and quality control of the studies.

DNA extraction was performed according to the laboratory's internally approved standard operating procedures using commercial nucleic acid extraction kits. Control samples were used during the extraction process to assess the quality of DNA isolation and to exclude possible contamination.

Primary detection of *F. tularensis* DNA was performed using PCR method, including conventional PCR and/or real-time quantitative PCR (RT-qPCR), utilizing specific primers targeting conserved regions of the pathogen genome.

For primary screening, a 4Pan1-type test system was used, which enables the detection of all major subspecies of *F. tularensis*, including subsp. *tularensis, holarctica, mediasiatica*, and *novicida*, while eliminating cross-reactivity with closely related species (*F. philomiragia, F. persica*, and *Francisella*-like endosymbionts).

In cases of pathogen DNA detection, multiplex real-time PCR platforms (Tier 1 and Tier 2) were applied for subsequent subspecies differentiation and strain typing. These systems allow not only confirmation of *F. tularensis* presence but also identification of its subspecies affiliation, including highly virulent variants.

The following controls were used to ensure the quality of PCR testing :

- positive controls (*F. tularensis* DNA):
- negative controls (no DNA template):
- internal control (16S rRNA amplification) to confirm the quality of DNA extraction and the absence of inhibitors.

All laboratory procedures were performed in compliance with biosafety requirements for handling high-risk pathogens. Material processing was carried out in a Biosafety Level 3 laboratory using PPE and monitoring for potential staff exposure.

Field epizootiological study results

During the field epizootiological component of the study, representatives of various small mammal species were trapped, which belong to background and epizootically significant species for tularemia, including *Sylvaemus sylvaticus*, *Apodemus agrarius*, *Myodes glareolus*, *Microtus arvalis*, *Crocidura suaveolens*, *Sylvaemus tauricus*, *Sylvaemus uralensis*, and *Clethrionomys glareolus* (Fig. 6)

The largest proportion in the structure of collected specimens comprised:

- *Apodemus agrarius* (striped field mouse) – 99 specimens (396 organ samples);
- *Sylvaemus sylvaticus* (wood mouse) – 40 specimens (160 organ samples).

Other species potentially involved in pathogen circulation in natural foci were represented to a lesser extent. In the initial stage of the study, 10 blood samples were collected from small mammals; however, after the methodology was updated, the focus shifted to organ sampling, which substantially increased both the volume and representativeness of material for laboratory analysis.

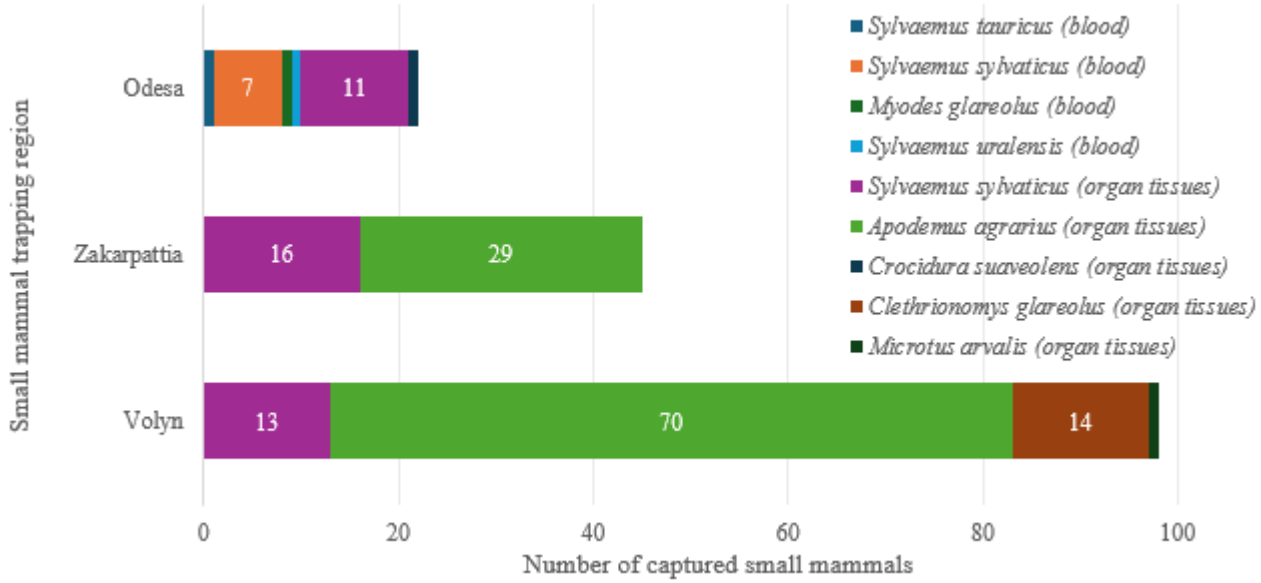

Figure 6. Total number of small mammals captured by region during the study

During the zooentomological study, 259 pools of ixodid ticks were collected, totaling 2,023 specimens (Fig. 7). The following species were identified among the collected ticks:

- *Ixodes ricinus* – 96 pools;
- *Dermacentor reticulatus* – 53 pools;
- *Haemaphysalis punctata* – 67 pools;
- *Dermacentor marginatus* – 16 pools;
- *Rhipicephalus sanguineus* – 21 pools;
- *Rhipicephalus rossicus* – 5 pools;
- *Hyalomma marginatum* – 1 pool.

The most common tick species in the studied regions were *Ixodes ricinus* (castor bean tick), *Dermacentor reticulatus* (ornate cow tick), and *Haemaphysalis punctata* (red sheep tick), which are potential vectors of pathogens causing natural focal infections such as tularemia.

All collected samples (organ tissues, blood, and tick pools) were tested in the Reference Laboratory using PCR method to detect *F. tularensis*-specific DNA fragments.

Based on the results of the conducted study, no *F. tularensis* DNA was detected in any of the samples. Thus, no active circulation of the tularemia pathogen was recorded among the studied populations of small mammals and ixodid ticks in the study regions during the fieldwork period.

The overall collected material (888 samples) provided a representative sample size for assessing tularemia pathogen presence in natural foci of the studied regions.

The obtained results indicate the absence of detectable active *F. tularensis* circulation in the studied populations of reservoirs and vectors at the time of investigation conduction.

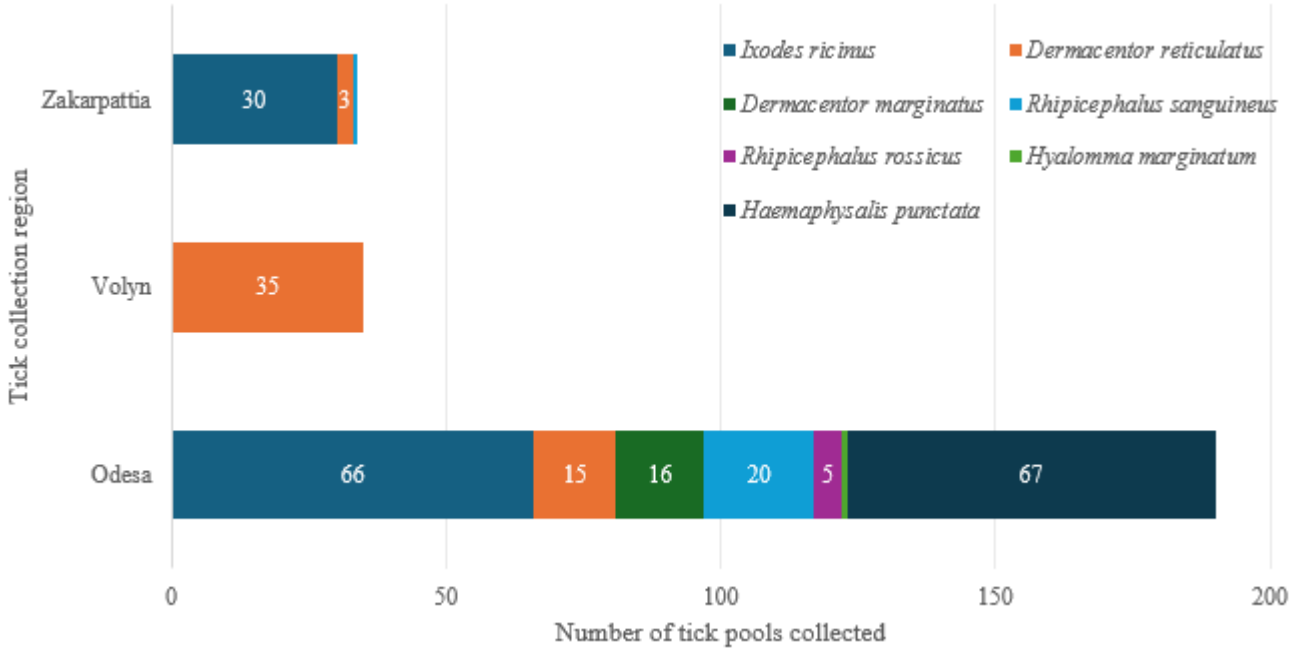

Figure 7. Total number of ixodid tick pools collected by region during the study

Methodological framework for the clinical component of the study

Within the framework of the project, a clinical component of the study was planned, aimed at determining tularemia seroprevalence in the general population and identifying risk factors for infection. The study involved conducting a cross-sectional population survey in designated endemic regions, as well as collecting venous blood samples for subsequent laboratory analysis using ELISA method to detect IgG class antibodies to the pathogen of tularemia.

During the preparatory stage, a complete package of study documentation was developed, including the study protocol, data collection instrument (questionnaire), informed consent forms, standard operating procedures for biological samples collection, storage, and transportation as well as terms of reference for engaging fieldwork personnel. In addition, a retrospective analysis of epidemiological data was conducted to identify high-risk areas, and the sampling frame design for the seroprevalence study was developed.

The protocol and instruments for the clinical component were approved by the relevant ethics bodies, including the Institutional Review Board of the PHC and OHRO, thereby ensuring compliance with international standards for studies involving human subjects.

At the same time, due to the premature completion of the project, the field phase of the clinical component, including data and biological sample collection, was not carried out. As a result, the seroprevalence of tularemia in the population was not determined within this study.

Nevertheless, the prepared methodological materials, agreed protocol, and developed tools constitute an important foundation for the future implementation of similar studies. In the event of securing additional funding, these practical developments could support the prompt launch of the clinical component and enhance tularemia surveillance activities in Ukraine.

The study of tularemia cases among the population of Ukraine was not undertaken due to the absence of officially registered human tularemia cases in the country during 2024 and 2025.

Ecological component of the study

Within the framework of the project, the implementation of an environmental component was planned, involving the collection of water samples from natural and anthropogenic water bodies in areas where *F. tularensis* presence was suspected. The methodology included the use of filtration methods through cellulose acetate membranes or field ultrafiltration systems, followed by elution, microorganisms culturing on/in selective media, and the performance of PCR analysis of the obtained samples.

However, due to the premature completion of the project, the collection and analysis of water samples were not performed. Consequently, the environmental component was not implemented, which limited the full implementation of integrated One Health approach envisaging comprehensive study of interactions between humans, vectors (small mammals and ixodid ticks), and the environment in the context of *F. tularensis* pathogen circulation.

Training and professional development of specialists in tularemia surveillance

Within the project, a series of training events was carried out aimed at enhancing the capacity of public health professionals, laboratory specialists, and field units' personnel on the issues of the detection, diagnosis, and response to tularemia cases.

Trainings were conducted in three regions of Ukraine:

- September 8-10, 2025 – in Odesa;
- September 16-18, 2025 – in Lutsk;
- September 22-24, 2025 – in Uzhhorod.

Representatives of the PHC, RCDCPs, the Anti-Plague Institute, as well as laboratory specialists and other involved professionals participated in the events.

The trainings were conducted in the format of 3-day workshops combining theoretical lectures, interactive discussions, and practical sessions. The program covered the following key topics:

- epidemiology of tularemia and peculiarities of its spread in Ukraine and the region;
- clinical manifestations and diagnostic approaches;
- laboratory methods for pathogen detection;
- epizootiological analysis and the role of reservoirs and vectors;
- principles of biosafety and biosecurity;
- organizing epidemiological investigations and responding to outbreaks;
- One Health approaches in the context of zoonotic infections surveillance.

The practical session focused on skill training in the PPE use, public health risk assessment, and integrating theoretical knowledge into practical work.

Participants underwent initial and final testing aimed to evaluate the effectiveness of the training. The training sessions results demonstrated a significant increase in participants' knowledge of tularemia epidemiology, diagnosis, prevention, and control.

Beyond theoretical knowledges, participants acquired practical skills in working with biological materials in compliance with biosafety requirements and enhanced their readiness to conduct epidemiological investigations and respond to outbreaks of infection.

The conducted trainings contributed to strengthening the workforce capacity of the public health system and laid the foundation for the further development of tularemia surveillance in Ukraine. The acquired knowledge and skills can be applied in routine practice as well as during future studies and biosafety activities.

The project also facilitated the participation of PHC representatives in an international bioinformatics training that took place in Istanbul, Turkey, on September 1-5, 2025.

The event brought together specialists from the Black Sea region countries and was aimed at developing skills in molecular analysis and genomic data processing in the context of *F. tularensis* studies. The training program covered key areas of modern bioinformatics, including:

- analysis of isolates using the EDGE platform;
- metagenomic analysis and 16S rRNA analysis;
- basics of working with the command line;
- phylogenetic and network analysis;
- approaches to study design and risk analysis.

Participation in the training contributed to strengthening the capacity of Ukrainian specialists in genomic analysis and bioinformatics, which is an important component of modern surveillance of zoonotic infections and complements laboratory and field studies within One Health approach.

Conclusions

As part of the project aimed at strengthening *F. tularensis* pathogen surveillance in Ukraine, a number of important results were achieved in the field of studies, laboratory diagnostics, and the building workforce potential in the public health system.

The field epizootiological component of the study was fully implemented. From March to September 2025, 888 biological samples were collected in Odesa, Zakarpattia, and Volyn regions, including specimens from small mammals and ixodid ticks. The obtained material is sufficient and representative for assessing the presence of the pathogen in the studied regions.

PCR-based laboratory testing detected no *F. tularensis* DNA in any of the analyzed samples. This indicates the absence of confirmed active circulation of the pathogen among the studied reservoir and vector populations during the study period; however, its persistence in natural foci cannot be ruled out.

The clinical component of the study was prepared at the methodological level, including the development of the protocol, data collection instruments, sampling design, and ethical approval. However, due to the premature completion of the project, its practical implementation was not carried out.

The ecological component of the study, which involved collection and subsequent analysis of water samples, was not implemented as a result of the project's premature completion. This limited the comprehensive application of the One Health approach, envisaging the integrated study of interactions between humans, vectors, and the environment.

Training and capacity building of specialists were implemented in full. A series of training sessions was conducted in three regions of Ukraine, covering key aspects of tularemia surveillance. Additionally, the development of bioinformatics capacity was ensured, in particular through the participation of Ukrainian specialists in international training, which contributed to increasing the level of knowledge in the fields of genomic analysis, metagenomics, and modern approaches to study of pathogen.

Notwithstanding the restrictions related to martial law and the premature completion of the project, the implemented activities made it possible to:

- establish a preliminary evidence base indicating the absence of detected pathogen circulation in natural foci of the studied regions in 2025;
- strengthen the laboratory, field, and analytical capacity of the public health system;
- create a methodological basis for future clinical studies;
- improve readiness for responding to zoonotic threats.

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