

Beyond Blue Zones: A Scientific Framework for Recognizing Centenarian Regions

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Biocognitive Monographs Series BM-2026-11 | Archived 2026

Citation

Martinez, M. E. (2026). *Beyond Blue Zones: A Scientific Framework for Recognizing Centenarian Regions*. Biocognitive Monographs Series, BM-2026-11. Biocognitive Science Institute.
<https://www.biocognitiveculture.com/working-papers-archive>

Abstract

The identification of geographical populations exhibiting exceptional longevity has significantly advanced public and scientific interest in healthy aging. However, continued improvements in demographic records, age verification, and interdisciplinary longevity research require a framework that reflects the evolving nature of scientific evidence. This monograph proposes a scientific framework for recognizing **Centenarian Regions** based on verified centenarian populations rather than longevity as a general demographic outcome.

The framework developed by the Biocognitive Science Institute establishes scientific recognition as a recursive process of empirical confirmation grounded in rigorous demographic verification and periodic scientific re-evaluation. Recognition identifies populations demonstrating exceptional concentrations of verified centenarians and establishes their eligibility for continued interdisciplinary investigation. Within this framework, demographic evidence serves as the criterion for scientific recognition, while biological, cultural, environmental, and biocognitive investigations examine the organizational relationships through which exceptional human aging emerges and is sustained.

The monograph further introduces the concept of **centenarian ecosystems** as the principal unit of scientific investigation and presents a methodological architecture integrating demographic, biological, and biocognitive levels of inquiry. Scientific recognition is therefore understood not as a permanent designation but as an evolving process that remains responsive to advances in demographic validation and longevity science.

By shifting the scientific focus from longevity as a demographic outcome to verified centenarian ecosystems as objects of interdisciplinary investigation, this framework provides a rigorous foundation for the recursive scientific recognition of exceptional human aging and expands the conceptual and methodological landscape of contemporary longevity science.

Keywords

Centenarian Regions; verified centenarian populations; exceptional human aging; longevity science; demographic verification; age validation; centenarian ecosystems; biocognitive science; Centenarian Consciousness Index; scientific recognition; recursive scientific confirmation.

Introduction

Scientific recognition is not a permanent designation but a recursive process of empirical confirmation. As demographic records improve, populations change, and new methods of biological and epidemiological investigation emerge, regional designations that were once considered definitive may require re-evaluation. Recognition, therefore, should not represent a permanent status but an ongoing scientific process.

The Biocognitive Science Institute (BSI) functions as a scientific confirming body whose responsibility is to evaluate and periodically re-evaluate regions exhibiting exceptional concentrations of verified centenarians. The Institute proposes a new framework for recognizing

Centenarian Regions based on current official demographic evidence, rigorous age verification, and periodic scientific revalidation. Unlike permanent regional designations, this framework recognizes that exceptional human aging is a dynamic population phenomenon whose scientific validity must continually be reassessed.

Blue Zones brought international attention to regions associated with exceptional longevity and stimulated valuable public interest in healthy aging. However, its primary scientific object is longevity itself—a broad demographic outcome that encompasses a wide range of survival patterns. Recent scientific discussions have demonstrated that demographic interpretation, age verification, and administrative record accuracy remain active areas of investigation rather than settled questions (Austad & Pes, 2025; Newman, 2024). Furthermore, contemporary reviews conclude that while Blue Zone regions continue to provide important scientific observations, the persistence of exceptional longevity should be evaluated as a dynamic demographic phenomenon rather than assumed as a permanent regional characteristic (Candal-Pedreira et al., 2026).

The Biocognitive Science Institute adopts a different scientific object. Rather than recognizing longevity as a general population characteristic, it recognizes verified centenarian populations as the highest demographic expression of exceptional human aging. Longevity is an outcome; centenarian populations are the scientific reference. The scientific question therefore changes from *Where do people live longer?* to *Where do verified centenarian populations emerge, and what biological, demographic, cultural, environmental, and biocognitive ecosystems sustain them?*

Within this framework, recognition is not an endpoint but the beginning of scientific inquiry. Regions qualifying as **Recognized Centenarian Regions** enter a process of periodic scientific review, allowing demographic updates, improvements in age verification, and future integration of biological and biocognitive measures as the science advances. Recognition identifies the region;

scientific inquiry investigates the centenarian ecosystem from which exceptional human aging emerges. Recognition therefore becomes recursive rather than static, reflecting the self-correcting nature of scientific investigation itself.

This monograph introduces the conceptual foundations of the Biocognitive Science Institute's Recognition Program for Centenarian Regions, including its methodology of recursive scientific confirmation, institutional recognition through Scientific Recognition Certificates and Scientific Achievement Certificates, and its broader objective of advancing the study of centenarian ecosystems as a distinct field within longevity science.

The Scientific Object: From Longevity to Centenarian Regions

Scientific inquiry begins by defining its object of investigation. The distinction between longevity and centenarian populations is therefore not merely semantic but epistemological. The object selected for investigation determines the questions that can be asked, the methods that can be applied, and the conclusions that may legitimately be drawn.

The Blue Zones framework established **longevity** as its principal object of recognition. While this perspective contributed substantially to public awareness of healthy aging, longevity itself represents a broad demographic outcome. Populations characterized by relatively long-life expectancy may differ considerably in the prevalence of verified centenarians, the accuracy of age verification, and the biological and cultural conditions associated with exceptional aging. Recent demographic debates have further emphasized that questions of age verification and administrative accuracy remain scientifically relevant when interpreting exceptional longevity populations (Austad & Pes, 2025; Newman, 2024). Longevity therefore provides an important demographic indicator but not necessarily the most discriminating scientific reference for investigating exceptional human aging (Candal-Pedreira et al., 2026).

The Biocognitive Science Institute adopts a different scientific object. Rather than recognizing longevity as a generalized population characteristic, it recognizes *Centenarian Regions*—geographical populations demonstrating exceptional concentrations of verified centenarians according to current official demographic evidence. Within this framework, verified centenarian populations become the scientific reference through which exceptional human aging is investigated.

This distinction changes the direction of scientific inquiry. Rather than asking why some populations exhibit greater average longevity, the primary question becomes: What characteristics define the ecosystems from which verified centenarian populations consistently emerge? Demographic verification becomes the criterion for recognition, while the centenarian ecosystem becomes the object of scientific investigation.

Recognition therefore serves a single purpose: to identify populations whose demographic characteristics warrant continued scientific study. It does not conclude inquiry but establishes the conditions under which inquiry begins. Once a region is scientifically confirmed, the investigation expands beyond demographic verification to examine the biological, cultural, environmental, and biocognitive organization associated with exceptional human aging. Recognition confirms the population; scientific inquiry investigates the ecosystem.

Centenarian Ecosystems

Verified centenarian populations represent naturally occurring laboratories of exceptional human aging. Their scientific value resides not in chronological age itself but in the organizational relationships that allow exceptional aging to emerge and persist.

Demographic verification establishes the existence of the population. It does not explain the processes through which the population is sustained. The demographic phenomenon therefore becomes the point of entry into a deeper level of scientific investigation.

Exceptional aging emerges through the continuous interaction of biological organization, perceptual orientation, cultural meaning, environmental context, and historical continuity. None of these dimensions alone explains the persistence of verified centenarian populations. Together they constitute a centenarian ecosystem whose organization can be investigated scientifically (Martinez, 2001).

Within this ecosystem, demographic evidence identifies the population while complementary levels of investigation reveal its organization. *Biocognitive* measures examine perceptual and emotional organization. Biological measures investigate molecular organization. Cultural analyses examine the historical continuity of meaning systems through which exceptional aging is lived rather than merely measured. These levels do not compete for explanation; they describe different organizational expressions of the same ecosystem.

The scientific value of centenarian populations therefore resides not in their rarity but in their capacity to reveal organizational invariants associated with exceptional human aging. The ecosystem, rather than longevity alone, becomes the unit of scientific investigation.

Methodological Architecture

Investigation proceeds through successive levels of organization. Each level contributes distinct evidence while remaining integrated within a single scientific framework.

The first level establishes **demographic confirmation**. Official demographic records and rigorous age verification determine whether a population exhibits an exceptional concentration of verified

centenarians sufficient to qualify for scientific recognition. Demography establishes the population; it does not explain its organization.

The second level examines **biocognitive organization**. The Centenarian Consciousness Index (CCI) investigates perceptual and emotional orientations linking meaning-making, temporal experience, and biological aging, extending inquiry from demographic description to the organization of human experience associated with exceptional aging (Martinez, 2026).

The third level investigates **biological organization**. IgG glycan profiling provides a robust biomarker of biological aging whose analytical precision and temporal stability permit the investigation of molecular organization associated with exceptional aging. Within the present framework, biological measures are interpreted as complementary expressions of the centenarian ecosystem rather than as isolated determinants of longevity (Rapčan et al., 2024).

The fourth level integrates these complementary observations through **recursive scientific review**. Demographic, biocognitive, and biological evidence are periodically re-evaluated as new data become available. Scientific confirmation therefore remains responsive to the evolving organization of the centenarian population rather than fixed to a single historical observation.

Together, these methodological levels investigate organizational invariants associated with exceptional human aging through complementary demographic, biocognitive, and biological evidence.

The Ontology of Scientific Recognition

Scientific recognition identifies a verified population whose organization can be investigated across complementary levels of evidence. Demographic confirmation establishes the existence of the population; it does not explain the organizational processes through which exceptional aging emerges and is sustained. The scientific value of a recognized centenarian region therefore resides

in the opportunity to investigate the organizational relationships that distinguish verified centenarian populations from the general population.

Scientific recognition begins with the verified centenarian population and expands to the ecosystem in which that population emerges. This permits investigation across demographic validation, biological age, immune organization, inflammatory regulation, cultural continuity, and biocognitive meaning-making. Current centenarian science supports this multi-level approach because centenarians are increasingly understood not simply as survivors of advanced chronological age but as biologically distinctive populations whose aging trajectories may involve preserved or adaptively remodeled immune function, delayed morbidity, and resistance to chronic low-grade inflammation. Consequently, verified centenarian populations have become important scientific models for investigating the mechanisms that promote health span, biological resilience, and successful aging across the lifespan (Arai et al., 2015; Barzilai et al., 2018; Franceschi et al., 2018; Fulop et al., 2026).

The Centenarian Consciousness Index (CCI) extends investigation from demographic verification to the organization of lived experience by examining recurring perceptual and emotional orientations associated with exceptional aging (Martinez, 2026). Rather than treating exceptional aging as the consequence of isolated psychological traits, the CCI investigates enduring modes of meaning-making through which centenarians interpret biological change, adversity, social belonging, mortality, and continuity of self. This level of investigation complements demographic and biological evidence by examining the biocognitive organization through which exceptional aging is experienced and sustained.

Biological investigation provides a complementary level of observation. IgG glycan profiling has emerged as a robust biomarker of chronological and biological aging because age-related changes

in IgG glycosylation are closely associated with inflammation and immune regulation. Studies show that reduced galactosylation and sialylation, together with increased agalactosylation and bisecting GlcNAc, are characteristic of aging-related immune remodeling (Kristic et al., 2014; Rapčan et al., 2024; Zhang et al., 2024). Within the present framework, these biomarkers do not replace demographic or biocognitive evidence; they provide a molecular level through which the organization of exceptional aging can be investigated.

Preliminary BSI centenarian findings are consistent with the need for this integrative approach. In the current centenarian cohort, IgG glycan profiling has indicated biological ages substantially younger than chronological ages in many participants, including marked biological-age reductions among the oldest individuals tested. These observations coexist with biological characteristics traditionally associated with advanced aging, including shortened telomeres and inflammatory burden. Such findings suggest that exceptional aging cannot be adequately explained by a single biomarker profile but requires investigation of compensatory organization across biological, immune, cultural, and biocognitive domains. Rather than viewing these observations as contradictory, they support the hypothesis that exceptional aging reflects higher-order biological organization in which adaptive regulatory processes preserve functional resilience despite the accumulation of age-related molecular change.

This interpretation is consistent with centenarian research showing that exceptional longevity does not reflect the simple absence of aging processes. Centenarians may exhibit inflammatory and immunosenescent features while also showing regulatory adaptations that distinguish successful aging from pathological aging. Studies of centenarians and their offspring indicate preserved telomere maintenance relative to age-matched older adults, while immune research suggests that centenarians may attenuate inflammaging through altered regulatory immune balance, including

Th17/Treg organization and anti-inflammatory phenotypes (Arai et al., 2015; Hashimoto et al., 2019; Wang et al., 2022). These findings reinforce the view that exceptional aging emerges through coordinated biological regulation rather than through the preservation of isolated biomarkers.

Recognition therefore identifies a population in which demographic, biological, immune, cultural, and biocognitive evidence can be investigated as complementary levels of organization rather than as isolated explanatory domains. The region is recognized because it provides a stable empirical context in which these levels can be examined together. The centenarian ecosystem, rather than longevity alone, becomes the scientific object.

The ontology of scientific recognition is therefore concrete: recognition selects a verified centenarian population as a living field of inquiry. It permits the study of how exceptional aging is organized across demographic records, biological systems, immune regulation, meaning-making, family continuity, cultural expectations, and temporal orientations. A recognized centenarian region is scientifically valuable because it permits the investigation of organizational invariants that would remain inaccessible if demographic, biological, cultural, and biocognitive evidence were studied in isolation.

Scientific Criteria for Recognizing Centenarian Regions

Scientific recognition is based on objective demographic evidence demonstrating that a geographically coherent population exhibits an exceptional concentration of verified centenarians according to current official records. Recognition identifies populations whose demographic characteristics justify sustained scientific investigation.

Recognition requires the convergence of two complementary demographic criteria. First, a region must demonstrate a sufficient number of verified living centenarians confirmed

through official demographic records, civil registries, census documentation, or equivalent governmental sources meeting contemporary standards of age verification (Austad & Pes, 2025; Newman, 2024).

Second, the region must demonstrate an exceptional concentration of verified centenarians relative to its total population. Because regions differ substantially in population size, demographic comparison is standardized by expressing centenarian prevalence as the number of verified centenarians per 10,000 residents. Population-standardized measures permit valid comparison among regions of different demographic size and represent an established approach in demographic analysis (Preston et al., 2001).

Numerical thresholds for recognition are established and periodically reviewed by the Biocognitive Science Institute according to current demographic evidence and advances in age validation. This approach preserves methodological consistency while allowing scientific standards to evolve as new evidence becomes available.

Recognition also requires geographic coherence. A recognized centenarian region must represent a naturally occurring population with sufficient historical and demographic continuity to justify investigation as a single ecosystem rather than an administrative aggregation constructed solely to increase centenarian counts. Geographically coherent populations provide appropriate units for population-health investigation because they preserve the contextual relationships through which demographic phenomena emerge (Diez Roux, 2001).

These demographic criteria establish eligibility for scientific recognition; they do not explain the mechanisms underlying exceptional human aging. Once a region is recognized, it

becomes eligible for continued investigation through the complementary demographic, biological, cultural, environmental, and biocognitive methodologies described in this monograph. Demographic confirmation identifies the population; scientific investigation examines the centenarian ecosystem (Candal-Pedreira et al., 2026).

Conclusion

The scientific study of exceptional human aging continues to evolve as demographic records improve, methods of age verification become increasingly rigorous, and biological and biocognitive investigations deepen our understanding of centenarian populations. Scientific recognition must therefore evolve with the evidence it seeks to represent.

This monograph has proposed a framework that distinguishes verified centenarian populations from longevity as a general demographic outcome and positions Centenarian Regions as scientifically recognizable ecosystems worthy of sustained interdisciplinary investigation. In doing so, it shifts the scientific focus from longevity as a demographic outcome to verified centenarian ecosystems as objects of interdisciplinary investigation, thereby expanding the questions that longevity science is able to ask. Demographic confirmation provides the foundation for recognition; biological, cultural, environmental, and biocognitive inquiry reveal the organizational relationships through which exceptional human aging emerges and is sustained.

Recognition is neither a permanent designation nor the culmination of scientific inquiry. It is a point of departure. By treating recognized centenarian populations as naturally occurring scientific laboratories of exceptional human aging, the recursive integration of demographic verification with complementary levels of investigation provides an expanding scientific

foundation through which the biology, ecology, and lived experience of exceptional longevity may be more fully understood.

As new evidence emerges, regions may be reaffirmed, revised, or newly recognized. Such evolution does not diminish scientific recognition; it strengthens it. The enduring value of recognizing Centenarian Regions resides not in preserving historical classifications but in advancing a self-correcting science capable of identifying the organizational invariants associated with exceptional human aging across populations, cultures, and generations.

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