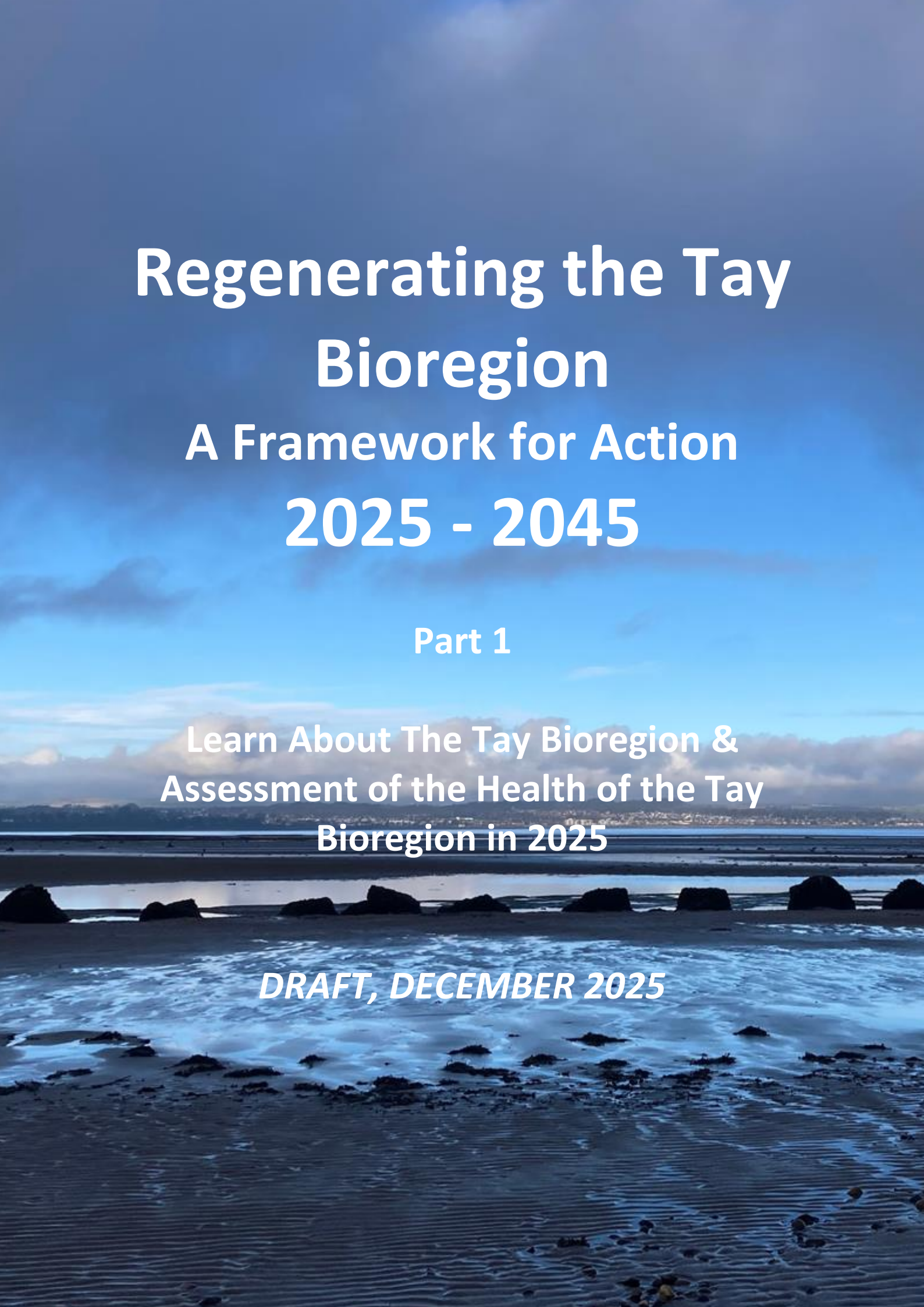

Regenerating the Tay Bioregion

A Framework for Action

2025 - 2045

Part 1

Learn About The Tay Bioregion & Assessment of the Health of the Tay Bioregion in 2025

DRAFT, DECEMBER 2025

Bioregioning is a place-based biophysical[1] and cultural response to the planetary crises[2] we are facing. It re-invigorates and restores how we humans think about our presence on this planet and how we act, because it challenges us to see a geographic area – our place – through its natural systems instead of the infrastructure humans have designed – turning shires and cities into biomes and watersheds.

Through this work we aim to create opportunities for the people of the Tay Bioregion to re-perceive their interdependence with the natural world and take the urgent action needed to bring human and biotic communities back into a healthy, balanced co-existence with each other.

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[1] Biophysics is an interdisciplinary science that applies the principles and methods of physics, chemistry, and mathematics to understand biological systems

[2] the interconnected challenge of climate change, biodiversity loss, and pollution that threatens ecosystems, human health, and the planet's future

Part 1: Learn About The Tay Bioregion & Assessment of the Health of the Tay Bioregion in 2025

Part 2: Opportunity Analysis & Strategic Directions

Part 3: Governance, Collaboration & Finance

Part 1

Learn About The Tay Bioregion
&
Assessment of the Health of the Tay Bioregion in 2025

Contents

1. Executive Summary

Regenerating the Tay Bioregion: A Framework for Action (2025–2045) presents the first comprehensive bioregional strategy for ecological and cultural renewal within the Tay River System of Scotland. The Framework recognises this bioregion as an interconnected living system - spanning land, water, biotic and human communities - and aims to guide the transition from extractive, fragmented practices to regenerative, place-based stewardship.

This document (Part 1 of 3) provides the foundational knowledge for understanding the Tay Bioregion and assessing its current ecological and social health. Parts 2 and 3, to follow, will address strategic opportunities and governance and financing mechanisms for regeneration.

Purpose and Vision

The Framework proposes a **bioregional approach** to regeneration - one that integrates ecological restoration, community wellbeing, and economic resilience. It treats the Tay Bioregion not as a set of human designed administrative zones but as a coherent living system defined by the **Tay River System**[3], encompassing 7,163 square kilometres from the Highlands to the North Sea.

Its core ambition is to realign human prosperity with the integrity of natural systems. It promotes regenerative land use, biodiversity protection, localised food and energy systems, and community-led governance to ensure that future development enhances, rather than undermines, the bioregion's ecological base.

The Framework acknowledges that healthy bioregions form the essential infrastructure for a liveable planet. In the context of climate breakdown, biodiversity loss, and social fragmentation - the polycrisis - regeneration is presented not as an optional cost but a necessary foundation for economic and cultural resilience.

Why Bioregioning Matters

Bioregioning is both an ecological and cultural practice of re-inhabiting place - learning to live in ways attuned to local landscapes, watersheds, and histories. It challenges the dominance of political and economic abstractions, asking instead: *what does the land itself require to thrive, and how can humans belong within its limits?*

The Tay Bioregion's approach draws on systems thinking, viewing forests, soils, rivers, and communities as interdependent parts of a single living matrix. This perspective enables integrated solutions - where soil regeneration improves water retention, which enhances biodiversity, which supports food security and social wellbeing.

Globally, bioregioning is part of a growing movement linking local ecological restoration with community empowerment. The Tay initiative aligns with networks such as the **Bioregional**

[3] See definition of the Tay River System here. The Tay Bioregion's boundary is based on this.

Weaving Labs[4] and the **Bioregions of the North Atlantic Isles**, situating Tayside within an international dialogue on living "indigenous to place."

Structure of the Framework For Action

The Tay Bioregional **Framework For Action** is structured as follows:

- **Part 1:** Understanding the Tay Bioregion - its land, water, biotic and human systems – and assessing current health (**this document**).
  Part 2: Opportunity Analysis and Strategic Directions - outlining pathways, transition scenarios, and illustrative regenerative projects over 5, 10, and 20 years.
- **Part 3:** Governance, Collaboration and Finance - designing institutional and financial systems to sustain long-term regeneration.

The Tay Bioregion: A Living System

The Tay Bioregion encompasses diverse geologies, ecologies and communities, unified by the River Tay System. From the Highland Boundary Fault to the fertile lowlands of Strathmore and the Carse of Gowrie, it includes upland moors, forests, farmlands, lochs, rivers and estuaries. These natural systems underpin one of Scotland's most productive agricultural regions, a globally significant freshwater ecosystem, and a human story that goes back c8,000 years.

Land - The Living Foundation

The region's geology - Dalradian metamorphic rocks in the Highlands and younger sedimentary layers in the Lowlands - has shaped its topography, soils, and land use. Its fertile lowlands are among Scotland's most productive, while upland areas support rough grazing and peatland. However, centuries of intensive agriculture, deforestation, and estate consolidation have fragmented habitats, eroded soils, and restricted land access.

Regenerative land practices - such as agroecology, rewilding, and mixed-use forestry - are identified as critical to restoring soil fertility, carbon storage, and landscape resilience.

Water - The Circulatory System

The River Tay, Scotland's largest river by volume, flows eastward through multiple catchments, lochs and tributaries. Its system sustains biodiversity of international importance, including **Atlantic salmon, otter, freshwater pearl mussel**, and **lamprey**. Yet water quality and flow patterns have been heavily modified by hydropower, agricultural runoff, and urbanisation.

The framework highlights the need for integrated catchment management - restoring natural hydrology through riparian replanting, wetland regeneration, and sustainable farming - to strengthen both ecological and community resilience against climate-driven flooding and drought.

[4] Bioregional Weaving Labs

Biotic Communities - The Web of Life

The Tay Bioregion's ecosystems range from **montane heaths and peatlands** in the north to **lowland farmlands, ancient woodlands, wetlands and coastal habitats** in the south and east. Despite high conservation value - 20% of the catchment is under ecological designation - biodiversity has declined sharply due to monoculture farming, invasive species, and climate stress.

Flagship species such as the **red squirrel, golden eagle, beaver, freshwater pearl mussel, and bearded tit** represent the bioregion's ecological wealth and vulnerability. Reconnecting fragmented habitats, increasing native woodland cover (currently 16%), and restoring degraded peatlands are central to regeneration.

Old Man's Beard Lichen on Alyth Hill, photo Clare Cooper

Human Communities – Participants in the System

The region's c416,000 residents are concentrated in **Dundee, Perth, Angus and northern Fife**, with a third in Dundee alone. Rural depopulation, an ageing population, and unequal land ownership constrain local resilience. Yet there is also a strong network of **24 Community Development Trusts** pioneering local energy, housing, and land initiatives.

Historically, the Tay Bioregion has been a crucible of cultural innovation - from Pictish kingdoms and monastic agriculture to the Scottish Enlightenment and industrial Dundee. Its story reflects cycles of connection and disconnection between people and land: from communal stewardship to enclosure and industrialisation, and now toward potential reconnection through community-led regeneration.

Challenges Identified (2025 Health Assessment)

The assessment of the Tay Bioregion's current health reveals **intertwined ecological and social stressors**:

- **Land degradation** through soil erosion, overgrazing, and monoculture, reducing fertility and biodiversity.
- **Water degradation** from agricultural runoff, hydroelectric alterations, and urban pollution.
- **Biodiversity loss** due to habitat fragmentation and climate change impacts on keystone species.
- **Inequitable land ownership**, with large estates dominating and limiting community control.
- **Socioeconomic vulnerability**, including depopulation of rural areas and limited affordable housing.
- **Climate change threats**, particularly increased flooding, peatland drying, and shifting species ranges.

Despite these pressures, the region also shows strong regenerative potential: ecological restoration and rewilding projects small and large, regenerative agriculture, local food movements, renewable energy projects, waste recycling and collaborative governance experiments are already underway.

From Vision to Action

The framework translates bioregional principles into **ten areas of practical intervention**:

- **Land use change** that restores ecosystem function and biodiversity.
- **Watershed restoration** and nature-based flood management.
- **Agro-ecological farming** through soil regeneration, biodiversity uplift and reduced chemical inputs.
- **Expansion of native woodland** especially of upland and riparian zones.
- **Renewable energy systems** integrated with landscape-scale ecological planning.
- **Circular and local economies** to reduce material throughput and build food security.
- **Place-based cultural and educational renewal** that celebrates human inter-connectedness with nature and reorients identity and learning toward local ecosystems.
- **Community governance** that devolves decision-making to catchment and bioregional scales.
- **Just Transition frameworks** ensuring fair social and economic adaptation.
- **Long-term monitoring** of ecological and cultural health indicators.

A Call to Reconnection

The Tay Bioregion **Framework For Action** extends a moral and cultural invitation: to reimagine progress not as endless growth but as *reciprocity with place*.

It argues that regeneration requires both ecological repair and cultural renewal - healing the relationship between people and their environment through attention, care, and collaboration.

It positions the Tay Bioregion as both a **model and a movement** - a living laboratory for bioregional regeneration that could inspire similar transitions across Scotland and beyond.

It calls on all who live within it to re-perceive themselves as part of the land's living systems and to co-create a regenerative future rooted in care for place. As regenerative thinker Pamela Mang says: "Love of place unleashes the personal and political will needed to make profound change."

Its success will depend on sustained collaboration among citizens, landowners, businesses, local councils, scientists, and artists, and on measuring success not in GDP but in the health of soils, rivers, and communities.

In essence, *Regenerating the Tay Bioregion 2025–2045* is a roadmap for transforming one of Scotland's great watersheds into a thriving, resilient landscape of life - socially just, ecologically rich, and culturally grounded.

Millenniums of change: The late Neolithic (c3,000 – c 2,500 BC) Park Neuk Stone Circle near Alyth with Drumderg Windfarm (2008) in the background, photo Clare Cooper

2. Foreword & Introduction

Structure of this document

The three parts of the document lay out a route map for how practical action might be taken.

- **Part One**: **Learn about the Tay Bioregion**, followed by an **Assessment of the Health of the Tay Bioregion in 2025**
- **Part Two**: **Opportunity Analysis and Strategic Directions**, with potential scenarios for the future over 5, 10 and 20 years, transition pathways, expected returns, and illustrative projects
- **Part Three**: **Governance and Finance** infrastructure needed for delivery

Defining Bioregions

Bioregions are "whole-life places."[5] They are shaped by the ecological patterns, cultural resonances, and shared context of a particular landscape. In the case of the Tay Bioregion, the boundaries are defined by the Tay River system[6]

Bioregions are not simply supply-sheds for water, food, minerals, or fibre. They are coherent ecological systems - forests, soils, rivers, seas - interwoven with human cultural knowledge developed over millennia. Unlike artificial political jurisdictions, bioregions are defined by natural and human patterns:

- **Hard boundaries**: geological, tectonic, hydrological
- **Soft boundaries**: ecological, climatological
- **Human boundaries**: cultural, identity-based

While many bioregions are defined by watersheds, they can also be mountain ranges, islands, marine environments, or deserts.

Why a Bioregional approach matters

Bioregioning is the practice of re-inhabiting a place - learning to live in ways deeply attuned to its ecological, cultural, and historical realities. It is about becoming native to that place through attention, relationship, and reciprocity. It is both repair and reimagination: tending to the wounds of disconnection and extraction while co-creating futures rooted in mutual care among human and other than human communities.

Bioregioning requires **systems thinking** - a way of looking at how different parts of something connect and affect each other, rather than focusing on each part separately. A bioregion is not a collection of separate parts - forests, rivers, farms, communities - but an interconnected, interdependent whole. This holistic view allows us to design regenerative ways of living that

[5] Dark Matter Labs Partnering Offer To The Field of Bioregioning

[6] See Tay Fisheries Management Plan Map

weave together community, ecology, culture and economy, building resilience at the scale of place.

The confluence of the Rivers Ericht and Isla in Strathmore, photo Markus Stitz

This framework begins from a simple recognition: healthy, thriving bioregions are not optional. They are the foundation of long-term economic resilience, climate adaptation, and collective well-being. In the context of today's deepening polycrisis, regenerating both natural and human systems must be understood not as a peripheral cost but as the core infrastructure needed for a liveable planet.

From Vision to Action

But for this framework to develop into a realised plan, bioregioning needs to translate into practical action. This includes:

- Land use changes that support healthy ecosystems
- Protection and enhancement of biodiversity
- Restoration of freshwater and marine systems
- Promotion of organic and agroecological practices
- Reduction of energy demand and carbon emissions
- Scaling down of material consumption and production
- Building local supply chains to strengthen food security and resilience
- Nurturing a sense of place and belonging through re-inhabitation
- Designing social and economic infrastructure for a Wellbeing Economy and Just Transition
- Applying appropriate technologies to enable all the above

Bioregioning as a Global Movement

Bioregioning in Tayside is part of a growing global phenomenon. The contemporary bioregional movement emerged in the 1970s along North America's west coast, where artists and activists

sought ecological, place-based alternatives to mainstream environmentalism. Inspired by Indigenous and regional traditions, it emphasised realignment with the rhythms of watersheds, soils, plants, and animals - an ethos long practiced by Indigenous peoples through reciprocal stewardship. Today, catalysed by planetary crisis, bioregional networks are flourishing worldwide - from the Americas and Australia to Europe, through initiatives such as the Bioregional Weaving Labs Collective and the Bioregions of the North Atlantic Isles Network, of which Bioregioning Tayside is a part. This movement is a contemporary articulation of an ancient truth: to live "indigenous to place."

A call to reconnection

This framework connects to and builds on this new global energy. It calls for ecological restoration, cultural transformation, economic relocalisation, and the patient rebuilding of social fabric badly weakened by centuries of colonialism and decades of neoliberalism.

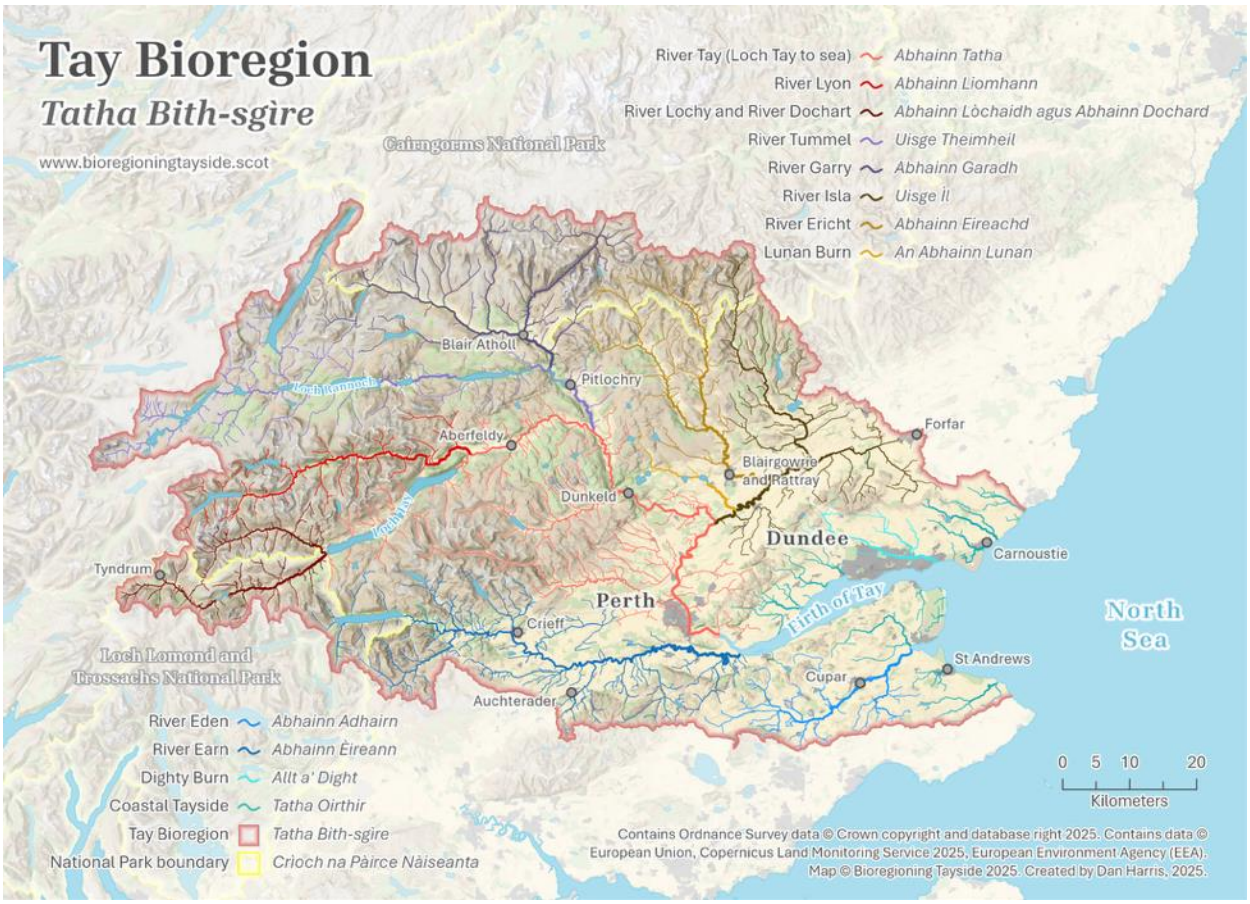
Bioregional organising reminds us that we cannot abstract ourselves from ecological reality. Water, food, energy, shelter all remain unavoidably local. A watershed does not care about political divisions. Soil degradation affects everyone who relies on it. Upstream estate owners and downstream farmers are bound together, just as rural and urban communities depend on one another. As Pamela Mang has written:

> "What makes a shift to true sustainability possible is the power of the connection between people and place. Place is a doorway into caring. Love of place unleashes the personal and political will needed to make profound change. It can also unite people across diverse ideological spectra because place is what we all share: it is the commons that allows people to call themselves a community."

The work begins with a place-based, relational worldview that measures progress in decades, not quarters - resilient to shifting climates, changing economies, and unknown futures. Wisdom sets the direction, knowledge fuels the journey. Together, they form the values of a region intent on thriving in harmony with its place in the world.

3. Learn About the Tay Bioregion

The Tay Bioregion is based on the Tay River system and covers 7,163 square kilometres.



A map of the Tay Bioregion showing the principal sub catchments and hydrometric areas

This section introduces the **four key elements** chosen to frame the Tay Bioregion; **land**, **water**, **biotic communities** and **human communities**, and summarises key aspects of its unique geology, history, ecology and human culture.

From a bioregional and systems perspective, none of the four key elements are isolated: together they form a living matrix of life. The integrity of soils, patterns of land use, water systems, biotic communities, and human cultures are mutually embedded and dynamically interdependent. Each element shapes, sustains, and is shaped by the others in a continuous cycle of exchange, feedback, and evolution.

Land - geology, soils and land use: The Living Foundation

The Bioregion's complex biodiversity only exists because of its underlying geodiversity[7]. An understanding of the geology beneath us is fundamental to the wider goal of Bioregional Regeneration because geological features and geomorphological processes have created many of our important finite resources. The region's rocks, soils and landforms are resources that provide

[7] See Tayside Biodiversity Partnerships' 'Tayside, A Land Moulded By Rock and Ice'

the essentials for life. These include water, raw materials for manufacturing and construction, soil for agriculture and land for recreation. The geology also determines whether and how the atmosphere can generate life, mainly through solar radiation and its interaction with temperature and precipitation to determine the capture of carbon dioxide and some other gases.

Images of the Land, Water, Human and Biotic Communities of the Tay Bioregion, photos Clare Cooper and George Logan

Soils are the foundational medium for terrestrial life - complex ecosystems in themselves. Rich in microbial life, organic matter, and mineral content, healthy soils act as biogeochemical hubs, mediating nutrient cycles, storing carbon, filtering water, and supporting plant, animal and fungal communities. Soil health is intimately tied to land use patterns: regenerative agriculture, permaculture, and forest stewardship can build soil fertility, while extractive practices such as monoculture, overgrazing, deforestation or urban sprawl deplete it.

Changes in soil structure and fertility ripple outward - affecting water retention and flooding, plant resilience, biodiversity, and even climate regulation through carbon sequestration. Degraded soils lose their capacity to retain water, leading to nutrient loss, erosion, flash floods, and desertification. Thus, soil is both a product and determinant of the bioregion's ecological trajectory.

Understanding land use is the foundation for bioregional planning, enabling the development of integrated strategies that balance human needs with the ecological integrity of a specific geographical area. By analysing how land is currently used and the impacts of those uses, areas of conflict, opportunities for restoration, and strategies for integrating human activities with the natural environment can be identified. This knowledge is essential for developing effective land management plans that support biodiversity, ecosystem health, and the well-being of communities within the Bioregion.

Water: The Circulatory System

Water systems - rivers, lochs, aquifers, wetlands, rainfall patterns - are inseparable from the land's form and use. In the Tay Bioregion, the power of water has carved deep glens, river valleys and dramatic waterfalls, eroding rock and creating fertile flood plains along the way. Vegetation cover, topography, and soil permeability regulate the flow, filtration, and storage of water. Land use directly impacts water health: deforestation, impervious urban surfaces, hydro power schemes and industrial agriculture can disrupt hydrological cycles, reduce groundwater recharge, and increase runoff pollution.

Conversely, well-managed land - through watershed-conscious planning, natural riparian buffers[8], natural flood management and regenerative land practices - can enhance water purity and availability. In systems/ecological thinking, water is not merely a resource but a connective tissue, linking upland and lowland ecosystems, species habitats, and human settlements.

A last fragment of the great 'Meigle Moss', drained in the 18thc-19thc, photo Markus Stitz

Biotic Communities: The Web of Life

Plant and animal communities arise from, and contribute to, the character of their bioregion. Vegetation (primary producers that capture energy from the sun via photosynthesis) creates food, stabilises soils and moderates climate. Plants (terrestrial, freshwater and marine) support all species, from insects to large mammals, fungi and soil microbes, freshwater and marine life. They are fundamental to defining the variety of habitats within an ecosystem and determine what other life can survive in any habitat.

[8] A natural riparian buffer is an uncultivated strip of permanent vegetation, such as grasses, shrubs, and trees, located alongside streams, rivers, and other water bodies. These naturally vegetated areas act as a barrier, filtering pollutants, sediment, and nutrients from runoff, slowing water flow to reduce erosion and flooding, stabilizing banks, and improving water quality for aquatic life. They also enhance biodiversity and provide important habitat for wildlife.

These biotic communities are deeply tied to soil and water dynamics. A decline in soil health or water availability leads to biodiversity loss, while degraded ecosystems in turn reduce the land's capacity to regenerate back to a productive state. Keystone species, native flora, and symbiotic relationships all provide resilience to land systems, buffering against shocks and maintaining function.

Human Communities: Participants in the System

Humans are not external to these systems but active participants. Indigenous and place-based cultures have long understood the reciprocal relationship between people and land, managing landscapes with an ethic of care and relational stewardship. In contrast, modern industrial land use often fragments ecosystems, externalizes ecological costs, and treats land as a commodity rather than a living system.

Yet human communities also hold the greatest potential for restoration. Through local governance, agroecology, ecological design, and community-based conservation, people can restore degraded landscapes and reconnect social systems with natural processes. Food sovereignty, climate adaptation, and cultural revitalization are all enhanced when land use is informed by bioregional awareness and ecological knowledge.

Interdependence and Feedback Loops

Each element - Land, water, biotic life, and human culture - exists in dynamic feedback with the others. A change in one component sends ripples throughout the system. For example:

- Poor land use leads to soil erosion → reduces water retention → stresses plant life → diminishes habitat → reduces biodiversity → undermines local economies.

- Conversely, community-led reforestation → builds soil → improves water cycles → restores habitats → enhances food and water security → deepens cultural connection to place.

From a systems view, the health of a bioregion is an emergent property of these relationships. True resilience and sustainability depend not on isolating variables, but on understanding and cultivating an understanding of the integrity of the whole system.

3.1 Land

3.1.1 Geology[9]

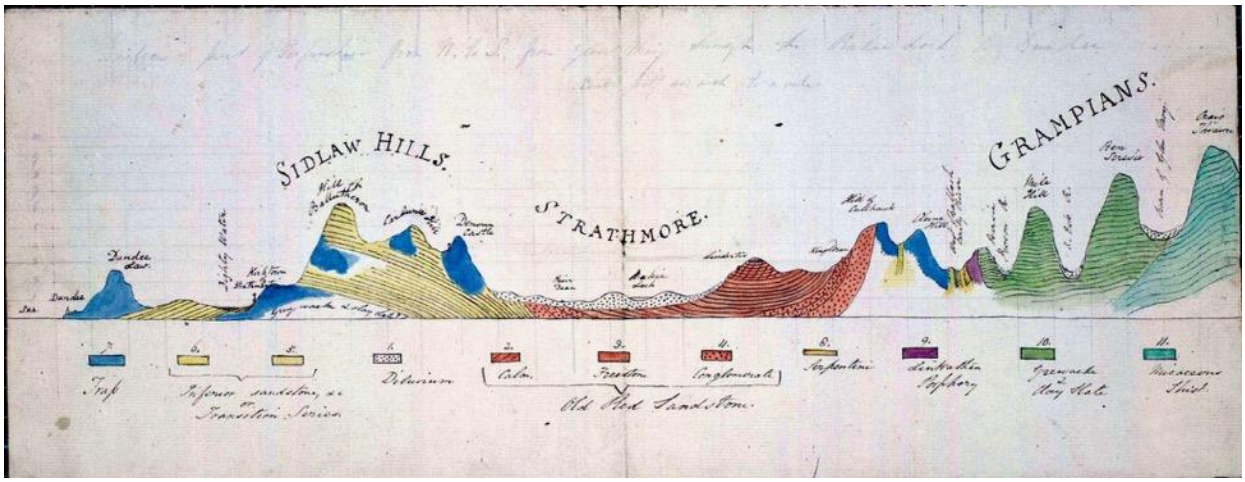
The Tay Bioregion can be seen as consisting of two broadly distinctive geomorphological areas separated by the **Highland Boundary Fault**, a geological fault that separates the Highlands and Lowlands of Scotland and crosses Scotland from Arran in the southwest to Stonehaven on the northeast coast. North of the fault, the rocks are primarily Dalradian metamorphic rocks, dating back to approximately 600-500 million years ago. South of the fault, the rocks are generally part of the Midland Valley including younger sedimentary rocks of Devonian and Carboniferous age, dating back between 400 million and 300 million years. The two ranges of hills in the south, the

[9]The narrative in this section has been drawn primarily from NatureScot's Landscape Character Assessment: Tayside and the Tayside Geodiversity Action Plan.

Ochils and Sidlaws, are igneous intrusions. As a result of tilting, these hills now form south-facing dip slopes and north-facing scarp slopes.

The Bioregion overlies two of Scotland's major geological units; the Grampian Highlands (which includes the Cairngorms) and the East Central Lowlands of the Midland Valley and stretches from the Loch Lomond and Trossachs National Park and Rannoch Moor in the west to the North Sea in the east. The Cairngorms National Park forms part of the north of the Bioregion and north Fife lies on the southern edge.

North of the Highland Boundary Fault, generally harder rocks have resulted in higher elevations despite being subject to similar glacial processes as to the south of the Fault. Much of this area is covered in either moorland or blanket bog, due to higher rainfall, low temperature, stronger wind and less fertile soils. Where valleys have been created or enlarged by glaciation, the more fertile soils occurring on drift deposits support agriculture along river flood plains.



Annotated geological cross section of Strathmore in coloured pencil and ink c1822-1824 by Sir Charles Lyall

To the south of the Fault are broad, flat, fertile straths[10] corresponding with areas of softer sandstone, eroded during glaciation. The fertile soils which now cover these areas are the result of glacial drift deposits and eroded material carried down by rivers from the Highland glens.

The coast varies from steep cliffs to wide bays and to low areas with raised beaches. These raised beaches are covered by marine deposits originating from periods of former higher sea levels. The estuaries form an important tidal habitat for wildlife, and form nursery areas for many fish species and are rich in bird and marine mammal life.

Glaciation had a significant impact on the landscape of the Bioregion. Glaciers carved out U-shaped valleys, such as Glen Isla, by eroding the bedrock as they moved. Harder rocks resisted erosion and now form prominent ridges and crags, while softer rocks were worn away more easily. When the glaciers melted c 11,500 years ago, they left behind moraines (mounds of glacial debris), drumlins (elongated hills of till), and erratics (large boulders transported from other areas). Much of the lowland areas, such as the Carse of Gowrie, have fertile soils formed from fluvio-glacial deposits.

[10] In Scotland, "strath" (from the Gaelic *srath*) means a broad, flat river valley. It is one of many Gaelic words, such as "gleann" (glen), that are commonly used in place-names and describe geographical features.

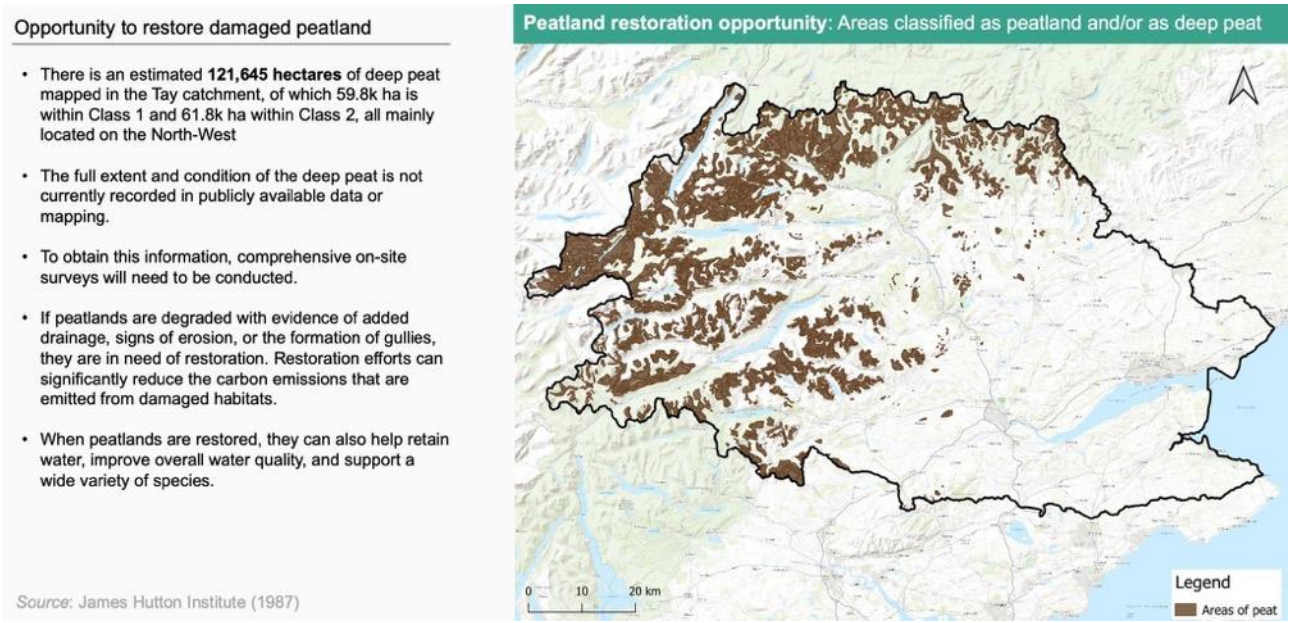
The scouring action of ice helped form many lochs, including Loch Tay. Glacial meltwater and blocks of ice also contributed to the formation of smaller lakes and kettle holes. Glaciation altered natural drainage by blocking valleys and redirecting rivers, leading to the formation of misfit streams and over-deepened glens. The glacial till and outwash plains created fertile farmland, especially in the Strathmore valley, making it one of Scotland's prime agricultural areas.

3.1.2 Soils[11]

Soils within the area can be divided broadly into two groups: low lying land; and those of the higher ground and surrounding hills.

Mineral Podzols cover much of the valley floors as they descend to the lowland, these consist of fluvial glacial sands and gravels, sandur plains, and are poorer in agricultural capacity but can support grazing. When uncultivated, these soils are dominated by gorse and heather, but pine also grows well and planting of pine forest has been used to prevent soil erosion.

Brown soils derived from glacial drift and Old Red Sandstone dominate in the lower land areas with alluvial soils closer to the rivers around Tay, Strathallan and Crieff. Strathmore is covered in a thick layer of late-glacial fluvio-glacial sands and gravels which dictates the soil type (a fertile red loam) and land uses.
Blanket bog and peat are primarily north of the Highland Boundary Fault see map below.



Graphic produced for Bioregioning Tayside by Palladium

Where blanket bogs have formed, they have done so independently of groundwater, unlike lowland raised bogs. They are more dependent upon high rainfall and atmospheric humidity. The blanket bog has thus become a typical vegetation type or 'climactic' formation in this high rainfall area. A base of peat, peaty gleys and peaty podzols soils has been created by the vegetation and drainage in these areas.

[11] The narrative in this section has been drawn primarily from NatureScot's Landscape Character Assessment: Tayside.

The highest areas and exposed slopes have montane soils and specially adapted but sparse vegetation, for example, Ben Lawers.

Since soil science developed in the late 19th and early 20th centuries, research and documentation of soils has often been framed through their capacity for agricultural production capabilities rather than the entire ecological role they play in our planet's life support system, including their ability to provide nutrients, regulate water, store carbon and support biodiversity.

This soil science data tells us that all low-level land, in the Bioregion with the exception of the area of valley peat at the foot of the Lomond Hills, and the surrounding lower hills are recorded as Grade 3.1 and 3.2 on the Macaulay Institute Soil Survey of Scotland for example. These are "soils suitable for arable cultivation" have supported a wide range of crops for millennia. Less fertile parts of this area are commonly grass leys reflecting the growth limitations for arable crops and the degree of risk involved in their production. These areas are more suited to grazing animals or timber production.

All other parts of the area are generally Grades 4.2, 5.2 and 5.3, "land suited only to improved grassland and rough grazings" as one or more limitations render the land unsuitable for arable cropping (e.g. adverse climate, wetness, floods, steep slopes, soil defects, or erosion risks). However, records over many centuries show that farming in this region has evolved to combine mixtures of crops and livestock across a diversity of arable fields, managed grass leys and less productive grazing.

One of the most intensively farmed areas is the Carse of Gowrie. However, this has not always been quality agricultural land. Prior to the agricultural improvements and drainage, begun by the monks of Coupar Angus Abbey[12] in medieval times and extended in the 18th century, the Carse was marshy due to its foundation of uplifted marine clay. The number or names prefixed 'Inch' or island mark the dry areas prior to drainage: Inchture, Inchyra, etc. Further regeneration and innovation came in the 18th Century Improvements period and more recently with post-1945 intensification. Today the lowland soils and climate in the Carse and Strathmore can support among the highest agricultural yields in the UK.

Unlike the carse clays of the Forth, the Carse of Gowrie never had a covering of peat on its surface. There is, therefore, no history of peat cutting in this area, but this has resulted in a rich heritage of clay-building.

3.1.3 Land use[13]

Humans have been present in the Tay Bioregion for at least 8,000 years. The landscape today has been the product of several millennia of human and other forms of life interacting and entangling with the geology, soils, the large river system and each other.

The **Mesolithic** (7,000 - 4,000BC), a transitional period between the Ice Age and the introduction of farming, saw hunter-gatherer groups settling in Tayside. These people relied on the landscape for resources, including wild animals, fish, plants, and shellfish. As the environment changed and new technologies emerged, hunter-gatherers began to transition towards more settled

[12] They established Carse Grange (one of nine such farmsteads centred on the abbey) and set about drainage and other improvements including the planting of orchards as early as the 15th century.

[13] The narrative in this section has been drawn primarily from NatureScot's Landscape Character Assessment: Tayside.

agricultural lifestyles. This shift is reflected in the archaeological record, with evidence of farmsteads, villages, and the development of towns.

During the **Neolithic Period** (4000-2500 BC), around 6,000 years ago, a society settled in Scotland that farmed the land for the first time. They cleared areas of woodland for crops, built houses and enclosures for animals, and had a society where a focus on ritual led to the construction of many stone circles and cairns, evident still throughout the Bioregion.

The **Bronze Age** (2500-800 BC) was characterised by new and extended forms of settlement, increased agricultural activity and clearance of natural forest cover, the erection of standing stones, some rock carving art, pottery and crude metalworking. The Bronze Age peoples are thought to have been migrants who crossed the North Sea from the lands around the mouth of the Rhine; alternatively, it may have been as much the skills and knowledge that migrated as it was the people. They brought with them the 'magical' knowledge of metal-working. This knowledge brought additional power to those with the skills, leading to a significant change to the previous communal Neolithic society. This period sees the development of a hierarchical societal structure of ruling classes, the warrior caste, farming peasantry, and slaves. The development of specialisms, such as stonework, metalwork and farming meant that trade also became established during this time.

Aerial view of the remains of an extensive area of medieval rig and furrow cultivation in Glenshee, photo © Perth & Kinross Heritage Trust

Remains of Bronze Age hut circles and field systems are frequent and extensive over the Tayside area. They are most obvious now on what is marginal land, particularly at the edge of the lowlands and highlands, and high on valley sides such as up Glen lsla at Brewlands Bridge and Burn of Kilry, up Glen Shee, in Strathardle and on upper reaches of the Tay and Earn Valleys.

The Iron Age (800BC - c400AD) saw a period of climatic deterioration, which reduced productive land, driving groups to become more warlike and to fortify their holdings. The adoption of iron enabled stronger tools and weapons, which facilitated further tree felling and renewed agricultural expansion and the Roman occupation (c.70sAD-c390sAD) saw the rise of a more political society, with concentrated settlements and land conflicts that spurred further fortification by tribal groups and communities.

The introduction of agriculture in the **Medieval** period (1050AD – 1600AD) began to increase the clearing of woodlands and the cultivation of land. This included planting of fruit trees, introduced by the monastic houses at Lindores and Coupar Angus, with the Carse of Gowrie, a lowland area between Dundee and Perth being drained, enabling it to become a major fruit-growing area with large commercial orchards established over centuries.

The Oslin apple, brought by The Benedictine monks in the medieval period, photo Wikimedia Commons

By the late **1600**s, the Scottish Agricultural Revolution introduced land reforms and new agricultural practices and technologies which began to drive a transition from what was a broadly subsistence agriculture toward a more commercial agricultural economy. This was accelerated by the political Union with England in 1707, which provided Scottish landowners with access to English markets and new knowledge. This included reshaping watercourses and draining waterlogged land, enclosure by stone dykes and hedges, the introduction of new crops such as turnips and cabbages, crop rotation and the allocation of more land for grazing sheep and cattle.

In upland areas during this period, the practice of transhumance[14] along with small scale subsistence farming of oats, barley and kale, formed the main agricultural practice.

The most dramatic period of this transformation is generally considered to be in the second half of the 18th and early 19th centuries, with major impacts not only on land use but on human society with the forced migration of thousands of cottars and tenant farmers - priced off the land by rent increases - to the new industrial centres of Dundee, Glasgow, Edinburgh and northern England. Its legacy persists today: land ownership in the Bioregion remains concentrated in large estates and expansive fields, with few smallholdings. This continues to restrict access to land and limit opportunities for small-scale farming.

In the later **19th and 20th centuries**, large scale commercial forestry was encouraged to create a strategic timber reserve, as much of the Bioregion's native pine forests had been cleared by the 17th century. Intended to reduce reliance on imports, which caused shortages during WWI, these conifer plantations - backed by the new Forestry Commission - often replaced moorland or rough grazing."

In the 19th century, sporting estates, evolving from sheep farms, significantly increased among the aristocracy and the merchant classes, enabled by the large increase in wealth from the Industrial Revolution, including the slavery compensation of 1837. This concentrated land ownership further amongst the wealthy elites. Many of the rich landowners of these estates, responding to the Victorian romanticised view of the Highlands as a place of natural beauty and wildness, introduced 'Designed Landscapes' to enhance the beauty of their estate, reflect their status, and create a space for their own recreation and enjoyment.

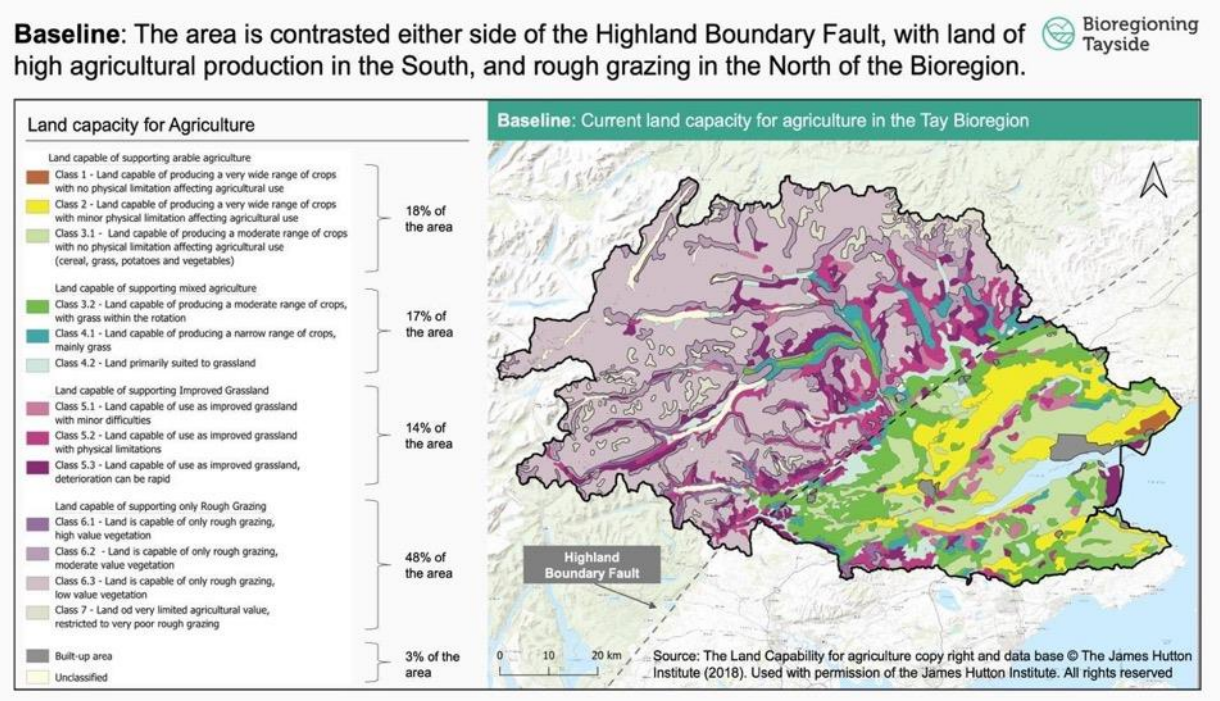
Urban and suburban growth expanded significantly, especially post war, with new housing estates built in Dundee and new road transport infrastructure. Hydro Electric power, pioneered before the war in the Highlands, expanded to stations in Highland sub-catchments such as the Tummel were built to provide electricity to aluminium smelting plants in Lochaber and Kinlochleven. The building of the Hydro infrastructure has had a massive impact on the natural drainage of both the Tummel and Garry catchments through the diversion of water via tunnels and aqueducts and the creation or alteration of lochs.

Harvesting potatoes in Strathmore in 1936 (L), photo Laing Collection, Harvesting potatoes in Strathmore today, (R) photo Clare Cooper

[14] Transhumance is the action or practice of moving livestock from one grazing ground to another in a seasonal cycle, typically to lowlands in winter and highlands in summer.

Agricultural ‘modernisation’ with its increased use of fertiliser and pesticides continued. Mechanisation and the removal of hedgerows created larger, more ‘efficient’ fields for increasingly large machinery powered by oil rather than steam or horsepower. Pasture was converted to arable land, especially in the fertile south and specialisation increased, particularly in dairy, cereal, potatoes and soft fruit.

Today, 22% of Scotland’s land dedicated to agriculture is in the Tay Bioregion particularly in the fertile lowlands, which produces a large proportion of the UK’s soft fruits as well as cereals – including barley for the whisky industry - vegetables, especially potatoes, and flowers. The emphasis on Forestry has shifted from the mid-20thc focus on large scale planting of non-native species to a growing awareness of the negative impact of industrial forestry on the environment and the need to plant native trees. In recent times, the Bioregion has become a popular destination for tourism and outdoor recreation, with the landscape playing a significant role in attracting visitors.



Graphic produced for Bioregioning Tayside by Palladium

3.2 Water

The hydrology of the region appears to be largely discordant with the topology: drainage across the region being generally north-west to south-east, against the grain of underlying structure which runs south-west to north-east.

This discordant condition is believed to be the result of ancient east-flowing rivers continuing their flow over an emerging landmass in which the greatest uplift was in the west. This gentle uplift was accompanied by local warping. As the consequent streams developed upon successively emerging coastal platforms, they continued to extend themselves towards the sea, but always down the steepest slopes. The rivers incised themselves across the underlying structural lines. Thus, the drainage of the area used to be accordant with former coastlines but became gradually more

discordant over time. Further examples of discordant drainage are found in the eastern part of the region in the Angus Glens, some of which lie in the Bioregion. Here, the rivers which occupy Glen Esk, Glen Prosen, Glen Clova and Glen Shee all flow against the structural grain, southeast towards Strathmore.

The River Tay catchment covers two-thirds of the region and is fed by seven other significant rivers, including the Earn, Almond, Tummel, Garry and Isla. There are several natural and human-altered lochs within that system, some of the largest of which are Loch Tummel and Loch Rannoch.

Loch Rannoch from Schiehallion, photo Wikimedia Commons

3.2.1 Freshwater

The Tay (Scottish Gaelic: *Tatha*) is Scotland's largest river system by length, catchment area and flow. Comprising a total of 232 rivers and canals and 27 lochs it is a Special Area of Conservation (SAC), the highest wildlife designation in the UK.

Two of the Tay's longest tributaries, The River Tummel and the River Lyon originate just a short distance from the west coast before traveling eastward across the country. They merge with the tidal Firth of Tay at Perth and eventually empty into the North Sea beyond Dundee.

Unlike many Scottish rivers, the Tay does not follow a straightforward course as a single main river. Instead, it features major tributaries that branch out in multiple directions from its central channel, with several of these being substantial rivers in their own right. The river's catchment

area is divided by the Highland Boundary Fault, meaning that much of its water comes from mountain ranges composed of resilient crystalline rock formations, including the Dalradian Supergroup. These mountains extend from Ben Lui and Black Mount in the west to the southern Cairngorms and the Angus Hills in the northeast. As the tributaries pass through deep valleys, they also feed into some of Scotland's most renowned lochs, such as Loch Tay, Loch Tummel, and Loch Rannoch. The combination of this vast mountainous catchment and loch storage - now largely controlled for hydropower - contributes significantly to the Tay's impressive water volume (100 cubic metres per second).

Pitlochry Dam, photo Markus Stitz

In its lower sections, the river carves through landscapes of old red sandstone, flowing through fertile agricultural lands and merging with additional tributaries of a more lowland nature, including the River Isla, before reaching Perth. Downstream of Perth, the tidal section of the Tay is joined by the River Earn, which originates in the hills near Loch Earn but transitions into a lowland river after passing Crieff. To the southeast, the River Eden drains the Howe of Fife and flows into the North Sea at St Andrews Bay, further adding to the region's extensive river network.

The whole Tay River System comprises of 12 substantial sub catchments and hydrometric areas and is heavily designated[15], comprising 13 Drinking Water Protection Areas (DWPAs), 18 Special Areas of Conservation (SACs) and 9 Special Protection Areas (SPAs). It is also designated under the EU Freshwater Fish Directive and as a Natura 2000 site for Atlantic salmon, sea lamprey, river lamprey, brook lamprey, clear-water lochs and otters; freshwater pearl mussel is another important protected species. There are 106 nationally important Sites of Special Scientific Interest

[15] If a site is 'Designated' it means it has special Government status as a protected area because of its natural and cultural importance

(SSSIs), including Rannoch Moor, which is the most extensive area of western blanket and valley mire in Britain. Most of the lower Tay is designated under the Nitrates Directive as a Nitrate Vulnerable Zone (NVZ) for groundwaters[16]

Lintrathan Loch, which forms part of the water supply to Dundee, photo Clare Cooper

3.2.2 Sea

Up until around 6,500 years ago, the east coast of Scotland was physically connected to mainland Europe via a land bridge called Doggerland until sea levels rose as ice melted and flooded the area. This land bridge was submerged by the rising sea levels around 6,500 BC. Scotland then became separated from Europe by the North Sea.

Today, the Firth of Tay Estuary extends eastwards from the confluence of the Rivers Earn and Tay, opening into the North Sea. Its channel is 23 miles (37km) in length and a maximum width of 3 miles (5km).

The Estuary is a glacial drowned valley, meaning that it was formed by glacial and river erosion, and subsequently submerged as sea levels rose after the last ice age. It exhibits a macrotidal regime, meaning it experiences large tidal ranges (up to ~6 meters in places), and plays a key role in the transport and mixing of freshwater and saltwater.

[16] Forest Research, Opportunity mapping for woodland creation to improve water quality and reduce flood risk in the River Tay catchment - a pilot for Scotland, 2013

(L) Doggerland Map by William E. McNulty and Jerome N. Cookson, National Geographic Magazine, (R) Mouth (south side) of the Tay Estuary at Tentsmuir, photo Markus Stitz

A strong salinity gradient exists, ranging from freshwater in the upper estuary (near Perth) to fully saline conditions near the estuary mouth (near Dundee and beyond). Seasonal changes in precipitation and river flow significantly affect freshwater input and estuarine mixing. During high flows, the freshwater plume can extend further out to sea, reducing salinity levels in the estuary. Urban areas (notably Dundee) and land use changes in the catchment area impact water quality and flow regimes. Modifications like flood defences and historical land reclamation have altered natural hydrodynamic patterns.

3.3 Biotic Communities

Ecosystems[17]

3.3.1 Upland Ecosystem

The Bioregion's upland habitats stretch from the Cairngorm Plateau and the Angus Glens in the northeast to the western edge beyond Crianlarich.

The area contains 9% of Scotland's total upland heath, found in a mosaic with peatland, rough grassland, and montane habitats. Heather moorland, the most widespread upland type here, accounts for 12% of the Bioregion.

Dwarf shrub heaths, which dominate upland heathland, make up 16% of Scotland's total for this habitat. With their distribution largely limited to the UK and Europe's western seaboard, these habitats are of international conservation importance. They support diverse wildlife, including the mountain hare, golden eagle, and red grouse.

[17] The narrative in this section has been drawn primarily from the Tayside Biodiversity Action Plan 2016-2026

The sub-arctic montane zones host species unique to Britain and globally significant populations. Alpine gentian, the rare blue dew moss, and various lichens and mosses are found exclusively within Tayside.

Parts of Rannoch Moor are in this Upland Ecosystem, one of the largest areas of blanket bog in Britain and Europe. These waterlogged peatlands formed over millennia and are important carbon sinks**,** storing large amounts of carbon and helping mitigate climate change. The moor supports a wide range of specialist plant species, including rare mosses, sedges, and heathers**,** many adapted to the acidic, waterlogged conditions. It provides habitat for rare and sensitive wildlife, such as:

- Specialist bog plants such sphagnum mosses, bog cotton and the carnivorous round-leaved sundew
- Hen harrier, golden eagle, and black-throated diver (birds)
- Otters and red deer
- Numerous invertebrates, including rare dragonflies

Shaped by glaciation, the moor features a mosaic of wetland habitats including numerous small lochs, pools, and rocky outcrops created by the high-water table and complex drainage patterns.

3.3.2 Farmland Ecosystem

The Bioregion covers probably the greatest variety of farm enterprises seen in Scotland: from extensive upland sheep grazing units on semi-natural grasslands, to highly intensive fruit, vegetable and crop growing on some of the best quality land in Scotland.

Accounting for just over 200,000 hectares, the traditional patchwork of different crop types, hedges, dykes and veteran trees still prevails, although since the second world war, much more intensive management has seen a decline in many habitat types and species as farm and field sizes have increased with the greater mechanisation of farming systems. This intensification has also impacted on soil and water quality and carbon storage.

Whilst malting barley, winter wheat, oats, potatoes and oilseed rape are the mainstay of the area's agriculture, many farms still have some land down to rotational grassland, used either for grazing sheep and cattle, or producing hay or silage for winter feeding. This rotational grassland covers 86,000 hectares of land. A further 11,000 hectares grow potatoes, there are 3,500 hectares of market-quality vegetables, over 1,500 hectares of soft fruit (raspberries, strawberries, cherries and blueberries), more than 8 commercial orchards and the Scottish National Cider Apple and Scottish National Heritage Apple and Pear Collections.[18]

There are also units producing herbs and 8 recently established tea plantations[19], as well as the commercial production of honey.

[18] The orchard at Megginch Castle houses the Scottish National Cider Apple and Scottish National Heritage Apple and Pear Collections. It is a research and experimental orchard containing over 420 cultivars of apple.

[19] See Tea Gardens of Scotland

Strawberries growing on Strathmore, photo Markus Stitz

3.3.3 Woodland Ecosystem

Despite excellent conditions for growing trees, Scotland has significantly less woodland than many other countries. Today, woodland and forestry cover stands at nearly 19% of Scotland's land area. This is about half of the average of other EU countries. The overall national target is to increase forest and woodland cover to 21% of the total area of Scotland by 2032.[20]

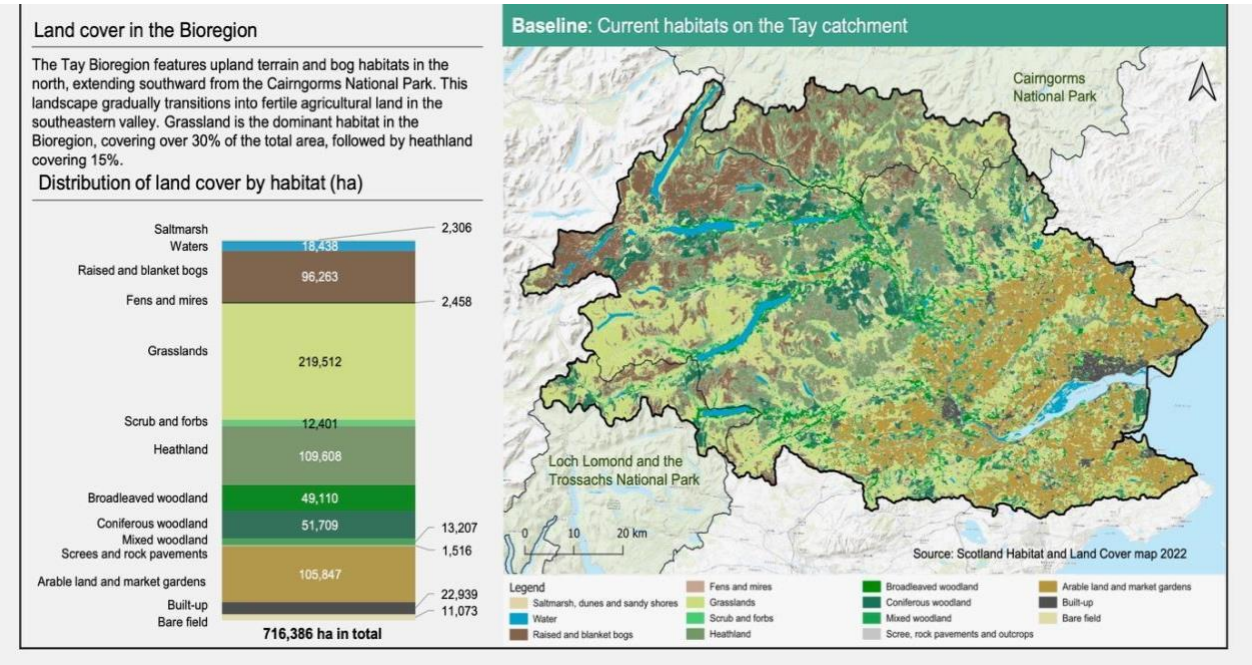
The Tay Bioregion has just over 16% tree coverage, some 115,000 hectares, of which 38,925 ha (2013 Forestry Commission Scotland Woodland Survey) is occupied by native and Ancient Woodland (sites that have been continually wooded since 1750). These are an important and irreplaceable national resource, preserving the soil's ecological processes and associated biodiversity. However, most of the woodland is made up of introduced conifer forests, the most significant proportion being Sitka Spruce.

Europe's oldest tree is the renowned Fortingall Yew, which is between 3,000 and 5,000 years old. Larch, Sitka Spruce and Douglas fir were first introduced here in the 19th century.

In Angus, forest and woodland cover is currently around 10.7%. The lower than the Scottish average percentage is probably, in part, a reflection on lowland areas being some of the most productive agricultural land in Scotland. In addition, the high levels of grazing pressure on upland areas by deer and sheep, together with muirburn associated with sporting estate management, have also contributed to low levels of woodland cover.[21]

[20] See Perth & Kinross Council Forest & Woodland Strategy 2014-2024

[21] See Angus Forestry & Woodland Strategy 2024-2034



Graphic produced for Bioregioning Tayside by Palladium

In Perth & Kinross, woodland covers 18% of the area[22]. This part of the Bioregion has a rich legacy of planted woodland and some of the earliest initiatives to re-establish woodland in Scotland. The Planting Dukes of Atholl started reforesting bare land, in what was probably the first example of establishing significant new conifer plantations in the British Isles more than 250 years ago using European larch. Twenty-two of Scotland's recognised heritage trees are located in Perth and Kinross which is more than any other area in Scotland. With this woodland heritage and tradition, it is perhaps not surprising that these long-established woodlands have been a major contributor to the area's tourism industry and alongside the introduced exotic conifers, giving it its reputation and renown as 'Big Tree Country'.

As with other woodland types, the disappearance of traditional orchards in Tayside has been driven by economic and development pressures. Since the Historic Orchards of the Carse of Gowrie Survey in 2007, some remaining orchards have been re-planted, and the loss of skills is being addressed.

The woodlands are a major asset for the Bioregion, providing carbon sequestration, biodiversity, recreation, tourism, and economic value through wood fuel and timber. Tayside is home to three of the 23 sites that make up the National Tree Collections of Scotland - Camperdown Park in Dundee, Scone Palace, and Dunkeld - as well as many other accessible woods and forests, including seven within the Tay Forest Park. Notable remnants of native woodland and flora can also be found at sites such as Balnaguard Glen in Strathtay and the Black Wood of Rannoch. Despite this richness, only 36% of native woodland in Perth & Kinross is in good health for biodiversity[23], compared to 51% in Angus[24].

[22] See - Perth & Kinross LDP3 2027 - Evidence Report, Topic Paper No. 007, Forestry, Woodland & Trees

[23] See Native Woodland Survey of Scotland, Perth & Kinross and Tayside Local Biodiversity Action Plan 2016 - 2026, Woodland Ecosystems

[24] See - Native Woodland Survey of Scotland, Angus

'Auld Maggie', this Beech Tree at Belmont in Meigle, is one of Scotland's Heritage Trees, photo Clare Cooper

3.3.4 Water & Wetlands Ecosystem

The Tay Bioregion has a rich heritage of water and wetland habitats and their associated species. The Tay River system is one of the most important river systems for the now endangered Wild Atlantic Salmon, supporting their different life stages from spawning and juvenile rearing to adult migration. Historically supporting one of the largest commercial salmon fisheries in the world, today, it remains a world-famous destination for recreational salmon angling, contributing significantly to local economies in Perthshire, Tayside, and beyond.

The Tay River System has played an important role in the re-introduction of Beavers[25], another protected keystone species, to Scotland and has a globally significant role in the conservation of freshwater pearl mussels (whose larvae must attach to the gills of salmon and trout during early development), one of the most endangered freshwater molluscs in Europe.

This diversity is due in large part to a complex geology and varied landscape. The division of the area by the Highland Boundary Fault is one feature which gives rise to some of the most valuable habitats in the region. The rivers and burns in Tayside tend to be fast flowing and nutrient poor and hold a wealth of habitats and rare wildlife. As important wildlife corridors, they enable dispersion and migration of species, interconnecting fragmented populations. They are particularly valuable in the Bioregion with a total length of over 5,000km not only making them essential to wildlife but also a familiar and important part of everyone's environment.

[25] The Tay catchment was instrumental in restoring beavers to the Scottish wild - not through formal trials, but through unexpected colonization. This unofficial population became the largest and most influential, prompting legal protection, enabling expansion, and acting as a seed source for broader rewilding. At the same time, its emergence sparked critical lessons about stakeholder engagement and responsible conservation strategies.

Associated with these river networks are many standing waters from the very large, deep highland lochs to small ponds and lochans and flood plain habitats such as wet woodlands, swamp and marshes, flood meadows and reedbeds. Wetlands, and particularly running waters, contribute to valuable habitat mosaics with thousands of kilometres of burns linking wildlife corridors between other terrestrial habitats. The margins of rivers and standing waters form the transitional zone between the aquatic and terrestrial environment.

Wetlands and Lochs in the Tay Bioregion, Photos Markus Stitz and Clare Cooper

3.3.5 Coastal & Marine Ecosystem

Tayside's coastline includes saltmarsh, brackish reed-swamp, dune systems, low cliffs and links grasslands, and coastal heaths.

The Firth of Tay and the Eden estuaries are two high-quality estuarine areas. Both are an integral component of a large, geomorphologically complex area that incorporates a mosaic of estuarine and coastal habitats[26]

The Tay Estuary is recognised as one of the least developed, least polluted least modified in Europe[27]. The mudflats of its tidal zone are designated for their importance as habitats for wildfowl and seabirds and the invertebrate communities they depend on for their food source such as worms (e.g., lugworms, ragworms), molluscs (e.g., cockles, mussels) and crustaceans (e.g., shore crabs).

The Saltmarshes support salt-tolerant plant species such as Sea Aster, Glasswort and Cordgrass.

[26] See Scottish Environment Link, Firth of Tay & Eden Estuary SAC

[27] See Tay Estuary Forum

The coastal grasslands and dune systems support wildflowers, grasses and rare orchids and the reedbeds are the largest continuous stand of this habitat anywhere in Britain, one of the largest in Europe - and they are the only place in Scotland where the rare Bearded tit breeds.

The Tay Estuary reed beds, the largest continuous reedbeds in the UK, photo Markus Stitz

The Firth of Tay is also known for its seagrass beds, a highly productive habitat capable of nutrient recycling and carbon sequestration as well as providing a physical shelter and feeding grounds for smaller species ducks and geese in winter, the beds of seagrass and seaweed also provide important nursery grounds for flat fish, such as Flounder, in the summer and Bass and Salmon, which migrate upriver. Lampreys and sea trout are also found in the Tay system.

A variety of other life supported by coastal habitats includes wintering wildfowl and migratory birds such as Ospreys, groups of dolphin, porpoise and Seals (especially common and grey seals). Otters are occasionally spotted, particularly around quieter parts of the Eden Estuary. Nearby woodlands and dunes support mammals like foxes**,** badgers**,** and roe deer**.**

3.3.6 Flagship Species[28]

Upland Ecosystem

- Upland mammals including Mountain hare and Water vole
- Upland birds, including Golden eagle, Snow bunting and Scoter

[28] These lists have been drawn from the Tayside Local Biodiversity Action Plan (LBAP) 2016-2026

- Upland plants, including Alpine Wood Vetch, Close-Headed Alpine -Sedge, Whorled Solomon's-Seal, Sea Pea, Woolly Willow, Brown Bog-Rush, Rock Speedwell, Oblong woodsia, Mountain Scurvy grass and Snow Caloplaca

The National Trust for Scotland has pioneered methods of regenerating montane willows and other rare plants at Ben Lawers. The reserve has the largest abundance of arctic-alpine plants in the UK; these include Snow gentian and Alpine forget-me-not which is restricted to Tayside and Upper Teesdale. It also hosts over 500 lichens which makes it the UK's most important site for lichens.

Farmland Ecosystem

- Bat species
- Farmland birds, including Barn Owl, Tree Sparrow, Grey Partridge, Linnet, Lapwing, Corn Bunting and Skylark
- Reptiles, including Common Lizard and Slow Worm
- Hirundine species (Swallow, House Martin, Sand Martin) and Swifts
- Calcareous Grassland species, inc. Osmia inermis (Mason bee), Northern Brown Argus, Rock Rose

Woodland Ecosystem

- Woodland mammals, including Red Squirrel and Pine Marten
- Scottish Crossbill and Nightjar
- Woodland invertebrates, inc. Scottish wood ant and moths
- Woodland plants, inc. Juniper, Blaeberry, Small Cow-wheat, Coral-root orchid and Twinflower
- Woodland lower plants and fungi

Salmon and trout fishing in the Bioregion in 1936, photo Laing Collection

Freshwater Ecosystem

- Salmon and brown trout
- Freshwater pearl mussel
- Beaver and water vole
- River birds including dipper, yellow wagtail and heron

Coastal and Marine Ecosystem

- Small Blue Butterfly
- Eider ducks, waders, Pink footed gees, Redshank, Oystercatcher, Bar-tailed godwit
- kittiwakes, fulmars, puffins and guillemot

3.3.7 Designated Conservation Areas

Over 20% of the Tay catchment is under designation for ecological or scientific importance – circa 160 k hectares.

- **Sites of Specific Scientific Interest** (SSSI): There are 324 registered SSSI sites, including the Forest of Clunie and Beinn a' Ghlo[29]
- **Special Area of Conservation** (SAC): There are 35 sites with this designation, including most catchment rivers and Rannoch Moor[30]
- **Nature Reserves**: There are 5 sites classified as nature reserves such as Beinn Ghlas[31]

Perth & Kinross has 36 designated conservation areas, 107 Sites of Special Scientific Interest (SSSIs), two National Nature Reserves (Ben Lawers and Loch Leven). Additionally, there are 4 National Scenic Areas (Loch Rannoch and Glen Lyon, Loch Tummel, River Tay, and River Earn) and 11 Special Landscape Areas (SLAs). There are also 41 Gardens and Designed Landscapes.

There are 4 proposed Local Landscape Areas in Angus, which are being considered for designation. Furthermore, 28 Local Nature Conservation Sites (LNCS) have already been designated, with more planned.

North Fife has 10 designated conservation areas, numerous SSSI's, Tentsmuir Nature Reserve, and 7 Gardens and Designed Landscapes.[32]

3.4 Human Communities

3.4.1 Current Demographics

Humans first arrived in Tayside in the Mesolithic period, around 7,000 – 4,000 BC. Hunter gatherers, they would have moved seasonally across the landscape. A more settled agricultural society began to emerge in the Neolithic period, (4,000 – 2,500 BC), but it would not have been until the Industrial Revolution in the mid-18th century that the population dramatically grew as a

[29] See NatureScot's Sitelink pages

[30] See NatureScot's Sitelink pages

[31] See NatureScot page on Nature Reserves

[32] See HES Inventory of Gardens & Designed Landscapes

result of the booming textile trade, especially in Dundee, where it grew from 2,472 in 1801 to almost 169,000 in 1921.[33]

Today, Tayside has a lower human population density compared to Scotland as a whole, around 416,000, of which almost a third lives in the Dundee City area. The population of Perth and Kinross has increased by 12.4% over the last 10 years, above the Scottish rate of 7.1%; Angus has increased at below the rate of Scotland (5.7%), whilst Dundee's population has decreased slightly. North Fife has c20% of this county's total population.

Dundee is the largest settlement in the area. Perth and Forfar were the historic county towns for the Unitary Councils now known as Perth & Kinross and Angus. St Andrews, Fife's fourth largest settlement, is home to the oldest university in Scotland, and the third oldest in the English-speaking world. Other significant settlements in the Bioregion are Aberfeldy, Blairgowrie, Carnoustie, Crieff, Dunkeld, Kirriemuir and Pitlochry, with many more small rural villages and hamlets.

Blairgowrie, looking north with the River Ericht running through it, photo Markus Stitz

In common with the rest of Scotland, the Bioregion has a rapidly ageing population, just over 18% is aged 65 and over, with a higher proportion compared to the Scottish average. By 2045 it is expected that almost 50% of the Scottish population will be over 50.

Just over 93% of people identify as white, with those who identify as Asian, Asian Scottish or Asian British being the next largest category. Dundee is the most ethnically diverse part of Tayside, with around 10% non-white residents and nearly 13% foreign-born.37% of households in the Bioregion are single person households. Additionally, seasonal agricultural workers from many different

[33] See A few census statistics for Scotland

countries come to the Bioregion each year. Whilst there is no formal census count, these number in their thousands and, post Brexit, recruitment has shifted markedly towards Central Asia.

3.4.2 Current political structure

Since 1996, when a major reorganisation swept away Scotland's regions and districts[34], the Bioregion has been divided into Unitary Councils. These include the southeast of Highland, northeast of Stirlingshire, all of Perth & Kinross, the north and centre of Angus, the City of Dundee and the north of Fife.

Each Council provides public services including education, social care, waste management, libraries and planning. Councils receive most of their funding from the Scottish Government but operate independently and are accountable to their local electorates. Councils raise additional income via the Council Tax, a locally variable domestic property tax and Business rates, a non-domestic property tax.

Councils are made up of councillors who are directly elected by the residents of the area they represent. Each Council area is divided into several wards, and three or four councillors are elected for each ward. The Tay Bioregion extends across 30 Wards (Highland 1, Stirlingshire 1, P&K 12, Angus 5, Dundee 8, north Fife 4).

Beneath the Unitary Councils are Community Councils. These are local, voluntary organisations made up of members of the community who act on behalf of people in the local area. Community councils are the most local tier of the statutory representation structure in Scotland and can act as an important bridge between communities and the Unitary Councils. However, it can be difficult for Community Councils to operate effectively because they do not have the powers to carry out many of the activities which are needed in their local area. This can make it difficult to recruit new community councillors, which means that Community Councils are often not representative of the communities they serve.

Whilst not a formal part of the political structure of the Bioregion or Scotland, Community Development Trusts[35] are growing in number and playing a vital role in fostering community empowerment and driving local economic, social, and environmental renewal. As community-led organisations, they often combine enterprise with social purpose to address local needs and aspirations. These trusts are diverse, ranging in size and location, but share the common goal of empowering communities to shape their own futures. Some of their key features include:

- Community Ownership and Management: CDTs are owned and managed by the local community, ensuring that projects and activities reflect community needs and priorities.
- A Social, Economic, and Environmental Focus: They aim to improve the quality of life for local people by tackling issues related to social well-being, economic development, and environmental sustainability.

[34] Local and regional government in Scotland has undergone significant reform throughout history. Prior to 1996, reforms in the 1970's introduced a two-tier system of 9 regions, 53 district councils and 3 island areas, replacing the previous structure of counties and burghs.

[35] Development Trusts in Scotland emerged in the late 20th century as community-led organisations focused on regenerating local areas and promoting sustainable development. Rooted in earlier traditions of cooperative and voluntary action, they began to grow significantly during the 1980s and 1990s in response to economic decline, depopulation, and the need for stronger local resilience. Today, they play a central role in Scotland's community empowerment agenda, with trusts across the country driving regeneration, creating jobs, and strengthening local democracy see https://dtascot.org.uk/

- Enterprise and Income Generation: CDTs often generate their own income through various ventures, including businesses, community-owned assets, via community contributions from windfarms and other initiatives, rather than relying solely on grants.
- Partnerships and Collaboration: They work in partnership with other organisations, including local councils, private businesses, and third-sector groups, to achieve their goals.
- Long-Term Regeneration: CDTs are committed to the long-term regeneration of their communities, focusing on building sustainable and resilient communities.

There are 24 Community Development Trusts in the Bioregion.[36]

3.4.3 Socio-cultural and political history

The transition from The Neolithic to **The Bronze Age (2500 - 800BC)** saw expanded settlements, increased farming, standing stones, rock carvings, pottery, and crude metalworking. Bronze Age peoples may have migrated from the Rhine area or simply brought new skills, notably metalworking, which shifted society from communal living to a hierarchy of rulers, warriors, peasants, and slaves. Specialisation in stonework, metalwork, and farming supported trade.

Glenisla Looking north to the Cairngorm Plateau, photo Markus Stitz

[36] See Bioregioning Tayside's Community Councils and Community Development Trusts in the Tay Bioregion

Remains of Bronze Age hut circles and field systems are common in the Bioregion, especially on marginal land, valley sides, and upland areas such as Glen Isla, Glen Shee, Strathardle, and the upper Tay and Earn valleys.

Burials evolved from communal cairns to individual stone-lined 'cists,' with a move towards cremation. Sites such as West Mains, Auchterhouse, and Bell Hillock, Kirriemuir, have yielded significant finds including urns, a spearhead, and jet beads. Old Neolithic sites were often reused for rituals over many generations.

Standing stones remained common, though less elaborate than Neolithic examples, often appearing singly or in pairs/lines across the area.

The Iron Age (c. 800 BCE – 500 CE) was dominated by tribal societies. Power was held locally in kin-based groups and was often hillfort[37] centred. People also lived in crannogs[38] and roundhouses. They likely spoke a P-Celtic language (early Brittonic/Pictish), and their culture would have centred on oral tradition, warrior elites, ritual landscapes and sacred hills. The Picts, who emerged during this period, formed complex alliances and confederations, with their political organisation evolving toward monarchy by the end of this historic period. Improved tools allowed for agricultural expansion and woodland clearance. Material culture included decorated metalwork, weaving, and farming tools. Religion was animist or polytheist, with reverence for rivers, hills, and other natural features.

(L) Barry Hill Fort as it could have looked like in the Iron Age and (R) what it looks like today. Reconstruction Image by Simon Edwards, aerial photo © Perth & Kinross Heritage Trust

The Roman Occupation took place between c.70 - 390. Tacitus records that his father-in-law, Roman governor Gnaeus Julius Agricola[39], led campaigns to complete the conquest of Britain. By

[37] Scottish Hillforts are fortified settlements built on a hilltop, often featuring earthworks, stone walls, or wooden palisades to create an enclosure

[38] A Scottish crannog is an artificial island dwelling, typically located in lochs or other bodies of water, built using timber and other materials

[39] Gnaeus Julius Agricola was an influential Roman general and governor of Britain in the late 1st century AD, known for his military campaigns that expanded Roman control into northern England, Scotland, and Wales.

80 AD, his forces had reached the Tay, remaining active in the area for several years. Although Tacitus's work is a biography rather than a direct account, and some remains may predate or postdate Agricola, many Roman sites in Tayside belong to this *Flavian* period (under emperors Vespasian to Domitian). Forts were established along a Roman road from Camelon to Ardoch, continuing east via Strageath to Bertha. Along the Gask Ridge, a fortified road with forts, fortlets, and watchtowers reflects Tayside's importance in early Roman frontier systems.

Roman Tayside includes a legionary fortress at Inchtuthil - the empire's most northerly - plus forts, fortlets, watchtowers, and temporary camps, especially in Strathearn and Strathmore. At Ardoch, successive turf-and-timber forts with multiple defences are still visible. Excavations across the region have yielded key dating evidence and insights into military and civilian life.

During the **Early Medieval Period (c. 500 – 1100)**, the region became the heartland of the Pictish kingdoms, centred around places like Abernethy, Scone and Clatchard Craig. By the 9th century, Kenneth MacAlpin united the Picts and Gaels, forming the Kingdom of Alba - the early foundation of the Scottish state. Pictish art flourished with the creation of carved stones, symbolic animals, spirals, and abstract designs. The area was a political heartland during this period (e.g. Scone, near Perth, became the coronation site of Scottish kings). Christianity arrived from the west of Scotland via St Columba and St Moluag in the 6th–7th centuries, laying the foundations for the Roman Catholic Church[40] in the region and radically transforming culture and education. Monasteries and churches became hubs of literacy, agriculture, and local governance. The Gaelic influence increased by the 9th century, changing the cultural-linguistic landscape and helping form a new Scottish identity.

From 1100 to the 1500s, the High and Late Medieval Period, the area became part of feudal Scotland, with land being granted by Kings like David I to nobles, church and military orders and society became stratified into nobles, churchmen, and peasants. Perth and Dundee emerged as important burghs (towns), with trade-based economies made up of a market culture, guilds, and a growing middle class. For a short time, Perth became a *de facto* capital of Scotland for royal councils and parliaments. Language gradually shifted from Gaelic in Lowland areas to Scots as trade networks expanded, although Gaelic predominated in the less accessible areas north of the Highland Boundary fault. The Christian church dominated culture with cathedrals (such as Dunkeld and St. Andrews) and abbeys (such as Coupar Angus) built[41] and saints' cults introduced. The region was also a centre for traditional ballads, folk music, and oral storytelling, many of which survived in later Scottish folklore.

During the wars of Independence in the 1200-1300's the region was a was a strategic battleground. Castles changed hands, especially Dundee and Perth and figures like William Wallace and Robert the Bruce had key campaigns in the area. Local loyalties were split with both English and Scottish forces occupying the region at various times.

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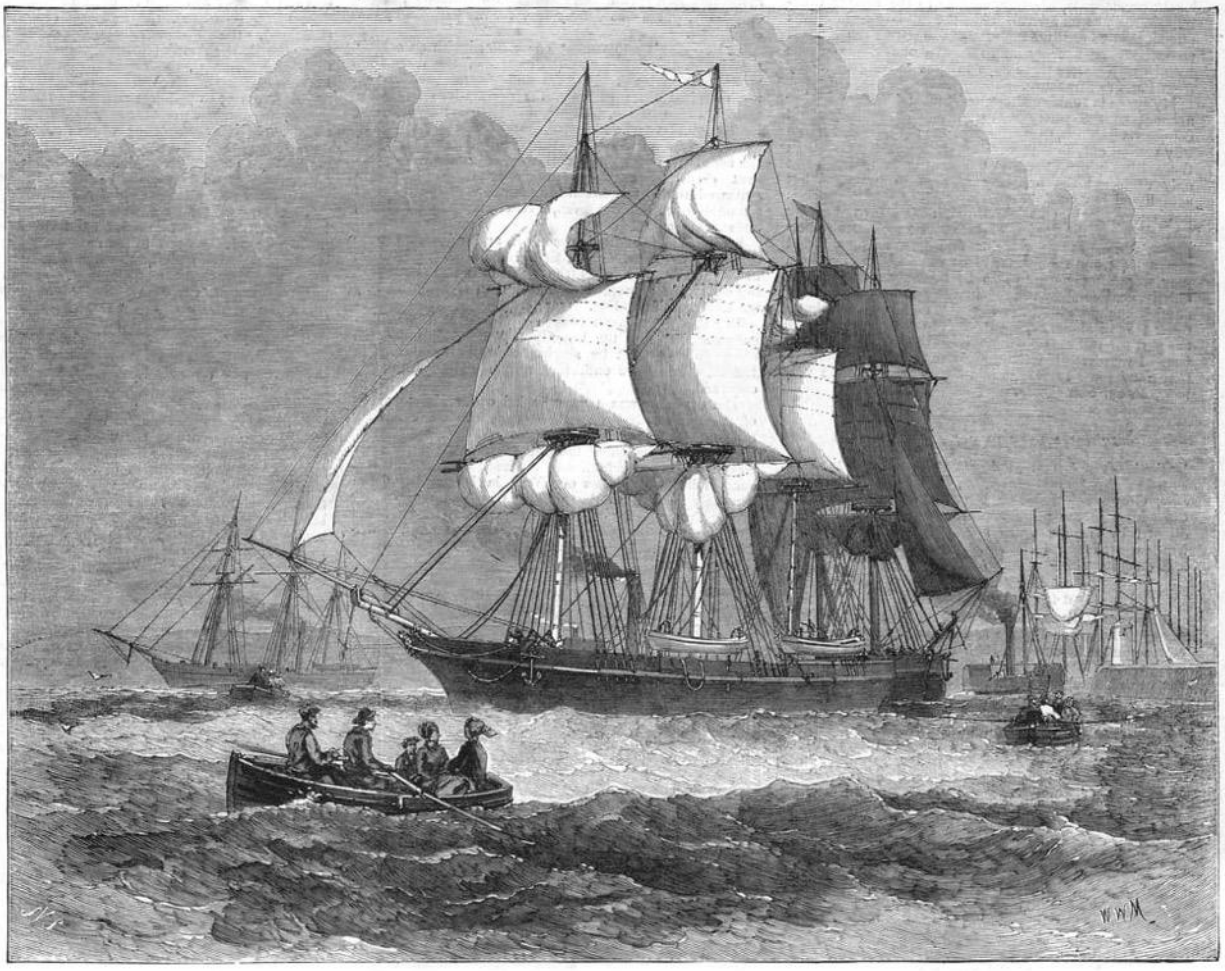
[40] Catholicism dominated until the 16th century, when the Scottish Reformation led by figures such as John Knox brought Protestantism to prominence, establishing the Church of Scotland as the main religious institution. Over the following centuries, Tayside saw periods of tension and coexistence between Protestant and Catholic communities, particularly during the 17th and 18th centuries. In modern times, both traditions continue in the region, with the Church of Scotland, the Scottish Episcopal Church, and Roman Catholic parishes contributing to Tayside's diverse religious life.

[41] Part of a network of French Cistercian Abbeys spreading up from England, through the Borders who brought with them expertise in farming, land reclamation and managing large estates. Their highly structured tradition of monasticism rooted in the centralised Rule of St Benedict and Roman customs, was quite different from the more decentralised structure that grew from St Columba's Irish variant to be found in centres like Dunkeld, which embraced a reverence for the natural world.

During the Late Medieval – Early Modern period (c. 1400s-1707) the region was largely loyal to the Scottish crown but was caught in internal noble feuds and clan conflicts, especially in Highland Perthshire. The Reformation (1560s) reshaped local power: Protestantism replaced Roman Catholicism, church lands were secularized, ornamentation stripped from churches and Dundee became a stronghold of Protestant reform. Despite the Union of the Crowns in 1603 which brought a single sovereign to Scotland, England and Ireland political unrest continued in the Wars of the Three Kingdoms (1640s) and later Jacobite risings (1715 & 1745), with Perth and Angus seeing notable activity. The Reformation dramatically altered cultural life. There was a new focus on literacy, Bible reading, and sermons were introduced; education expanded with parish schools, creating a literate Scottish peasantry. Witch-hunts were frequent in this era - especially in Dundee and Perth - reflecting cultural fears of magic and heresy. Music, poetry, and folk customs (e.g. Beltane fires, ceilidhs) persisted despite religious suppression. The Highland-Lowland divide hardened: Gaelic culture held on in Highland Perthshire but faded elsewhere. Political unrest continued during the Wars of the Three Kingdoms (1640s) and later Jacobite risings (1715 & 1745), with Perth and Angus seeing notable activity. In 1707, with the Union of Parliaments (the unification of the English and Scottish parliaments) Scotland lost its independent parliament but retained distinct legal and educational systems.



DEPARTURE OF THE DUNDEE WHALING FLEET

Departure of the Dundee Whaling Fleet. Illustration for The Graphic, 18 March 1871

As the Industrial and Enlightenment eras took hold (1707-1800s), Dundee became a booming industrial port, focused on jute, whaling, and shipbuilding.

Rapid urbanisation led to overcrowding and poverty, but also to radicalism, especially of women's labour movements, and the rise of working-class identity. Perth and Forfar retained more artisanal and agricultural economies. Religious revivalism and denominational diversification led to many new churches being built. The region played a role in the Scottish Enlightenment, with figures contributing to philosophy, science, and reform. Of particular note to Bioregioning is Patrick Geddes (1854-1932), the biologist and sociologist, who was educated in Perth and held the first chair of Botany at what later became the University of Dundee. He is considered to be a pioneer of bioregionalism, emphasising the interconnectedness of people and their environment. He advocated for regional surveys to understand a place's unique characteristics - its hydrology, geology, flora, fauna, climate, and social and economic conditions - as a foundation for planning and education.) During this period, language shifted and Scots and English dominated. Cultural nationalism rose, with renewed interest in Scottish history, tartan, and folklore, sometimes romanticised (e.g. Walter Scott's "Fair Maid of Perth"). The late 1880's saw the introduction of the first heritage designation aimed at protecting Scheduled Monuments (nationally important archaeological sites), with Listed Buildings, Designed Landscapes and Conservations Areas coming into being in the mid-late 20th century.

The strong tradition of working-class activism in Dundee continued into the **Victorian and early 20th century (1800's – 1945**). Women involved in the Jute mills, such as Mary Brooksbank[42], blended labour politics with folk music.

Education and cultural institutions grew such as museums, libraries, orchestras and theatre groups. Religious pluralism increased, Catholic immigrants (especially Irish) added diversity to cities like Dundee. The urban vs. rural cultural divide widened, with Angus and Perthshire retaining folk traditions and agricultural shows. During this time, Tayside reflected the national pattern of Liberal-Conservative politics, with growing Labour support in urban Dundee. Winston Churchill famously lost Dundee's parliamentary seat in 1922 to a Prohibitionist candidate. Rural Angus and Perthshire remained largely Conservative or Liberal, with powerful landed elites still influencing politics.

Post-war WWII reconstruction brought new housing, the National Health Service and increased higher education. Mid-century, church attendance began to decline, and the current period of greater secularisation began. In the second half of the 20th century a cultural renewal began in the City with a focus on the Comics Industry (which grew up in the 1930s and peaked in the 1950s-70s), the greetings card designs of Valentine & Son, the return of the RRS Discovery and artist-led initiatives such as Forebank Studios, Seagate Gallery and the Blackness Public Art programme.

More recently, a Gaelic revival has begun in rural areas and Highland Games, pipe bands, traditional music, and community festivals continue to be regular fixtures. In Dundee and Perth, cultural buildings and centres of education such as Dundee Contemporary Arts, the new V&A Dundee, Duncan of Jordanstone College of Art and Design and the new Perth Museum all play key cultural roles. Heritage in the landscape of the Bioregion is recognised and protected, with over 1,000 Scheduled Monuments, over 6,000 Listed Buildings and 56 Inventory Gardens and Designed Landscapes. Immigration and globalisation have also contributed to contemporary cultural life in the Bioregion, with Bangladeshi, Italian, Chinese, Syrian, Ukrainian, Polish, Pakistani, and African communities bringing new food, music, and religious traditions.

[42] Listen to Mary Brookbank's famous song 'Jute Mill Song' sung by Aileen Ogilvie for the Cateran Ecomuseum and set to old photographs of the Blairgowrie Mills from the Laing Collection.

Duncan of Jordanstone graduate Martin McGuinness's temporary landscape scale portrait of Blairgowrie born Scots poet Hamish Henderson at the Spittal of Glenshee in 2019, made out of Jute and pinned to the hillside to mark the 100th anniversary of his birth, photo Clare Cooper

From 1945 until well into the 21st century, the Labour party dominated in Dundee and the influence of Trade Unions grew. Conservatives retained strength in rural areas, most notably in Perthshire and Angus. The Scottish Nationalist Party (SNP) have held all major constituencies in the area since 2011. At a Unitary Council level, since 2022, the SNP lead a minority administration in Angus and Perth & Kinross. In Dundee the SNP have led a majority administration since 2012. Today, while "Tayside" exists mainly as a geographical and service area (e.g. NHS Tayside**),** its political landscape reflects broader Scottish trend such as urban progressivism in Dundee**,** rural conservatism (now more SNP than Tory) in Angus and Perthshire and pivotal contributions in debates over Scottish independence**,** land reform**,** and national identity**.**

3.4.4 Land ownership

Tayside's landowning history reflects those of broader Scotland. In medieval times, particularly after 1050 AD, the Bioregion saw the rise of feudal land tenure under southern kings and Norman allies, who granted royal estates as rewards for service. Monasteries like Arbroath Abbey acquired significant holdings, while burghs such as Dundee and Perth emerged as royal administrative and commercial centres.

Local 'lairds' also consolidated land. For example, the Campbell family amassed holdings around Loch Tay in the 15th and 16th centuries - Sir Colin Campbell acquired feudal rights over Crown and monastic lands, and these remained with his descendants for generations.[43]
In the 18th and 19th centuries, Scotland - including parts of Tayside - was affected by further land consolidation trends driven by the agricultural and industrial revolutions.

Today, Scotland has one of the most concentrated land ownership patterns in the world, through a bioregional lens, the disadvantages and impacts are widespread[44]:

Ecological Stewardship Misaligned with Place	• Large, absentee, or distant landowners may manage land for profit or prestige (e.g. sporting estates, timber extraction) rather than in ways that respect local ecosystems. • This undermines the bioregional principle that land care should be rooted in intimate knowledge of place
Disconnection of People from Land	• When communities have little control over the land they inhabit, they are unable to shape it to meet local needs. • This weakens the reciprocal relationship between people and the ecosystems that sustain them.
Homogenised Land Use	• Concentrated ownership tends to favour monocultures (forestry, grouse moors) or extractive practices. • A healthy bioregion requires diverse land uses that support biodiversity, soil health, water cycles, and local food systems.
Erosion of Local Resilience	• Limited access to land means fewer opportunities for community-led housing, farming, or renewable energy. • This increases dependence on external markets and undermines the self-reliance that bioregionalism values.
Social Fragmentation and Outmigration	• When local people cannot live and work on the land, rural areas become depopulated or seasonally inhabited. • A thriving bioregion depends on stable, engaged communities living in balance with their landscapes
Democratic Deficit in Land Governance	• Decision-making power over ecosystems is removed from those who live within them. • Bioregioning emphasises that governance should emerge from within the bioregion itself, not imposed from outside.

3.4.5 Profiles of some of the Bioregion's villages, towns and cities

[43] See Highland Strathearn

[44] See Land Reform Review Group (2014). The land of Scotland and the common good: report of the Land Reform Review Group, Wightman, A. (various years). Who Owns Scotland. Edinburgh: Who Owns Scotland Project, Scottish Land Commission (2019). Concentrated Land Ownership in Scotland. Inverness: Scottish Land Commission, James Hutton Institute (2020). Community perspectives on land ownership and land use in Scotland. Aberdeen: James Hutton Institute, SEFARI (2020). Socioeconomic and biodiversity impacts of driven grouse moors in Scotland: Review of evidence. Edinburgh: Scottish Government/SEFARI Gateway, Community Land Scotland (2023). Economic indicators of community ownership. Glasgow: CLS, ScotLand Futures, Scottish Land Commission (2025).

With a population of just under 500,000, the Tay Bioregion has relatively few human settlements of over 2,000 people. See table below.

Human Settlement	Population above 2,000	Catchment	Unitary Council Area	Community Development Trust	School(s)	Community Services	Visitor Services
Auchterarder (incl. Gleneagles)	6,061	Earn	Perth & Kinross	Yes	Yes	Yes	Yes
Perth City	47,893	River Tay (Loch to Sea)	Perth & Kinross	No	Yes	Yes	Yes
Crieff	7,142	River Tay (Loch to Sea)	Perth & Kinross	Yes	Yes	Yes	Yes
Scone	5,231	River Tay (Loch to Sea)	Perth & Kinross	No	Yes	Yes	Yes
Alyth	2,345	Isla	Perth & Kinross	Yes	Yes	Yes	No
Bridge of Earn	2,918	Earn	Perth & Kinross	No	Yes	Yes	Yes
Pitlochry	2,694	Tummel	Perth & Kinross	Yes	Yes	Yes	Yes
Coupar Angus	2,132	Isla	Perth & Kinross	No	No	Yes	No
Forfar	13,801	Isla	Angus	No	Yes	Yes	Yes
Carnoustie	11,359	Coastal Tayside	Angus	Yes	Yes	Yes	Yes
Monifieth	9,367	Coastal Tayside	Angus	No	Yes	Yes	Yes
Kirriemuir	6,012	Isla	Angus		Yes	Yes	Yes
Cupar	8,817	Eden	Fife	Yes	Yes	Yes	Yes
Auchtermuchty	2,042	Eden	Fife	Yes	Yes	Yes	No
Newburgh	2,110	Coastal Tayside	Fife	Yes	Yes	Yes	Yes
Dundee	150,390	Coastal Tayside	Dundee	Yes	Yes	Yes	Yes

This section profiles some of these, together with others that have smaller human populations.

Profile: Kinloch Rannoch (Tummel Catchment)[45]

Loch Rannoch, photo Markus Stitz

Kinloch Rannoch (Scottish Gaelic: Ceann Loch Raineach) is a village that lies at the eastern end of Loch Rannoch on the banks of the River Tummel. The village is a tourist and outdoor pursuits centre. It has a small population of around 750 and is fairly remote, partly due to a lack of through road access.

The name of the village, Kinloch Rannoch, or rather Ceann Loch means 'end' of the loch. Formerly a tiny hamlet, Kinloch Rannoch was enlarged and settled, under the direction of James Small, formerly an Ensign in Lord Loudon's Regiment, mainly by soldiers discharged from the army, but also by displaced crofters. Small had been appointed by the Commissioners for the Forfeited Estates to run the Rannoch estates, which had been seized from the clan chieftains who had supported the Jacobites following the Battle of Culloden in 1746. Local roads and bridges were improved, enabling soldiers at Rannoch Barracks to move more freely around the district.

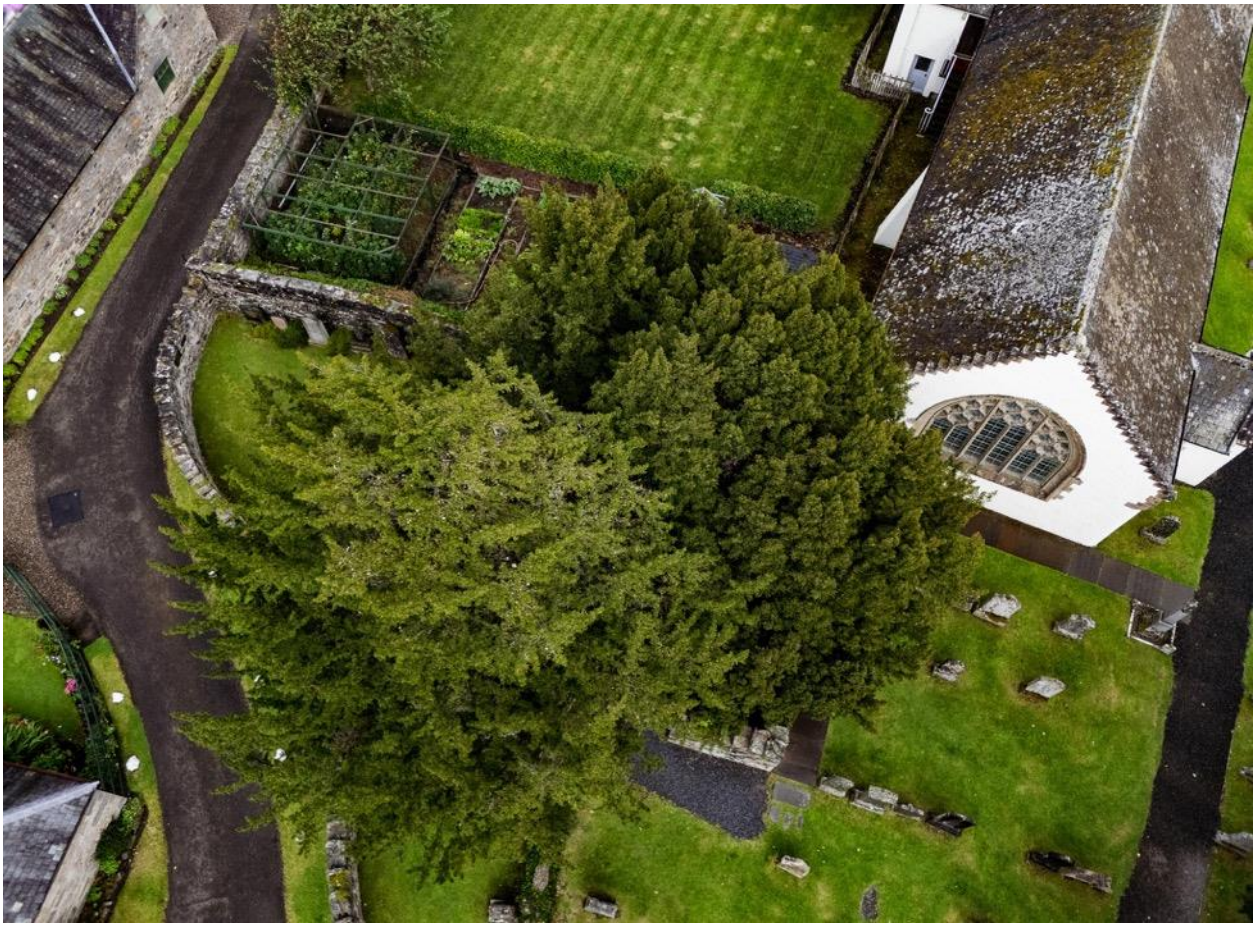
The main economic activities in the area are agriculture, forestry, hydro power and tourism with local tourist activities including fishing, rafting, cycling and hiking. The area has seen a shift over the last decade away from labour-intensive land-based industries and the vulnerability of other hubs of private employment such as the former Rannoch School and hotels/visitor accommodation. This has impacted significantly on the population profile, housing, employment and ultimately community life. The community recognises that they need to re-think the 'way of life' in Rannoch and Tummel and consider how they strengthen their community and its assets to retain them for themselves, visitors and future generations and have developed a Community Development Plan[46] to take their vision forward. Currently,

[45] See Wikipedia entry for Kinloch Rannoch

[46] See Delivering Rannoch's Sustainable Future

Rannoch Community Trust, which was set up in response to the plan, are leading key projects to improve local housing, elder care and the development of a multi-use community and visitor space.

Profile: Fortinghall (Lyon Catchment)



The Fortinghall Yew, photo Markus Stitz

Fortingall is a small village located near the southern shore of Loch Tay. It is situated in beautiful Glen Lyon, which Sir Walter Scott described as the longest, loneliest and loveliest glen in Scotland. Known for its stunning natural scenery and rich cultural heritage it dates to the prehistoric era, with the surrounding area considered to have one of the richest concentrations of prehistoric archaeological sites in Scotland.

One of the most famous landmarks in Fortingall is the Fortingall Yew, an ancient yew tree estimated to be between 2,000 and 5,000 years old. It is one of the oldest living things in Europe and is believed to have been used as a gathering place for Druids in ancient times.

In addition to its rich history, Fortingall is also a popular destination for outdoor enthusiasts. The surrounding hills and forests offer opportunities for hiking, cycling, and wildlife watching, while the nearby loch is perfect for fishing, kayaking, and sailing.

Situated in the Kenmore & District and Glenlyon & Loch Tay Community Council areas, which combined cover 218 sq mi, the population of the village itself is very small with most properties being holiday homes and/or tourist accommodation. It has its own recently refurbished, community hub, Molteno Hall, which hosts various events, including the annual Fortingall Art Summer Exhibition, showcasing local artists' work. In common with other human settlements in

the area, challenges include availability of affordable homes for local people, access to shops, restaurants and hotels and road and transport infrastructure. Other concerns include the future of the environment and the large-scale Taymouth Castle development.

The most recent Community Action Plan for the area, shares a vision for the future which includes:

- A vibrant rural community which can support existing residents and newcomers with the right infrastructure.
- A place where people can find and live in suitable housing.
- A place where people can access high-quality, year-round employment opportunities and local businesses can thrive.
- Friendly, well connected community offering opportunities for all age groups to engage in community life.
- A rural, beautiful and scenic area which is both accessible but also well protected for the future.
- A high-quality, year-round tourist destination.

Profile: Killin and Ardeonaig (Lyon/Dochart Catchment)[47]

Killin with the Falls of Dochart in the foreground, photo Markus Stitz

[47] See Killin and Ardeonaig Community Place Plan 2021 -2031

Killin and Ardeonaig are scenic Highland villages rich in history and surrounded by mountains, including Ben Lawers and Tarmachan Ridge, and the iconic Falls of Dochart. Loch Tay is nearby, contributing to the area's appeal for visitors. The community lies on the edge of both the Loch Lomand and the Trossachs National Park Authority and Stirling Council area.

Historically agricultural, Killin evolved into a hydro-town and now a growing tourist destination. However, transport links have declined, retail options have shifted, and public services feel increasingly remote. Population trends show a shrinking and aging demographic, with fewer young people and working-age residents. As of the 2022 census, the Killin Community Council area had around 739 residents.

Households with all residents over 65 are more common than average (12% vs. 7.8%), and 17% of over-65s live alone within the town boundary. Employment is mainly full-time (34.4%), with a notable 20.6% self-employed - nearly triple the Scottish average. The local economy leans heavily on tourism, with 19.7% working in accommodation/food services, and many also in agriculture, construction, and trades.

Car ownership is high: only 13% of households lack a vehicle, 17% below the national average, reflecting limited public transport. General health is mostly on par with national figures, though slightly more report “very bad” health. Developmental disorders are more common, while mental health issues are reported slightly less.

Key goals for the community include supporting tourism, agriculture, and energy, improving services, attracting young people, and ensuring sustainable development across community, environment, and economy.

The village lies within the geography embraced by one of the Bioregions’ largest nature restoration projects, Wild Strathfillan. This ambitious nature restoration project is led by Loch Lomond and The Trossachs Countryside Trust in partnership with over 30 land managers, local communities, NGO’s, and statutory bodies including the Loch Lomond and The Trossachs National Park Authority. The project is helping to transform an area of 50,000 hectares in the Lochy/Dochart catchment through habitat creation and restoration, helping to build a nature recovery network which will benefit the area’s iconic Scottish wildlife and the habitats they call home. Long-term, this work will help to increase resilience to climate change across the landscape and its communities.

Profile: Blair Atholl (Garry)[48]

Located in Highland Perthshire where the Rivers Tilt and Garry meet, Blair Atholl is home to around 600 people. Situated on rare flatlands among the Grampian Mountains, it includes the nearby communities of Struan, Calvine and Bruar. The area’s character, economy and community life are closely tied to Blair Castle and the wider Atholl Estates. This iconic castle, with its unique private army, has deep roots in Scotland’s military and cultural history and remains a major influence on the area.

The River Garry runs through the heart of Blair Atholl, linking communities and helping preserve its traditional charm. While residents value the area's heritage, they also recognise the need for sustainable growth - more housing, employment for young people, and stronger service and

[48] See Blair Atholl Community Action Plan: Looking to 2030

tourism sectors. However, the geography, the River Tilt, and conservation protections present challenges to expansion.

Blair Atholl at the confluence of the River Tilt and Garry, photo Markus Stitz

Blair Atholl residents are known for their strong community spirit and self-reliance, shaped in part by the village's relative isolation. Local businesses promote the village as the gateway to the Cairngorms National Park, boosting its tourism appeal. The local economy includes hotels, self-catering accommodation, gift and food outlets, tradespeople, farmers, crofters, estate workers, and artisans.

Looking ahead, the community's long-term vision is built on three themes:

- **A Socially Connected Community:** Priorities include sustainable public transport, affordable housing, versatile community spaces, and access to quality healthcare.
- **A Climate Conscious Community:** Focused on biodiversity, promoting active travel, and removing barriers to fish migration in the river.
- **An Economically Thriving Community:** Aiming to repurpose vacant buildings, attract more tourism and business, and create local jobs.

This vision reflects a desire to balance growth with sustainability, preserving Blair Atholl's heritage while embracing future opportunities.

Profile: Crieff (Earn Catchment)[49]

Crieff, located in the Strathearn Valley, has grown due to its central location in Scotland, offering strong connections to both Highlands and Lowlands. Originally a cattle market town, it later evolved into a popular tourist destination. Nestled between hills to the north and the River Earn to the south, it provides excellent access for walking and cycling, with scenic parks, riverside walks, and panoramic views from the Knock, a wooded hilltop.

With a population of around 7,000 (2022 census), Crieff is the main town in Strathearn and serves as a retail and service hub for nearby villages. It has a strong tourism tradition, anchored by Crieff Hydro, and hosts annual events like the Crieff Highland Gathering, Drovers' Tryst Walking Festival, and Crieff Succeeds BID events, including the Crieff Cowches and Santa's Post Office. Despite recent pandemic challenges, new businesses, building regeneration, and plans for Market Park reflect optimism and growth.

Crieff's vision for the future emphasizes connectivity, eco-conscious living, shared community values, and a thriving economy rich in culture and recreation. Its Community Action Plan focuses on seven key themes:

- **Community & Inequality**: Create a 'Uniting Crieff' partnership, address inequalities, and amplify youth voices.
- **Facilities & Events**: Map community resources, explore a hub, expand youth and outdoor activities, and promote inclusivity.
- **Local Economy**: Strengthen retail, hospitality, arts, and support small businesses.
- **Town, Environment & Heritage**: Beautify the town, grow a green network, celebrate heritage, and foster sustainability.
- **Sport, Health & Wellbeing**: Create a Sports Hub, enhance access, support youth sports, and promote well-being.
- **Services & Transport**: Address anti-social behaviour, improve services, and boost public transport.
- **Traffic & Pedestrian Safety**: Implement traffic calming, review parking, and upgrade pavements.

Profile: Kirriemuir (Isla Catchment)

A historic "Wee Red Toon" of c6,000 people, with a higher-than-average older demographic, Kirriemuir lies between the Strathmore valley and the foothills of the Grampian mountains. Its history dates to Pictish times, with the town being granted a charter, as a burgh of barony (which granted the right to hold weekly markets), in 1459.

The economy of Kirriemuir in the eighteenth and nineteenth centuries was massively dependent on the local linen industry. In 1841 there were over 2,000 weavers in the parish, out of a total population of about 7,000, and by the late 1860s it has been estimated that 8.2 million metres of cloth were produced annually in Kirriemuir.

[49] See Crieff Community Action Plan 2021-2026

Kirriemuir from the Sidlaws, photo Clare Cooper

The town developed a modest jute industry, but brown linen remained the trademark of Kirriemuir weavers, and most weaving continued to be done on hand looms despite the opening of two power loom factories in the nineteenth century. Kirriemuir was also a market town for the surrounding rural areas, and in addition to weekly produce markets and fortnightly cattle markets, agricultural fairs were held four times a year.

Today, it is known for being 'The Gateway To The Glens' – the Angus Glens, renowned for their diverse landscapes, including 10 Munros, birthplace of Sir J M Barrie, author of Peter Pan, Geologist Sir Charles Lyell and AC/DC singer Bon Scott and for its very strong commitment to being a sustainable, net-zero community where people and nature flourish, led by Sustainable Kirriemuir.

Key themes for the town's future are active and sustainable travel, action for nature, promoting a circular economy, growing more food locally and growing the number and diversity of people volunteering in the town.

Profile: Perth (River Tay, Loch Tay to Sea Catchment/Hydrometric Area)

Perth lies on the banks of the River Tay and had a population of around 17,500 in the 2022 census. The area has been inhabited since prehistoric times, with evidence of human presence going back 8,000 years. Mesolithic hunter-gatherers lived along the river, and later Neolithic and Bronze Age communities left burial mounds, standing stones, and artifacts. Though the Romans never founded a major settlement, they were active in the area.

The Tay at Perth, photo Mike Pennington, Wikimedia Commons

In the early medieval period, Perth was important in the Kingdom of the Picts and later the Kingdom of Alba. It became a royal burgh in the 12th century under King David I. Its location on the Tay made it a key trading centre, and by the 13th century it was one of Scotland's richest

burghs, acting as a de facto capital. Nearby Scone Abbey was the traditional site of Scottish royal coronations.

The city suffered during the Wars of Scottish Independence and was captured by the English several times. In the 14th and 15th centuries, Perth was a centre of political and religious conflict, including the 1437 murder of King James I at Blackfriars Monastery.

The 16th-century Reformation changed the city's religious and social structure, as Protestant reformers attacked churches and monasteries. Though it later lost prominence to Edinburgh, Perth remained a commercial and administrative centre.

The Industrial Revolution brought expansion, with Perth known for textiles, whisky, and leather. Improved roads, canals, and railways boosted growth. Officially named a city in 1829, its status was later revoked, then restored in 2012 during Queen Elizabeth II's Diamond Jubilee.

In the 20th and 21st centuries, Perth became a centre for governance, retail, and light industry, and retained its historic charm - sometimes nicknamed the "Fair City" from Sir Walter Scott's *The Fair Maid of Perth*. More recently, it has focused on cultural renewal, sustainability, and climate resilience, aiming to modernise while preserving heritage and promoting social equity.

Profile: Blairgowrie & Rattray (Ericht Catchment) [50]

The twin towns of Blairgowrie & Rattray lie on either side of the River Ericht from each other and form the largest town in Perthshire, with a population of nearly 10,000, over 2,000 volunteers, and 150+ community groups. They serve as a hub for Eastern Perthshire and the wider Strathmore area, offering a range of independent shops, restaurants, supermarkets, and a monthly farmers' market.

Home to 220+ businesses, they also host national firms like Castle Water, Graham Environmental Services, and the A. Proctor Group. The River Ericht runs in between the towns, offering scenic walks past the remnants of 14 historic jute mills, central to the town's prosperity. Known as the "Berry Toon," it's rooted in Scotland's fruit farming district.

Blairgowrie & Rattray, as the towns are known, is also the gateway to the Cairngorms National Park, just 14 miles away via the A93 and nearby Glenshee Ski Centre, Scotland's largest, is only 40 minutes away. The towns also feature Blairgowrie Golf Club, home to three world-renowned courses including the Rosemount Course, recently ranked eighth-best parkland course in the British Isles.

The surrounding area offers outstanding natural beauty, from moorlands to Munros. The 64-mile Cateran Trail, one of Scotland's premier walking routes, runs through them.

[50] See Blairgowrie & Rattay Local PLace Plan 2025 - 2035

Blairgowrie & Rattray looking south, photo Markus Stitz

A strong community-led approach drives local ambitions for the future. Key focus areas include:

- Economy and Tourism**:** Enhancing the town as a vibrant place to live, work, and visit.
- Housing and Infrastructure**:** Ensuring services grow to meet new housing needs.
- Transport and Accessibility**:** Expanding sustainable, connected travel.
- Health and Wellbeing**:** Investing in inclusive recreational and health facilities.
- Green Spaces and Biodiversity**:** Protecting natural areas and promoting well-being.
- **Climate Resilience**: Reducing carbon and preparing for environmental challenges.

Blairgowrie and Rattray Development Trust are one of the lead partners in the River Ericht Catchment Restoration Initiative, one of the Bioregion's largest community-led nature catchment restoration projects whose ambition is to work alongside landowners, farmers, businesses, communities, educational institutions, and relevant statutory bodies to sequester carbon, increase biodiversity, improve water quality, mitigate extreme weather and save the Salmon, enabling the lives and livelihoods of all those that depend on the waters of the Ericht to thrive now and in the future.

Profile: Dundee City (Coastal Hydrometric Area)

Dundee is Scotland's fourth-largest city, with a population of around 150,000. Its location on the sheltered Firth of Tay helped establish it as a major port.

Dundee became a key trading centre in the Medieval period, and the site of frequent battles. During the Industrial Revolution, the city expanded rapidly due to its booming textile industry.

General oblique aerial view of the Tay Estuary at Dundee, looking NW © Crown Copyright: HES

Dundee also gained recognition for its marmalade production and journalism, earning the nickname “city of jute, jam and journalism.” The success of jute manufacturing boosted shipbuilding and supported the whaling trade, which had declined after gas lighting reduced demand for whale oil.

Between 1801 and 1901, Dundee’s population had grown from 2,472 to 161,173, driven by industrial growth. Women dominated the textile workforce, as mill-owners could pay them less than men. Despite declining after 1900, jute remained the city’s largest employer until the 1950s. The high number of working women fostered a strong female culture, earning Dundee the nickname “She Town.”

Wealth from the jute trade allowed mill-owners -nicknamed ‘jute barons’ - to build grand homes in Broughty Ferry, Newport, Tayport and the west end of Dundee. In 1861, the UK census recorded 33 millionaires in one square mile of Dundee’s West Ferry, the highest concentration in the British Empire.

Today, Dundee faces significant poverty and deprivation, with many areas ranked among the most deprived in Scotland. Over 31% of children live in relative poverty.

The River Tay and port remain central to Dundee’s economy, supporting the de-commissioning of oil rigs, the assembly of offshore wind turbines, and cruise ship tourism. Modern industries such as video game development and life sciences now help to drive the economy, and the city also hosts a large student population thanks to the University of Dundee, Abertay University, and Dundee & Angus College. Its considerable investment in developing the city’s waterfront and cultural assets

(DCA, Science Centre, V&A, Discovery Point) are aimed at promoting economic and social regeneration.

Profile: Cupar (Eden)[51]

Cupar from the west, photo Markus Stitz

Cupar lies in the fertile Eden valley in Northeast Fife. With a population of 9,200 (2022 census) that is older than average and declining, this picturesque medieval town has preserved its historic charm while offering independent shops and modern amenities. Cupar and surrounding settlements boast an active community supported by numerous volunteer-led groups.

The community's 10-year vision for Cupar and Country is of a friendly, thriving, and well-connected hub in NE Fife - lively, sustainable, and the best place in Fife to live, work, play, and retire.

Priority projects include:
A Connected community

- Ensure Cupar North is well integrated with the town
- Promote Active Travel across Cupar & Country
- Enhance public transport linking Cupar with nearby communities

[51] See Cupar and Country Community Action Plan

An Active community

- Increase community-wide events and activities
- Support local community and voluntary groups

Inclusive economy and growth

- Connect jobseekers and young people with local businesses through employment and skills development initiatives
- Tackle child poverty and improve wellbeing through community-led efforts
- Identify and allocate new development sites for housing and business
- Promote Cupar & Country as a tourist destination

A Vibrant market town

- Improve town centre accessibility for disabled people, young families, and the elderly
- Regenerate unused or underused buildings, such as repurposing the old TSB building through Options in Life

Amenities and community spaces

- Support and grow the local arts and culture scene
- Provide a cinema and projection facilities in the area
- Establish an adequate recycling centre
- Improve the River Eden environment

One key volunteer group, Sustainable Cupar, helped launch the River Eden Sustainability Partnership, an ambitious community-led catchment-wide initiative aiming to develop source-to-sea solutions for the river and its tributaries. Their vision is for a restored river corridor, rich in biodiversity, free from invasive non-native species, resilient to climate change and connected to the community for well-being and economic benefit.

Other community anchor organisations spearheading the community's future plans area Cupar Development Trust and Cupar Community Council.

3.4.6 Current economic characteristics of the landscape[52]

In the Medieval and Early Modern period, the region was already trading with Europe, especially the Low Countries, the Hanseatic League and later France and Scandinavia. By the 17th century, Dundee was Scotland's second largest town and a major exporter of linen, wool and cured fish. The 18th and 19th centuries industrial boom saw Dundee become the global centre of the jute industry and a major hub for ship building and whaling, with Perthshire and Angus contributing linen, tweed and later, engineering products exported to Europe and the British Empire. Today, key economic characteristics include:

Agriculture

The Bioregion's fertile soils particularly in the lowlands of Angus and Perthshire making it ideal for agriculture. The region is a major producer of soft fruits (especially strawberries and raspberries), potatoes, and cereals, with a large proportion of the latter being Malting Barley sold for the

[52] https://www.taycities.co.uk/sites/default/files/tay_cities_res_2019.pdf

Whisky Industry. There is a mix of arable farming in lowland areas and livestock grazing (sheep and cattle) in upland zones.

The Prime Agricultural Lands of Strathmore, looking from the Sidlaws, north, photo Clare Cooper

Tourism

The Highlands and glens of Perthshire and the Angus Glens attract tourists for outdoor activities such as hiking, fishing, and skiing. The area's castles, distilleries, and historical towns (like Dunkeld and Pitlochry) are major visitor destinations, and the region includes the world-renowned golfing locations of St Andrews, Gleneagles and Carnoustie. The recently opened V&A Dundee has received world-wide attention and attracted over 2 million visitors since it opened in 2018. Television and movie-related tourism from productions such as Outlander, Mary Queen of Scots and Outlaw King have also significantly boosted interest in the region. The area also has a strong programme of events, festivals and performing arts networks and venues and a wide network of creators in arts, crafts, textiles & ceramics.

There are currently around 1,500 businesses operating within the tourism sector across the region that employ over 20,000 people. It is the fourth biggest employment sector within the region, accounting for around 10% of the total workforce and has been identified as one of six growth sectors within Scotland's current Economic Strategy.

Education and Research

The Bioregion is home to the Universities of St. Andrews, Dundee and Abertay with the University of the Highlands and Islands also having a presence in Perth. Dundee and Angus College is the main Further Education provider and the James Hutton Institute operate major science research and training hubs in the region. Ninewells Hospital is also a major research hub, renowned for its work on leukaemia. A £1.9 million workforce development programme under the Tay Cities Deal, is planning to connect industry, education providers (Dundee & Angus College, University of

Dundee, Abertay, UHI Perth, James Hutton) and employers to build career pathways in science and life sciences. This programme will support the upcoming Life Sciences Innovation Hub (opening 2025), which aims to create hundreds of future jobs in the region.

Riders taking part in the Cateran Dirt Dash with a view of Glen Beag from the Cateran Trail, photo Markus Stitz

Urban Economy

Dundee has emerged as a hub for biotechnology, video game development, and digital media (notably Abertay University and the V&A Dundee) with the Bioregions' Universities providing research, innovation and skilled labour. St Andrews is Scotland's oldest University, renowned for the humanities. The City of Perth has a strong finance and business services base, with several large companies represented.

Energy and Environment

The renewable energy sector is increasingly important to the region with a growing focus on wind, solar, and other green technologies. The hilly terrain and rivers have supported multiple interlinked **hydroelectric power** schemes since the last century and more recently, onshore windfarms have transformed many of the glens of the Bioregion, benefiting some communities through windfarm fund payments to Development Trusts. There is a growing focus on the potential for carbon sequestration which can be used as voluntary carbon emission off setting for businesses and organisations, especially through woodland creation and peatland restoration.

3.5 Climate, Climate Change and Climate Change Projections

Before human-induced climate change began to be recorded in the 1960s, the climate of the Tay Bioregion during the Modern Age[53] was typical of the British Isles. It was dominated by maritime air masses - characterised by moderate conditions and a lack of extremes - though occasionally influenced by continental high-pressure systems that brought greater temperature extremes and calmer winds.

3.5.1 Climate - General Characteristics

Located in eastern Scotland and mostly at low altitude, the Bioregion generally receives less rainfall and more sunshine than the west coast, although this contrast is less marked in the more mountainous inland areas of the Highlands.

Until recently, average annual rainfall was around 1,000 mm, with more rain typically falling in the west than in the east, and substantially more in upland areas such as the Highlands and Lowland hills. Summer rainfall is particularly low in the eastern and southern parts of the region.

Roughly two-thirds of strong winds (greater than force 5) blow from the south-west.

January temperatures are lowest in the uplands to the west, averaging 1–2°C, and the Ochils also tend to be cooler than the surrounding lowlands. The region experiences some of the highest July averages in Scotland (19–20°C), although upland areas are typically 5°C cooler.

At latitudes of 56–57°N, the region's climate has strongly shaped human activity, soil characteristics, and the types of plants and animals - including crops, trees, and livestock - that can thrive here. The daily and annual movement of the sun defines these possibilities (see Fig. 1 below). In summer, long daylight and twilight hours mean visibility for most of the 24-hour cycle, while in winter there remains just enough light for biological and economic activity to continue, albeit briefly.

The elevation of the sun (or its height in the sky) is much lower than that, say, in the mediterranean or tropical lands, but is high enough between the equinoxes and summer solstice to warm the land and drive the growth of vegetation. In fact, the long periods of solar income per day and the moderate temperatures of the maritime climate in spring and summer combine to produce highly favourable conditions for the growth of crops and grass, a state that has sustained human populations for millennia.

The solar elevation and position east to west in Fig. 1 determine the potential for solar income. The actual solar income and the associated temperature of the earth and air is then modified by other aspects of the maritime location.

[53] See definition

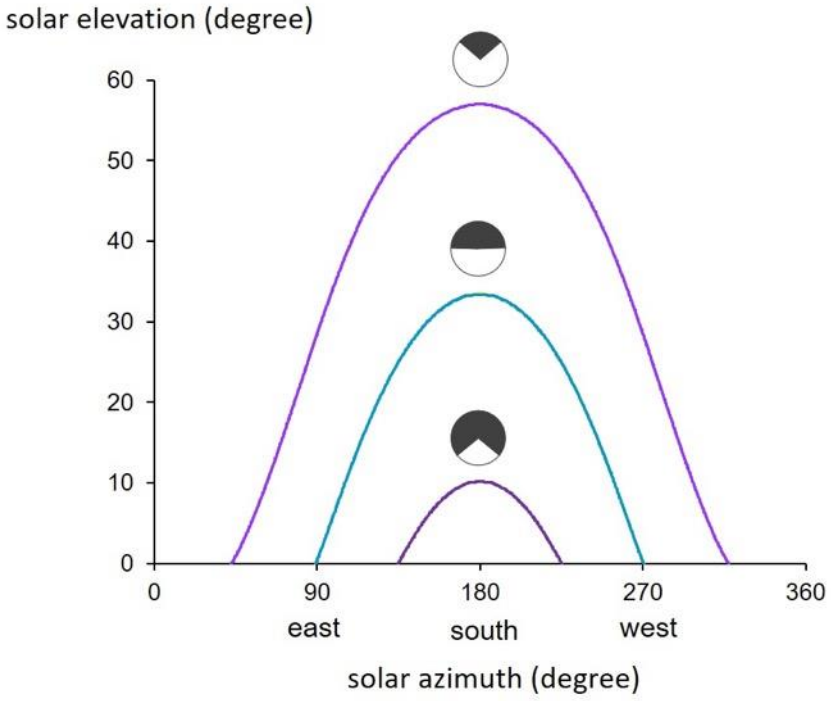


Fig. 1 Change in height of the sun (solar elevation) and its position from east through south to west (solar azimuth) throughout the day at the summer solstice (upper), equinox (middle) a winter solstice (lower). Symbols above each curve show the proportions of day (white) and night (black). Values for latitude 57 N (Tay Estuary).

First, the nearness of the sea (for much of the region) leads to the annual rise and fall of temperature lagging behind the course of solar income by typically four to six weeks. Second, the possible presence of cloud at any time causes great variability in solar income between hours, day, months and years. The progression of solar income and air temperature is therefore - despite the ever-present lag - highly variable and unpredictable (e.g. Fig. 2 below).

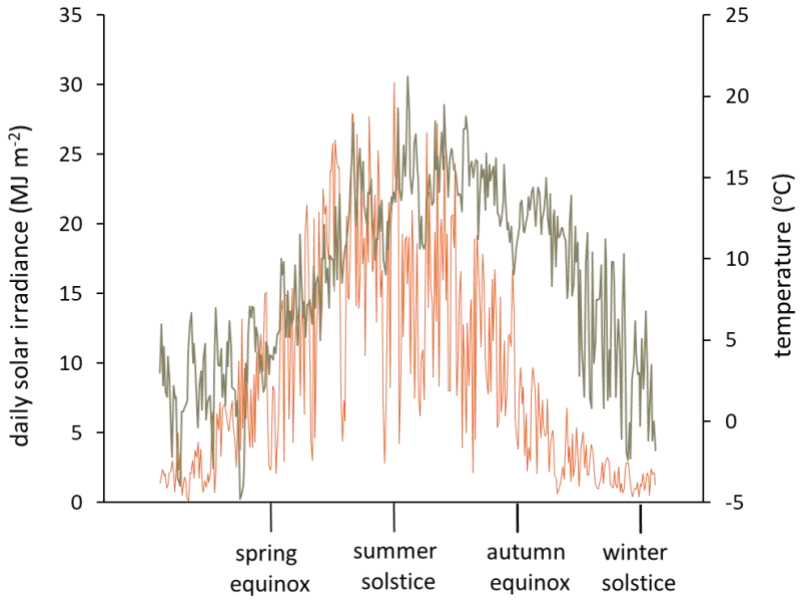


Fig. 2. The yearly progression of daily solar radiation income (red) and air temperature (grey) showing the lag in temperature and the great variability between days and seasons. Values for a typical year at 56-57 N.

Most types of land use in the region have had to accept and manage both the lag and the variability in solar income, temperature and related climatic factors such as precipitation. At best they support some of the highest agricultural productivity in the world, but at worst, historically, they have led to food insecurity and famine. One of the main challenges for the Tayside Bioregion is to maintain the high productivity of fields, forest, livestock and water storage in the ace of further uncertainty in climate.

3.5.2 Climate Change

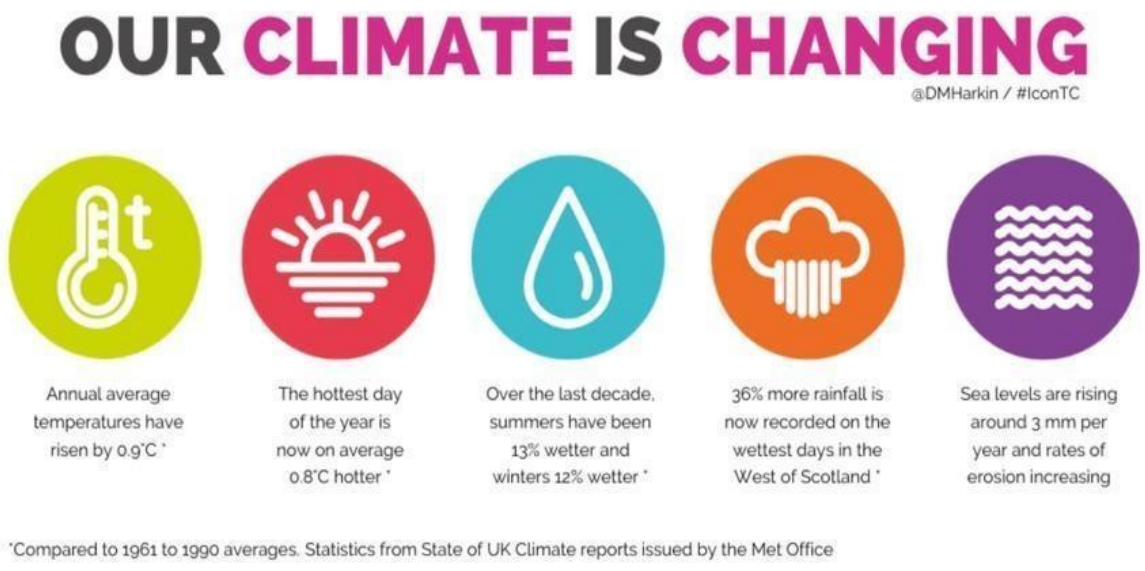


Image credit: David Harkin, Climate Change Scientist at Historic Environment Scotland

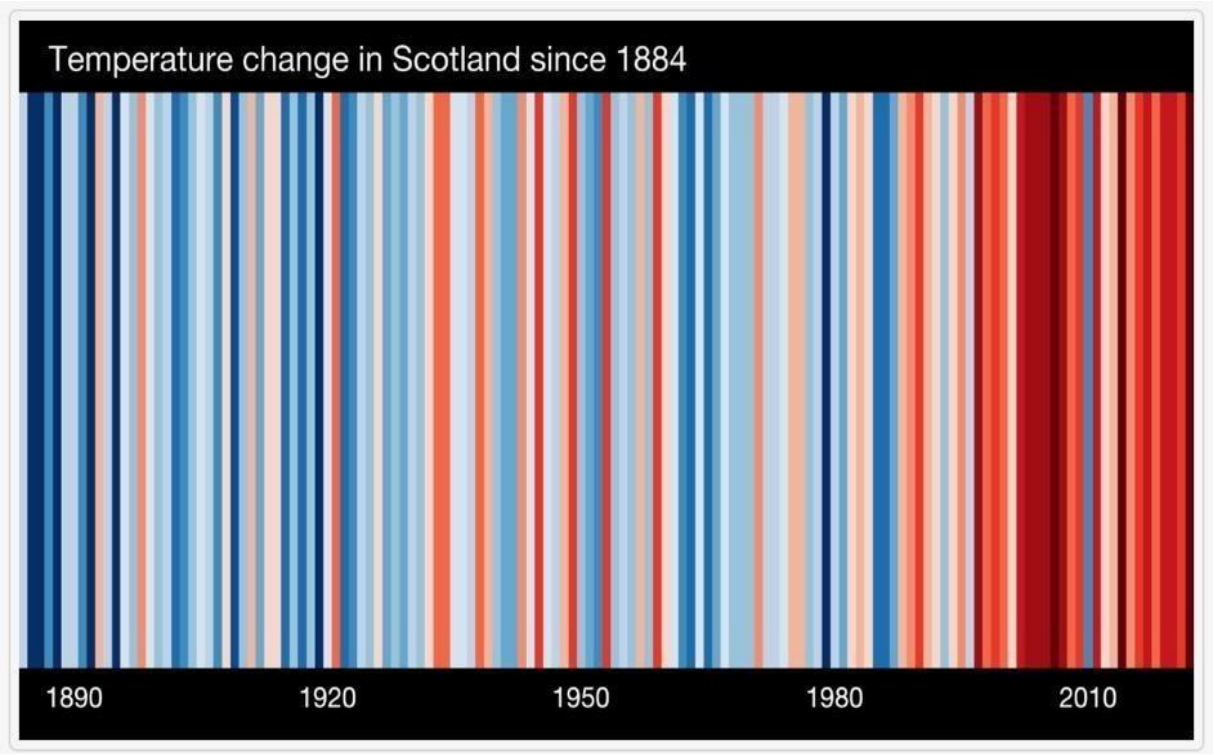
Scotland's weather patterns have already changed markedly since 1960. Shifts once expected to unfold gradually over future decades are now occurring more rapidly - and are projected to intensify[54].

Scotland's average temperature has risen by about 0.9°C, with the warmest years on record occurring since 1997. The average temperature in 2010 - 2019 was 0.69°C higher than the 1961–1990 average.

Recent analyses[55] show Scotland's climate is changing faster than previously predicted, with more frequent and severe weather events. Without major cuts in global greenhouse gas emissions, projections for 2080 (though uncertain) suggest winters could be up to 19% wetter and 2.7°C warmer, while summers may be 3°C warmer and 18% drier. Sea levels are expected to continue rising, driving coastal erosion and the loss of low-lying land.

[54] See Scotland's Environment Web

[55] See Scotland's climate changing faster than predicted



Climate change in Scotland 1884 - 2022

Some climate impacts are now unavoidable due to past emissions, bringing both challenges and opportunities for Scotland's environment, infrastructure, economy, and communities.

For the Tay Bioregion, observed changes and future projections include:

- November to January precipitation totals have already surpassed the 1960–1989 baseline and even exceed projections for 2020 - 2049.
- February temperatures have risen to match the lower range of high-emission projections for 2020–2049.
- August, September, and autumn months are likely to become drier, while winters are expected to be wetter. Spring conditions will vary greatly, raising drought risks for crops and natural systems.
- Reduced precipitation and higher evapotranspiration will decrease water availability, affecting ecosystems and agriculture.
- Upland areas in central and eastern Scotland are projected to shift from a climatic water surplus to a deficit.
- Climate extremes - including longer dry spells and heavier winter rainfall - are expected to intensify.
- Sea levels along eastern Scotland could rise by up to 0.9 metres by 2100.

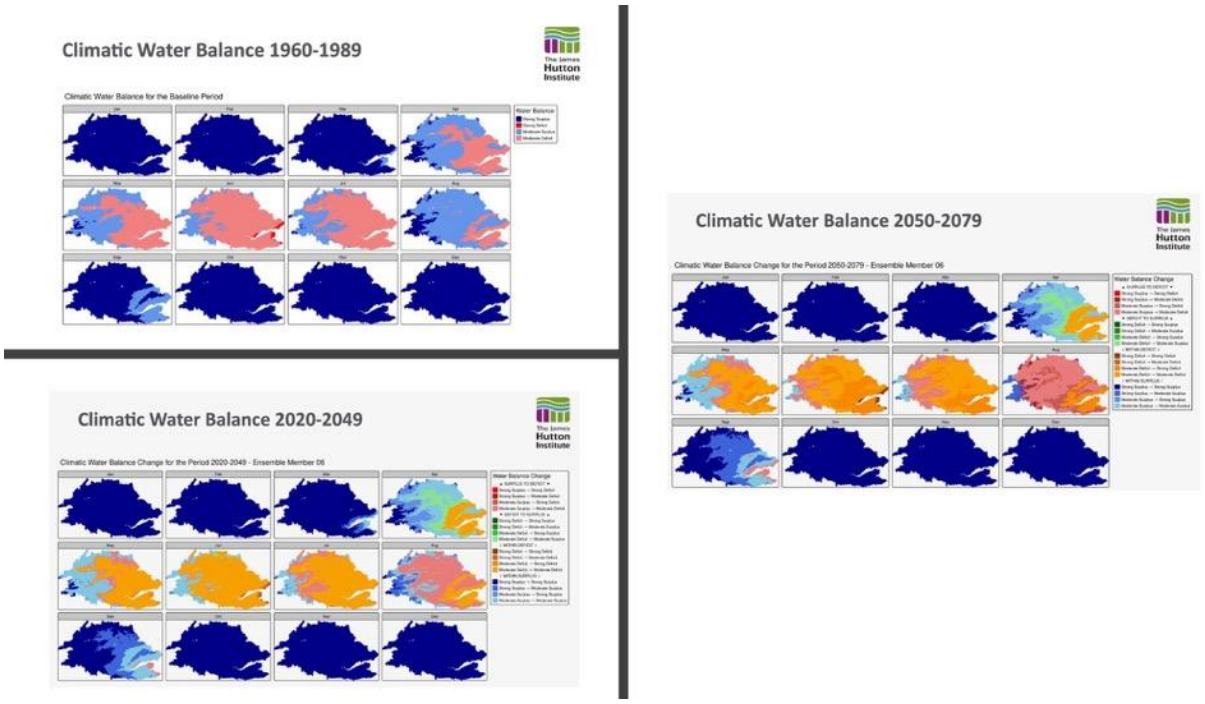
3.5.3 Regional Impacts in the Tay Bioregion

Rising temperatures will alter plant communities, affecting all levels of life from soil organisms to invertebrate food webs. Water stress will increase for many species and habitats, influencing ecosystem function and the delivery of ecosystem services. Reduced streamflow and warmer

water will heighten competition for resources, favouring species with broader tolerances (e.g., pioneer and invasive species) and threatening biodiversity. Seasonal mismatches between interdependent species - such as pollinators and plants - are likely to become more common.

Soil biodiversity will also come under pressure. Heavier rainfall will raise risks of erosion, compaction, and nutrient leaching, especially on slopes in Perthshire and Angus. In low-lying areas with poor drainage, waterlogging may increase, reducing soil oxygen and damaging crops. Conversely, hotter, drier summers will cause soils - particularly sandy ones - to dry and crust more readily.

In the upland peatlands of Highland Perthshire, warmer and drier summers threaten to accelerate peat decomposition and carbon loss unless restoration is expanded. Poor management, such as increased tillage, could worsen this loss. Drier, more flammable vegetation and peat soils will raise wildfire risk, threatening both biodiversity and human safety.



Climatic Water Balance Projections by the James Hutton Institute (2025)

3.5.4 Effects on Agriculture and Food Security

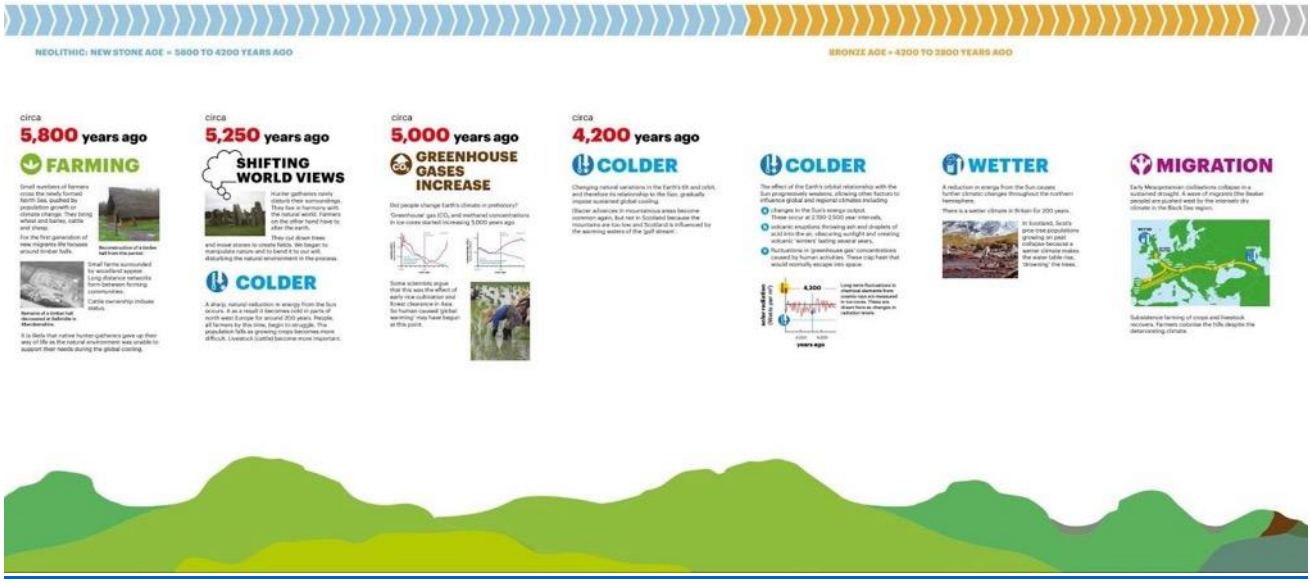
Past climatic extremes have had major impacts on rural life, land use and food security. In the late 1870s, a sequence of bad-weather years devasted agriculture in Tayside and in the UK as a whole. The government turned to import staple food from North America rather than support the rural economy. This combination of events led to decades of agricultural depression and rural depopulation. Agriculture and food production began to recover in the mid-20th century through a combination of government planning and scientific advances. Then three decades of intensification (1960-1990) raised outputs to levels never before seen.

The negative effects of this rise in production included (as stated earlier) degradation of soil and biodiversity. There were also positive consequences, notably the adoption of a wide range of innovative technology, which in turn enabled farming to limit the effects of challenging weather

post-2000. There has been no total crop failure as would probably have occurred due to such conditions a century ago. Government data on grain production shows the most severe reduction (of around 13% of the two-decadal average) probably occurred in 2012 due to excessive wetness. Even the unusual weather of 2018 marked by a prolonged winter, delayed spring and an unusually hot-dry summer depressed yields no more than in 2012. And yield actually rose above the average in recent dry years such as 2020 and 2022.

Nevertheless, the highly variable year to year weather in recent decades is inflicting a strain on land management. Not all effects have been fully documented. For example, hill farms could see reduced grassland productivity during summer droughts, with altered pasture composition and more variable yields. While warmer conditions may open opportunities for crop diversification (e.g. maize, sunflowers) and allow earlier sowing and harvesting of cereals and potatoes, they also pose new additional risks. In particular there is also growing concern about the expanding range and impact of pests, pathogens, and invasive species. These could further disrupt terrestrial, freshwater, and marine ecosystems, threatening priority species, forests, and agriculture. Currently, one in nine Scottish species faces extinction due to climate change, including red squirrels, capercaillies, and mountain hares. Even restored ecosystems may struggle to remain resilient as warming accelerates.

You can view a timeline of climate change for the Bioregion over the last 20,000 years here.



Snapshot of the timeline of climate change for the Bioregion over the last 20,000-year, photo Cateran Ecomuseum

3.5.5 Broader Impacts

Climate change is disrupting the natural, social, and economic systems upon which humans depend. It threatens terrestrial, freshwater, coastal, and marine ecosystems, undermines food and energy security, reduces water quality and availability, and increases flood and fire risks[56].

Cultural heritage sites are being damaged, and public health faces new challenges from vector-borne diseases and heat-related illnesses. The most vulnerable communities are

[56] See Adaptation Scotland for more detailed information

disproportionately affected, deepening existing inequalities. Climate-induced displacement is driving migration and geopolitical instability, which may worsen as tropical and equatorial regions become increasingly uninhabitable.

Critical infrastructure - including transport, housing, and communications - also faces escalating risks from extreme weather and sea-level rise.

3.6 The Tay Bioregion in Numbers

- The Tay Bioregion covers 7,163. 86 square kilometres
- 115,542 hectares (16%) is covered by woodland, with most being introduced coniferous woodland
- Europe's oldest tree, the Fortinghall Yew (estimated to be between 3-5,000 years old), grows in the Bioregion
- There are 9 priority tree habitats in the Bioregion; Native conifers, Scottish Pinewoods, Yew and Juniper; Upland Birchwoods; Wet Woodlands; Upland Oakwoods; Upland Mixed Ashwoods; Lowland Mixed Broadleaf (Deciduous) Woodlands; Aspen; Traditional Orchards; Planted Coniferous Woodlands (especially the woodland edge/glades)
- Arable land and market gardens cover just under 15% of the Bioregion
- The majority of land cover – 219,512 hectares – is grassland
- There are 232 rivers and canals, 18% of which are classified with either a 'Poor' or 'Bad' overall quality rating
- The Tay River is c 193 kms long and is the longest river in Scotland
- Over 20% of the Bioregion is under designation for ecological and scientific importance although condition issues affect c 50% of SSSI's (Sites of Special Scientific Interest)
- The human population is just under 500,000

4. Assessment of the Health of the Tay Bioregion in 2025

A Bioregional Health approach ties human health and well-being to the health of the ecosystems and communities in which people live. It emphasises place-based, ecological, and cultural relationships that support health in sustainable and regenerative ways.

Human, ecological, economic, and cultural systems are seen as interconnected, and health outcomes are understood as emergent properties of the dynamic interactions within these systems. Achieving bioregional health - meaning communities and ecosystems that are resilient, able to adapt to change, and capable of thriving - requires approaches that are rooted in the specific characteristics of a place, respectful of local cultures, and committed to fairness and equity.

These approaches must be supported by inclusive processes that engage community participation and guided by long-term, regenerative ways of thinking that restore and sustain natural and social systems."

It is through this system's thinking perspective that the following assessment has been made.

4.1 Land

4.1.1 Assessment of land degradation issues

Soils

From a bioregional perspective, soil is not merely a physical substrate or a chemical medium - it is the living, breathing foundation of local ecosystems and human communities. It is the skin of the Earth, shaped over millennia by the climatic, geological, and biological processes specific to a place. In the Tay Bioregion, soil carries the memory of the land - its weather, water, vegetation, wildlife, and the people who have lived in reciprocity with it.

Soils are central to the ecological identity of the Tay Bioregion. They underpin the vitality of forests, farmlands, wetlands, and rivers, providing the conditions necessary for food sovereignty and biodiversity to flourish. They regulate the region’s microclimates, absorb and store rainwater, and cycle nutrients that sustain life - not only for humans but for the full web of other-than-human beings.

The soils of Scotland are slow-forming and fragile. It can take centuries to develop just a few centimetres of fertile soil, yet humans and climate can degrade or destroy this living layer very quickly. This fragility highlights the urgent need to protect and regenerate soils through place-specific knowledge and care. Although specific data for the Tay Bioregion is limited, national figures show that soil degradation - including erosion, compaction, and loss of organic matter -

costs Scotland an estimated £125 million annually[57], not including the cascading ecological and cultural consequences.

A bioregional lens also urges us to see the deeper ecological role of soils in regulating climate and supporting biogeochemical cycles. Healthy soils are crucial carbon sinks. In Scotland, around 80% of peatland soils - a globally significant carbon store - are currently degraded. The Tay Bioregion contains more than 121,000 hectares of deep peatland, which if fully restored, could become a cornerstone of regional climate resilience. Protecting these peaty soils is not only a matter of carbon accounting; it is a commitment to restoring a keystone ecosystem unique to this place. Soil erosion is another key challenge in the Tay Bioregion, especially in intensively farmed areas. The loss of topsoil due to wind and water - exacerbated by climate change and unsustainable agricultural practices - threatens the fertility of the land and degrades nearby water systems. Similarly, soil compaction caused by heavy machinery and overgrazing restricts root growth, reduces biodiversity, and contributes to surface water runoff and downstream flooding.

Soils, when viewed through a bioregional lens, are not static. They are dynamic communities of microbial life, fungi, insects, and organic matter, all of which interact with plant roots, groundwater, and seasonal cycles. Soil health is inseparable from landscape health. Declines in organic matter - now a widespread concern across Scotland - diminish soil's ability to retain water, cycle nutrients, and support resilient ecosystems.

In the Tay Bioregion, responding to these challenges means restoring relationships between people and place. It means grounding land use in the ecological patterns and limits of local soils. It means cultivating a culture of stewardship that sees soil not just as a resource, but as a relative - integral to the health of our watersheds, food systems, and communities.

Land use

Land is essential for human and biotic life, but the human demands on its use are increasing and human-driven climate change and biodiversity loss require urgent changes in how land is used, managed and inhabited.

In Scotland, including in the Tay Bioregion, land use lies at the heart of interconnected environmental, economic, and social challenges. Much of the land is dominated by commercial forestry (primarily Sitka spruce[58]), intensive livestock farming, or sporting estates. These uses reduce biodiversity, store less carbon than natural ecosystems, and often prioritize profit over ecology.

Scotland also has one of the most concentrated land ownership patterns in the Global North. A small number of individuals or corporations control vast tracts, restricting community access, stalling land reform, and limiting democratic input into land decisions[59].

Around 25% of Europe's peatlands are in Scotland, but many are degraded through drainage, overgrazing, and burning. While burning can encourage fresh vegetation for grazing and game, degraded peatlands release carbon instead of storing it, exacerbating climate change. Urban

[57] See The Risks to Scotland's Soils - a scoping report

[58] Data shows that Sitka spruce covers 28,374 hectares, which is about 45% of all conifer woodland in Tayside.

[59] See this Community Land Scotland link.

expansion and infrastructure developments further threaten peri-urban green spaces, leading to biodiversity loss and fewer opportunities for people to access nature.

Restoration efforts, like rewilding or species reintroduction, may conflict with traditional land uses or community interests if not designed inclusively. This raises critical questions around who benefits from which environmental initiatives or interventions.

Butterflies, including the rare Northern Brown Argus, (BL) in restoring meadows at Wester Tulloch Curran in 2025, photo Clare Cooper

Currently, the way land is used is impacting the health of the Bioregion in the following ways:

- Damaged peatlands and intensive agriculture are major greenhouse gas sources, which trap heat in the atmosphere and contribute to climate change.
- Habitat simplification from grazing and non-native forests, field enlargement, removal of hedgerows and monoculture cropping all harm native species, reduce biodiversity and are contributing to the population decline of pollinators, birds, and rare plants. This leads to reducing ecosystem functions like soil health and water purification.[60]

Social inequity can arise as a result of land profits bypassing local communities or conservation activities that displace traditional land-based jobs. However, ecosystem restoration and regenerative land management practices have the potential to bring new types of jobs to the bioregion.

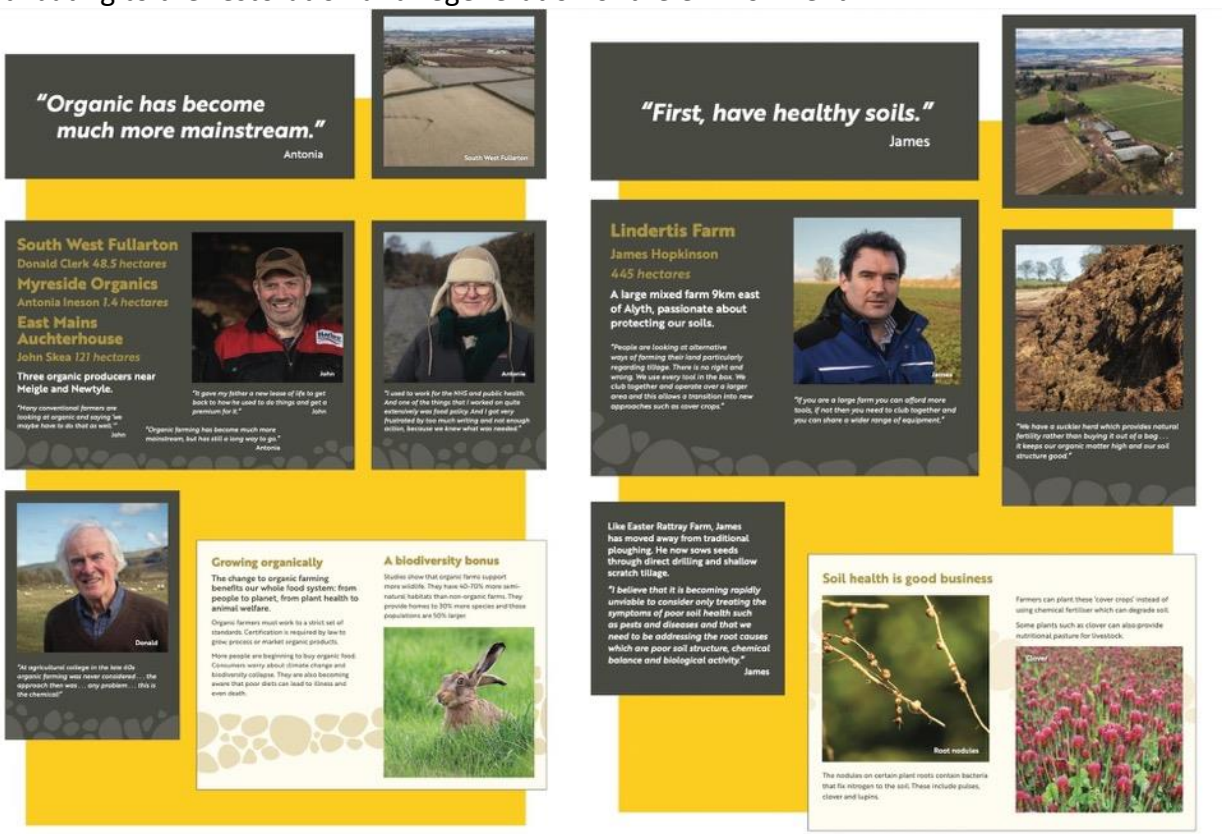
Responding to these challenges requires land use changes to be generated through a holistic systems approach, not by sector, e.g. agriculture or forestry, if they are to result in balanced ecological, social and economic demands.

[60] See Scottish Biodiversity Strategy to 2045

4.1.2 Restoration and regeneration achievements to date

Bioregioning Tayside is actively mapping nature restoration across the Bioregion and is co-leading the River Ericht Catchment Restoration Initiative. This is one of four community-led landscape scale nature restoration projects in play across the Bioregion, the other three being the River Eden Sustainability Partnership, Wild Strathfillan and Dun Coillich. In Dundee, there are a number of organisations actively involved in nature restoration focusing on involving local people in creating wild-life friendly habitats, including Tayside Woodland Partnerships, Dighty Connect and Urban Releaf. There are a small number of inspirational projects led by private landowners such as Bamff Wildland, Wester Tulloch Curran and Glen Lochay Estate. A growing number of farmers are adopting agroecological practices.

There are also three active Farmer Clusters and potential interest in creating more. Perth & Kinross Countryside Trust operate the Nature Connections Partnership, which brings together landowners, land managers and communities to create and/or re-establish sustainable and resilient landscapes that deliver environmental and socio-economic benefits. Across the Bioregion, local people are involved in many different participatory science projects, all of which are contributing to the restoration and regeneration of the environment.



Part of a 2023 exhibition by the Cateran Ecomuseum, focusing on farmers in Strathmore who are in working regeneratively, photo Clare Cooper

The Bioregion also benefits from the presence of the James Hutton Institute, a well-respected and globally recognised research organisation delivering fundamental and applied science to drive the sustainable use of land and natural resources. The Institute has several major projects on in Agroecology and Soil Science, focusing on regenerative land use, agricultural innovation, climate change solutions, and food security.

4.1.3 Significant short- and long-term challenges and developments

Short term[61] challenges

The **lack of coherence across environmental, agricultural and planning policy** is hindering the systems approaches required for holistic landscape scale nature restoration.

There is a **dearth of dedicated legislative protection** for the environment in Scotland or where this does exist, laws are underutilised and enforcement poor often due to the large burden of proof required. For example, current laws focus on safeguarding water and air, with soils, despite their importance, are only indirectly addressed. New legislation could be developed to incentivise private landowner participation in nature restoration and create binding obligations to align nature restoration with biodiversity, land use and net-zero policies. New laws could formally enshrine landscape-scale restoration as a national priority, similar to the way climate targets have been legislated. New governance structures could be created which had community and stakeholder engagement mandated and further accountability mechanisms could be introduced adding to the new Ecocide (Prevention) (Scotland) Bill. Legal protection could also be given to restored landscapes and more restoration projects could be encouraged through streamlining regulation and reducing barriers.

Funding and economic viability are a huge challenge. Current public and philanthropic funding is insufficient, too short term for the scale of the problem and/or tied to government policies that are in flux. Current Nature Finance approaches are emergent. In Scotland and elsewhere, the focus is still on commodified carbon and biodiversity markets and siloed project funding – there are no Nature Finance Aggregation Platforms for example that could help smaller landowners join together to access private finance. Land for natural capital schemes remains low and continues to fall as there is growing scepticism over the finances and practical realities of carbon projects as currently designed. This current Nature Finance model risks fragmenting ecological value, externalising risk and engraining existing power dynamics that exclude communities. Similarly, community development finance approaches usually don't integrate well the different types of financial capital that want to flow into place-based regeneration.

Land ownership and land use conflicts are preventing scaling of landscape restoration. The Bioregion has a concentrated land ownership structure, with a few individuals and entities owning large areas[62]. This can slow collective action. Additionally, conflicts often arise between restoration goals and traditional land uses like grouse shooting, sheep farming, and forestry. More recently, renewable energy developments have caused concern for many local communities. Proposals for large onshore wind or ground-mounted solar is viewed by some as competing with farming, tourism/landscape values, biodiversity sites and peat/carbon-rich soils. Wind developments in particular raise landscape and cumulative-visual concerns; solar raises concerns over use of prime agricultural soils and temporary loss of grazing/arable land.

Community involvement in and benefit from landscape restoration needs building and strengthening. Currently, communities are sometimes overlooked or only lip-service is paid to consultation requirements, particularly when it comes to direct community benefits and involvement in decision-making. While some projects prioritise community engagement and

[61] In government and public policy circles, a "short term" time horizon is typically up to 5 years, sometimes 0–3 years depending on the area.

[62] See 3.4.4. above and Who Owns Scotland

benefits, such as the River Ericht Catchment Restoration Initiative and the River Eden Sustainability Partnership, others face challenges in effectively including local voices and ensuring equitable outcomes.[63]

People from Blairgowrie & Rattray playing the Strategy Game created especially for the River Ericht Catchment Restoration Initiative, which enables a shared vision for landscape management to develop, photos, Clare Cooper

Ecosystems are complex due to the intricate web of interactions between living organisms (biotic factors) and non-living components (abiotic factors), as well as the influence of human activities and ecological responses can be slow and non-linear. Restoration of degraded peatlands or woodlands for example can take decades for positive impacts to be seen. Furthermore, there is a lack of joined up data and baseline monitoring that is hampering decision making.

Long term challenges

Over the longer term, **changing climate conditions** may alter species distributions and threaten the resilience of restored ecosystems. And extreme weather events can damage peatlands, woodlands, and newly restored habitats.

Non-native species (e.g., rhododendron, Sitka spruce) and overgrazing by deer impede regeneration of native woodlands and bogs and long-term deer management is both politically and logistically difficult.

There are challenges relating to **scale and connectivity**. True landscape-scale restoration needs coordination across multiple landholdings, local authorities, and ecosystems and there is a lack of integrated, region-wide restoration strategies.

[63] For example, forestry/woodland strategies and large planting proposals show a pattern where online/formal consultations risk missing marginalised local voices and existing fund distribution and programme governance such as the National Nature Restoration Fund run by NatureScot can favour well-resourced actors unless funds deliberately build in equity-focused rules and local governance.

The challenges in relation to **cultural and economic shifts** need to be overcome. Sustaining restoration will require long-term behavioural change in how land is valued and used and rural economies will need to evolve to integrate ecotourism, renewable energy, and nature-based jobs.

Governance and institutional capacity will require significant investment to build the competencies, qualities and attributes needed to engage diverse stakeholders, resolve conflicts track outcomes, and ensure equitable sharing of resources. (See human communities' section below for more of an explanation about this challenge)

4.2 Water

4.2.1 Assessment of water degradation issues

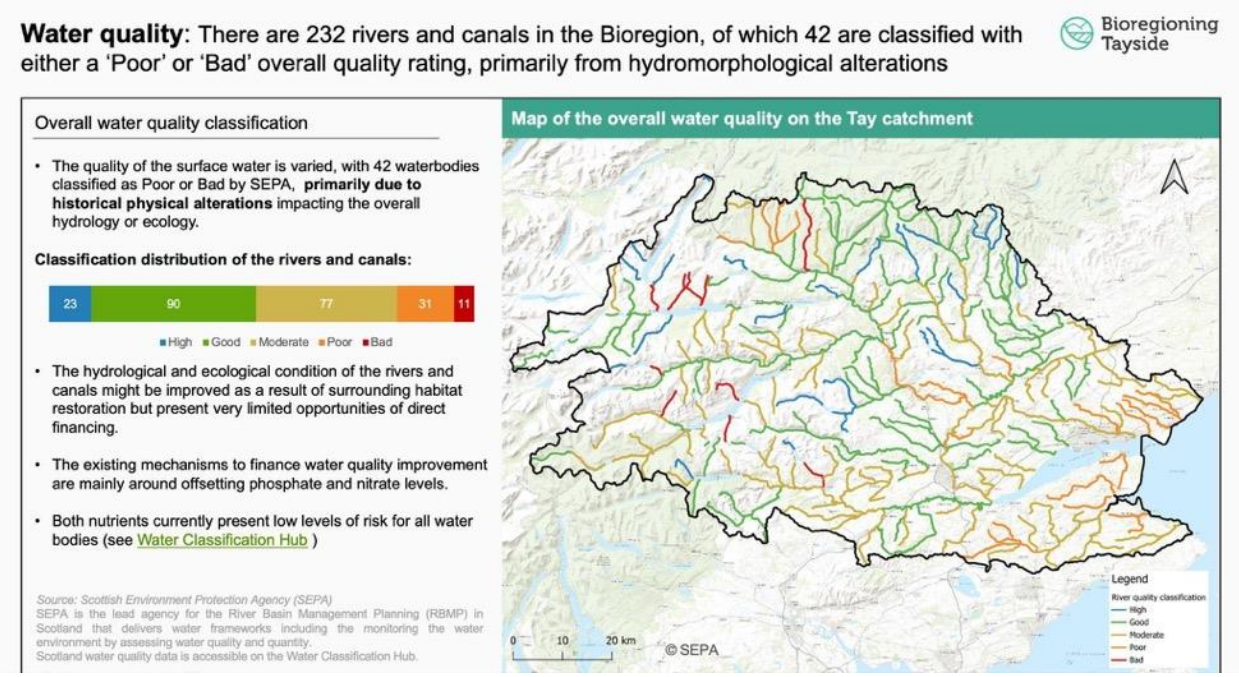
Tayside's rivers are contending with a complex mix of acute pollution events, chronic diffuse impacts, over-extraction amid drying trends, and inadequate wastewater infrastructure - all of which harm ecological health, biodiversity, fisheries, and public welfare.

As has been noted (see 3.3.4) the entire River Tay system is crucial for Wild Atlantic Salmon, with its diverse habitats supporting the full range of salmon life-history types found in Scotland. As one of the top salmon rivers in Scotland, the Tay consistently produces over 5,000 salmon annually, and its extensive catchment provides varied spawning and nursery grounds. Salmon plays a key role in the ecology of aquatic ecosystems and are an indicator of high environmental quality. They are also an important component of the rural economy, both through fisheries and wider nature tourism, employing 4,300 full-time equivalent jobs Scotland-wide and contributing £79.9m GVA to the economy.

While SEPA, Scottish Water, fisheries boards and trusts, and communities are tackling these issues through regulation, restoration, and awareness, long-term solutions will require coordinated policy, investment, and behavioural change. Current water degradation issues include:

Chemical & Pollution Incidents	**Aluminium sulphate spills** have repeatedly struck the River Farg (a tributary of the Earn and Tay), notably in 2014 and again in 2015 - 2016, leading to multiple fish kills (~4,900 fish) and visible milky discoloration, prompting multi-agency investigations and fines to Scottish Water. **Silt/diffuse pollution** from agriculture is especially problematic in the Eden and Isla catchments. Heavy rainfall can trigger brown cloudy runoff that "suffocates" salmon by clogging their gills. Historic landfill erosion near the River Ericht has also been linked to silt-laden flows harming migratory fish and impacting the local fishing economy
Diffuse Pollution & Land Use	**Agricultural runoff** carries fine sediments, fertilizers, manure, and agrochemicals into waterways, affecting fish spawning and invertebrate life. **Commercial forestry practices**, particularly dense conifer planting and

	historical ploughing, contribute to soil erosion, acidification of soils, and reduced summer flow - altering ecological balance. **Peatland drainage** accelerates runoff, lowers groundwater levels, dries bogs, and alters river flow regimes - worsening summer low flows and downstream flooding risk
Water Scarcity & Flow Reduction	In May 2025, SEPA classified the River Tay catchment as experiencing *Moderate water scarcity*. The River Tilt hit its **lowest flow in 34 years**, while the River Tay and other east-coast catchments remain unusually low after prolonged dry weather. These record low flows are stressing aquatic ecosystems and heightening competition for water among farmers, industries, and hydropower operations.
Sewage & Pharmaceutical Contamination	Across Scotland, **untreated sewage discharges** - including wet wipes, sanitary items, and condom debris - occur frequently, affecting rivers and beaches. Semi-regular overflow issues have been flagged in Tayside catchments. **Pharmaceutical residue** (e.g. ibuprofen, contraception hormones, antibiotics) has been detected in Tayside rivers above 'predicted no-effect' safety levels, raising serious concerns for wildlife and human health
Plastic & Marine Litter	Community surveys under the "Upstream Battle" campaign in 2021–22 revealed that over **3,000 pieces of litter** (predominantly cigarette butts, snack wrappers, wet wipes, period products) were found along the Tay and its tributaries - posing hazards to wildlife and marine ecosystems.



Graphic produced for Bioregioning Tayside by Palladium

In the Tay Estuary and coastlands of the Bioregion, water degradation concerns include:

Nutrient enrichment	(Eutrophication) from agricultural runoff (particularly from Fife and Perthshire), wastewater discharge, and diffuse pollution. This can cause algal blooms, oxygen depletion, and harm to aquatic life.
Microbial pollution	from a combination of sewer overflows, livestock access to waterways, and septic tanks can cause public health risks (especially for shellfish and recreational water use).
Sediment and turbidity issues	from riverbank erosion, dredging and storm events can affect water clarity, smothers benthic habitats, and can transport pollutants. Additionally, the Tay Estuary has naturally high sediment mobility, which can be exacerbated by land use changes upstream.
Chemical contaminants	from Historic industry (e.g. jute processing), urban runoff, pesticides can accumulate in sediments and biota, with risks to wildlife and food chains.
Climate and hydrological changes	from trends such as sea-level rise, increased rainfall variability, and temperature shifts influence salinity patterns, estuarine mixing, flood risks, and pollutant dispersion.

4.2.2 Restoration and regeneration achievements to date

The Scottish Environment Protection Agency (SEPA) has regulatory oversight via its implementation of the Water Framework Directive. It also leads Scotland's water monitoring programme, investigates and responds to pollution incidents and ensures that permits don't harm aquatic species or habitats, including freshwater pearl mussels, Atlantic salmon, or wetlands. The Scottish Invasive Species Initiative (SISI) has a non-native species control programme which works at catchment and landscape scale across the Bioregion with land owners, land managers and volunteers.

As previously summarised in 4.1, there are a number of community-led landscape scale nature restoration projects in play in the Bioregion who are aiming to positively impact water health at a catchment scale. Additionally, there have been other recent initiatives such as the sustainable urban drainage systems - SuDS Pond Enhancement & Tayside Ponds project led by Tayside Biodiversity Partnership and Perthshire Wildlife, which enhanced multiple SuDS ponds across Perth & Kinross through clearing invasive species, planting native wetland flora, adding amphibian ladders, and boosting invertebrate and amphibian habitats. There have been various community-led interventions in Dunkeld, at Lunan Burn and Clunie Loch and at Alt Eigheach, supported by Perth & Kinross Council, Nature Restoration Fund that have focused on riparian and riverbank restoration, and a partnership between Dundee City Council, Scottish Water, SEPA, and NatureScot aims to retrofit blue-green infrastructure and SuDS into St Mary's area such as better

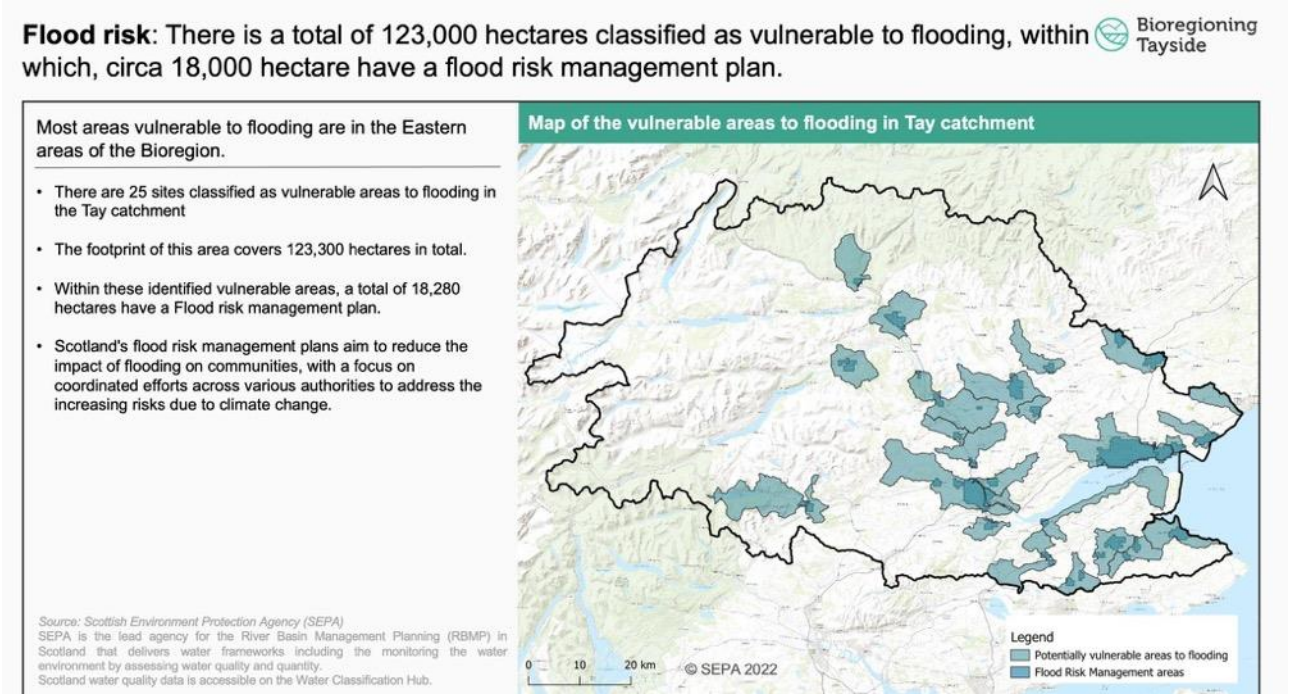
stormwater management, flood risk reduction, biodiversity enhancement, and improved community amenity.

A new Tay Catchment Salmon Alliance has been set up to attract new resources from a broader number of organisations to help restore habitats that Wild Atlantic Salmon depend on. The Cateran Ecomuseum has recently completed a community-led project investigating how the people of Strathmore managed their rivers, bogs and lochans in the past and how this knowledge might help local communities take better care of them now and in the future and the Tay Estuaries Forum brings together organisations and individuals with a common interest in the welfare and sustainable use of the Tay Estuary and adjacent coastline.

4.2.3 Significant short- and long-term challenges and developments

Short term challenges

The Bioregion has a significant agricultural base (livestock, arable farming), which contributes to nutrient pollution, especially nitrates and phosphates from fertilisers and animal waste entering water bodies. The Diffuse Pollution Priority Catchment (DPPC) work by SEPA (Scottish Environment Protection Agency) includes targeted advice and inspections to reduce diffuse pollution in key catchments.



Graphic produced for Bioregioning Tayside by Palladium

Growing urban areas (particularly around Dundee and Perth) can lead to increased surface runoff, sewage overflow, and contamination of local rivers and burns. Unitary authorities are promoting sustainable urban drainage systems (SuDS) to manage stormwater and reduce pressure on aging infrastructure.

More intense rainfall events are stressing existing flood defences and increasing sediment and pollutant loads in rivers. The Flood Risk Management Strategies for Tayside (led by SEPA and local

councils) include short-term projects like riverbank reinforcement and community flood alert systems.

Invasive Non-Native Species such as Himalayan Balsam, Japanese Knotweed, Giant Hogweed, American Mink and American Signal Crayfish are affecting river ecosystems and public safety. SISI, Local environmental groups and NatureScot (formerly Scottish Natural Heritage) are involved in monitoring and eradication programmes.

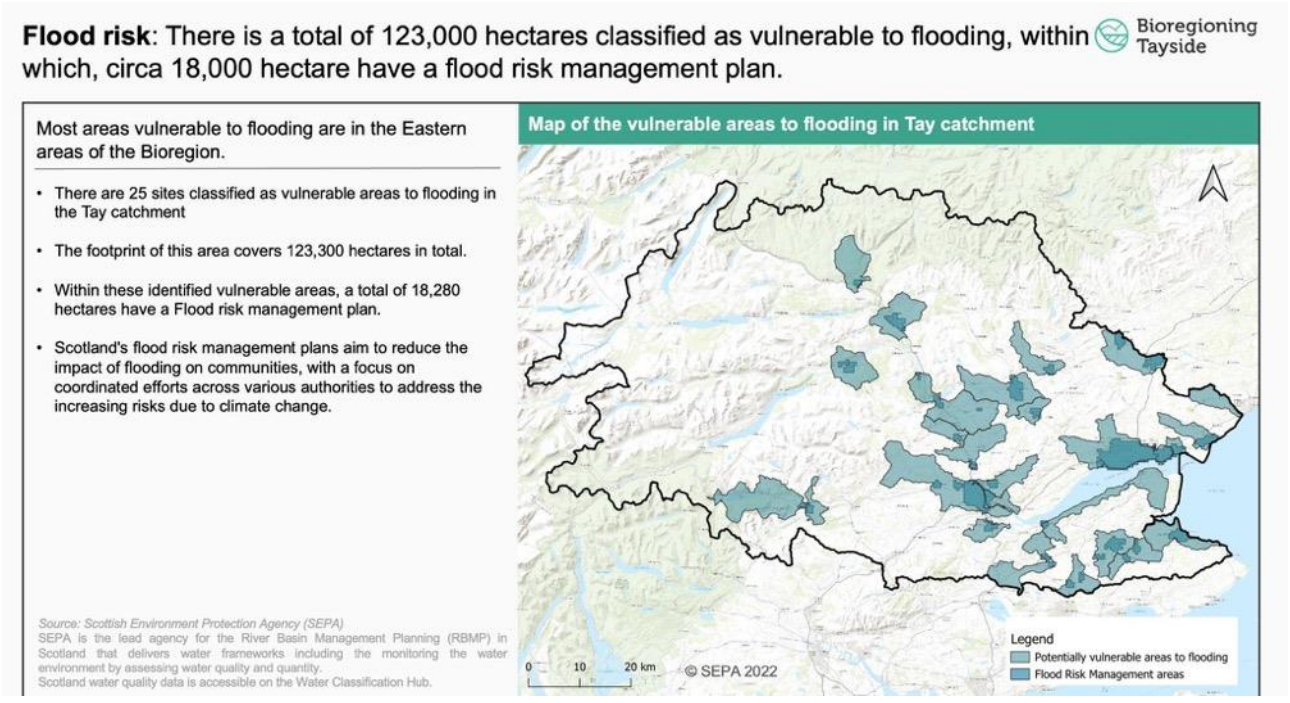
Long term challenges

Rising temperatures and altered precipitation patterns will continue to impact river flow regimes, water availability, and aquatic biodiversity across the Bioregion. Long-term water resource planning by Scottish Water includes climate resilience modelling, especially for drinking water sources and wastewater infrastructure.

Meeting evolving EU-derived **water quality standards** (like those under the Water Framework Directive, retained post-Brexit) remains a challenge due to historical pollution and land use pressures. Continued investment in catchment-based approaches and nature-based solutions, like wetland restoration, is central to improving ecological status.

Much of the water and wastewater infrastructure in the Bioregion is aging, with risks of leaks, overflows, and treatment failures. Scottish Water's Investment Programmes (e.g., 2021–2027) include major upgrades to water treatment plants and sewer networks in Tayside.

Coordinating landowners, farmers, conservation bodies, and local authorities is complex, especially across catchments like the Tay that span multiple council areas. Strengthening integrated water resource management through River Basin Management Plans and partnership catchment groups is essential but complex work.



Graphic produced for Bioregioning Tayside by Palladium

Long-term degradation of aquatic habitats threatens Wild Atlantic Salmon populations and other sensitive species. Rewilding efforts, riparian buffer zones, and barrier removal projects (e.g., fish pass installations) are being promoted.

4.3 Biotic communities

4.3.1 Assessment of Biotic degradation issues[64]

Upland ecosystem

Overgrazing by Deer and Sheep	Intense grazing by deer and sheep has fragmented and degraded montane habitats like dwarf shrub heath, willow scrub, herb-rich vegetation, and moss-heath. Grazing-tolerant species such as Mat grass now dominate, reducing grassland species diversity. Trampling from grazing animals threatens blanket bogs, high-altitude plants, water seepage zones, and sub-alpine calcareous grasslands. Ground-nesting bird nests and chicks are also at risk
Fragmentation of Habitat	Mountain willow populations are now small, isolated on inaccessible ledges, and vulnerable to landslides and rock-falls. With separate male and female plants - and females more common - natural regeneration is failing. Other rare montane species face similar risks and need long-term management. Windfarm routes and hill roads further fragment habitats.
Muirburn	Poorly managed muirburn followed by heavy grazing removes dwarf shrubs, turning heath into grassland prone to bracken colonisation. It can also lead to erosion and watercourse sedimentation.
Increasing Recreational Use	Rising numbers of hillwalkers, climbers, and cyclists damage fragile soils and vegetation, especially on wet paths and below cliffs with calcareous grassland. Path management can help prevent further erosion. People and dogs disturb ground-nesting birds like Dotterel, Golden Plover, and Dunlin, increasing predation risks and trampling of eggs or chicks - especially where walkers stray from paths.
Climate Change and Pollution	Montane areas are highly vulnerable to climate change, with temperatures projected to rise 1.4 - 3°C by 2050. Many species may not relocate successfully, leading to altered species distribution and potential loss of rare alpine plants. Acidification from sulphur and nitrogen compounds may disrupt soil nutrients and vegetation communities.
Unlocking Carbon	Grazing and development on peatlands damage hydrology and peatland species. Long-term bog drainage lowers water levels, dries peat, and hinders sphagnum regeneration. As peatlands lose their carbon-retaining ability, they release more carbon, contributing to climate change.
Lack of Knowledge	There is limited information on managing Tayside's montane areas and insufficient ecological data, especially for lower plants and invertebrates.
Afforestation	Non-native conifer planting negatively impacts species like Black Grouse and Curlew, though early-stage plantations can temporarily benefit some.

[64] These summaries have been drawn from the Tayside Local Biodiversity Plan 2016-2026

	Calcareous grasslands should be preserved for their flora and rare species like *Osmia inermis*, a rare mason bee.
Wildlife Crime	Scotland has seen a rise in wildlife crimes, including illegal snaring, badger baiting, deer and hare coursing, and bird poisoning.

The River Isla in Flood, photo Markus Stitz

Farmland ecosystem

Agricultural Intensification	Fertiliser, herbicide use, ploughing, and reseeding destroy calcareous and wet grasslands. Supplementary feeding enriches soils, promoting ruderals. Drainage alters flood regimes, nutrient levels, and lowers water tables. Unsustainable and carbon intensive farming practices cause major biodiversity loss, such as topsoil erosion from potato fields, reduced pollination for crops, and neglected field margins.
Overgrazing	Heavy grazing by sheep, cattle, and horses reduces species-richness and structural diversity, particularly tall herbs. Uncontrolled deer and rabbit populations worsen the problem in some areas.
Loss of Traditional Rural Buildings	Demolition or conversion destroys roosting and nesting sites for bats and birds. Restoration excludes them, and timber treatments or rodenticides can harm species like owls and Red Kites.
Habitat Fragmentation	Enlarged fields remove boundary features like hedges, treelines, and drystane dykes. Annual cutting degrades hedges, removing berries vital to birds. Spray drift and fertilisers harm bumblebee nests and ploughing near hedges weakens them. Dyke restoration is often unaffordable without grants.

Climate Change	Changing weather disrupts crop ripening and haymaking. Low temperatures delay ploughing and affect soft fruit. Shifts in ecosystems will pressure many species, some of which may have nowhere else to go.
Loss of Boundary Trees	Age, wind, and disease are reducing boundary trees. With few replacements, biodiversity loss worsens. These trees, including roadside and treeline hedges, are key for habitat connectivity.
Inappropriate Tree Planting	Open landscapes vital for breeding waders are harmed by tree planting, which removes habitat and creates a 'predator shadow' - birds avoid nesting near woodland due to real or perceived threats.

Woodland ecosystem

Invasive Species and Diseases	Non-native species like Himalayan Balsam, Japanese Knotweed, and Giant Hogweed suppress natural ground flora. Oak, a strong light-demander, struggles to regenerate under its own canopy when invasive species like Rhododendron and Sycamore (*Acer pseudoplatanus*) are present. Rhododendron heavily shades native shrubs, young trees, lichens, and bryophytes. Even native Bracken (*Pteridium aquilinum*) can inhibit young tree growth. Tree pathogens, including Ash dieback (*Hymenoscyphus fraxineus*) and *Phytophthora ramorum*, are spreading across Britain, making research and treatment a priority.
Climate Change	Bird species such as Black Grouse, Scottish Crossbill, and Pied Flycatcher are expected to be increasingly affected by climate change.
Silvicultural Systems	Declines in coppicing and increased grazing from domestic and wild animals have reduced the structural diversity of upland oakwoods. Early 20th-century timber removal significantly altered the composition of Tayside's upland oakwoods. Though the planting of non-native species like Douglas Fir is now historical, its impact continues.
Afforestation	Poorly planned afforestation and encroachment of trees, scrub, and bracken into non-woodland priority habitats can degrade those environments. Similarly, short-rotation coppice for biofuel must be carefully sited to avoid harming existing upland or woodland habitats.
Habitat Fragmentation	Woodland clearance for agriculture, housing, infrastructure, golf courses, and quarrying fragments habitats. Trees near developments risk removal due to perceived nuisance or damage risk, and current Tree Preservation Order systems are often inadequate. Spray drift, runoff, and the loss of connecting features like hedgerows further degrade woodlands. Large-scale planting should consider surrounding priority habitats and aim to link fragmented woodlands through forest or urban greenspace networks.
Lack of Management	Under-planting with conifers has contributed to a 40% decline in Scotland's oakwoods. Poor management, nearby land use changes (e.g., roads, quarrying, recreation), and a limited age structure hinder woodland health. In planted coniferous woods, a lack of species diversity and open areas makes them susceptible to pests, fire, and wind-throw.
Grazing Pressure	Overgrazing by livestock and deer can degrade ground flora and prevent natural regeneration. Species like Sycamore and Beech can exploit gaps,

	outcompeting native trees. In contrast, undergrazed wood pastures may convert to intensive grassland, threatening veteran trees.
Water Abstraction	In wet woodlands, drainage and excessive grazing degrade soil and flora. Water abstraction, eutrophication, and pollution further stress these ecosystems.
Recreational Impacts	Increased visitor activity can disturb birds, badgers, deer, and bats - especially during breeding or hibernation. Poorly managed paths for walking or biking may destroy ground cover and invertebrate habitats, but careful path design can mitigate these effects.

North American Signal Cray Fish on the River Ericht, an Invasive Non Native Species, photo Clare Cooper

Water and Wetland ecosystem

Acidification	occurs in areas lacking alkaline bedrock like limestone, which normally neutralises acids. It can result from acid rain (from sulphuric and nitric acids), livestock waste, and nitrogen fertilisers. Natural sources include nearby coniferous forests and acid rain from dissolved CO_2.
Toxic and Organic Pollution	comes from point or diffuse sources. Organic pollutants raise nutrient levels, often causing eutrophication and algal blooms that deplete oxygen. Species like *Slender Naiad* (*Najas flexilis*) are particularly vulnerable.

Drainage and Dredging	alter watercourses and surrounding habitats, displacing key species. Water Abstraction for farming or renewable energy can significantly lower water levels, threatening protected and priority species.
Sedimentation	while natural, is exacerbated by river works that destabilise banks. Excess sediment reduces river capacity and harms riparian zones, especially fish spawning grounds and Freshwater Pearl Mussels (*Margaritifera margaritifera*).
Climate Change	brings shifting weather patterns with widespread negative impacts on river temperatures and wetlands, endangering fish spawning and migration, especially of Wild Atlantic Salmon as well as other freshwater dependent species, making mitigation efforts critical.
Invasive Non-Native Species (INNS)	outcompete native species, disrupting ecological balance and threatening biodiversity.

Coastal and Marine

Erosion	Seaward dune edges are highly mobile unless artificially constrained. Most dune systems are not in equilibrium, and the Tayside coast generally shows net erosion. Some natural erosion helps regenerate dunes, but excessive erosion threatens their structure and biodiversity.
Development & Sea Defences	Older dune systems face ongoing development pressure, often leading to habitat loss. Many dunes have been converted into golf courses where fertilisers, herbicides, and irrigation alter the natural vegetation. Car and caravan parks increase access, trampling, and fires. Coastal defence structures hinder dune formation and reduce their natural dynamism. Offshore developments - like oil and gas platforms, marine turbines, and cable infrastructure - also impact coastal and marine ecosystems.
Climate Change	Rising sea levels and more frequent storms could lead to foreshore steepening, increasing wave impact on dunes. Invasive marine species may find it easier to spread. Elevated carbon dioxide levels are warming and acidifying oceans, affecting species' health, distribution, and interactions.
Recreation	Dune systems offer accessible spaces for walking, wildlife watching, and outdoor sports like golf. However, this leads to vegetation loss and exposes sand to erosion. Though rehabilitation is possible, natural diversity takes years to return. On the sea, boating, jet skiing, and irresponsible whale watching also add pressure to marine wildlife.
Grazing	Grazing helps maintain grassland and prevents scrub growth, but overgrazing can be harmful. Under grazing, more widespread, allows coarse grasses and scrub to dominate. Other pressures include nutrient runoff, marine pollution, bait digging, cable and pipeline installation, non-native species, dredging, shipping accidents, beam trawling, scallop dredging, and waste dumping.

4.3.2 Restoration and regeneration achievements to date

As previously summarised in 4.1 and 4.2 there are a number of community-led landscape scale nature restoration projects in play who are aiming to positively impact the Biotic communities of the Bioregion. In addition, the Unitary Authorities are required to report on their actions to further the conservation of biodiversity, as mandated by the Nature Conservation (Scotland) Act 2004 and the Wildlife and Natural Environment (Scotland) Act 2011. The latest of these can be viewed here for Angus, here for Perth & Kinross, here for Stirling and here for Dundee. Whilst these reports are based on political rather than ecological boundaries and tend to report primarily on individual projects rather than biogeographic units, they document a broad diversity of efforts by local people to improve ecological literacy and restore and regenerate the biodiversity on their doorstep. One project of note that epitomises Bioregional connectivity is the Strathmore B-Lines project run by Buglife aiming to restore 20 Hectares of grassland and nectar rich habitats to increase both the area and quality of pollinator-friendly wildflower habitat between Dunkeld and Montrose. The B-Line crosses some of the most agriculturally intensive land in Scotland and will connect fragmented habitat. This network will support the recovery of threatened species and allow movement across the landscape increasing adaptability and resilience to the impacts of climate change.

Hemp, now being grown in Tayside, is twice as effective as tree at absorbing and locking up carbon in its fibres, photo Clare Cooper

4.3.3 Significant short- and long-term challenges and developments

The regeneration of the Bioregion's Biotic communities involves a wide range of challenges and developments across short and long-term timeframes. These are shaped by ecological,

agricultural, policy, and community dimensions. Many are common to each of the key elements this strategy is documenting and have been highlighted in previous sections.

Short term challenges

- Habitat Fragmentation
- Invasive Non-Native Species (INNS)
- Agricultural Pressure
- Climate Change

Additionally, most regeneration efforts are under-resourced. Unitary authorities, NGOs and community-led organisations focusing on nature restoration generally lack adequate funding or staffing to implement biodiversity action plans effectively.

Long term challenges

- **Climate Change Escalation:** Increasing temperature, extreme weather events, and shifting species ranges may outpace habitat adaptation or regeneration.
- **Land Use Conflicts:** Balancing biodiversity goals with food production, forestry, renewable energy development (e.g., wind farms), and urban growth will be an ongoing and increasing tension.
- **Decline in Pollinators and Soil Health: There will be** long-term degradation of ecosystem services if biodiversity isn't restored across agricultural landscapes.
- **Cultural Disconnect from Nature:** Ongoing urbanisation and lifestyle changes risk reducing public support or understanding of biodiversity goals.
- **Biodiversity Funding Uncertainty:** Reliance on project-based funding creates instability in long-term planning and workforce continuity.

Many efforts are being made locally, regionally and nationally to respond to these challenges.

30x30, Nature Networks, The Scottish Biodiversity Strategy, National Planning Framework 4 are all emerging policy tools aligned with the Scottish Biodiversity Strategy, aiming to map and plan priority actions.

There are a growing number of community-led rewilding and habitat restoration efforts see Bioregioning Tayside's nature restoration project map.

There are a number of **Nature-based Solutions Pilots** underway to help improve biodiversity.

There are many participatory science projects collecting data and monitoring biodiversity and the potential for designing a new governance architecture for this is being explored by Bioregioning Tayside who are looking to pilot a Landscape Observatory for the Bioregion.

As previously referenced, the number of Landscape Scale regeneration projects is growing, including 30x30 and Nature Networks**,** which aim to restore large-scale ecological networks including peatland and native woodland.

The Scottish Government are planning to incentivise an Agroecological Transition which will encourage farmers to adopt biodiversity-friendly practices (e.g., hedgerow planting, regenerative agriculture, organic conversion).

Biodiversity regeneration is linked to national (Scottish) net-zero targets through the 'nature positive' by 2030 goal and ecosystem resilience planning is being developed at both national and local levels.

4.4. Human communities

Assessment of short- and long-term challenges

The human communities of the Bioregion face many interconnected challenges in responding effectively to the polycrisis. These span environmental, social, economic, and political dimensions:

4.4.1 Public Awareness & Behavioural Change

Whilst there is no specific survey data for the Bioregion, general awareness of climate change and biodiversity collapse in Scotland is high. Almost three quarters (72%) felt climate change is an immediate and urgent problem.[65] 52% of Scots say they "worry a lot about climate change in everyday life" and 71% consider the loss of species, habitats, and ecosystems "an immediate issue"[66]. However, there is a gap between concern and action. Many people are unsure what personal or collective actions are most impactful and there is little widespread understanding about the drivers of biodiversity loss, the interconnectedness of climate and biodiversity and the way our current high consumption economic model is fuelling them. High consumer lifestyles also facilitate resistance to change in areas such as meat consumption, car use, and energy use, slowing down efforts to meet emissions targets. Education at primary and secondary school about the polycrisis and its impacts is limited.

4.4.2 Governance

Current governance structures in the global north, which are used across all fields, including nature restoration, have grown out of the values of mercantile and consumer capitalist worldviews that have shaped human culture over the last 4-600 years. Top down, extractivist, elitist and inequitable, these organising structures and processes are incapable of enabling the generative and generational values and systems shift required for long term nature restoration that enables humans to better co-exist in balance with other than human life.

Today, in Scotland, there are a number of ways that national, regional, and local governance structures inadvertently impede or delay effective action on climate change, biodiversity loss and their impacts. These barriers stem from issues of fragmentation, underfunding, not understanding or recognising the level of risk, policy conflict and lack of enforcement, among others:

[65] See Scottish Climate Survey 2024: main findings.

[66] See this NatureScot Opinion Survey.

National Level	**Policy conflict:** Net-zero ambitions clash with fossil fuel support and misaligned agricultural subsidies. **Slow implementation:** Delays in key legislation (e.g., Biodiversity Strategy, Land Reform) stall progress. **Centralised control**: Power and resources are concentrated at national levels, limiting local action. **Funding gaps**: Ambitious goals lack sufficient investment, especially for nature-based solutions.
Regional Level	**Economic Growth Priorities Over Ecological Limits** **Tay Cities Region Deal (£700m+ investment) focuses heavily on economic growth, infrastructure, and innovation** without sufficient integration of biodiversity or climate objectives. **Regional growth frameworks can often entrench car dependency, urban sprawl, and carbon-intensive development.**
	Underpowered Environmental Agencies **NatureScot and SEPA often lack the regulatory teeth, staffing, or funding** to enforce biodiversity protections or climate resilience in regional planning. **Environmental assessments can be treated as box-ticking** rather than substantial constraints on harmful developments.
	Fragmentation and Lack of Coordination **The Unitary councils within Tayside often operate independently from each other**, leading to piecemeal climate and biodiversity actions without strategic regional integration, although this is now changing with initiatives such as Climate Ready Tayside. **Different political leaderships and priorities can slow unified action**.
	Resource and Capacity Constraints **Unitary Councils often lack staff, funding, and technical expertise** to deliver meaningful climate adaptation, biodiversity enhancement, or enforcement of nature policies. **Many councils rely on external funding** (e.g., Scottish Government's Climate Action Towns fund), which is often short-term and project specific.
	Planning System Weaknesses **Development planning often prioritises housing or commercial needs over ecological protection** (e.g., greenbelt loss). Local plans may include climate and biodiversity language but lack statutory force or monitoring. Unitary Councils have limited power to compel or incentivise private landowners to manage land for climate and nature. **Many policies and decision-making processes do not support or prioritise e.g. adaptation action**
Local Level (Community Councils & Community	Community Councils (CCs) and Community Development Trusts (CDTs) in Scotland play important roles in local democracy and grassroots development. However, they face several structural, financial, and practical challenges that can limit their effectiveness:

Development Trusts)	**Limited Powers and Influence (CCs)** **Advisory Role Only**: CCs have no statutory powers. They can express views on local issues (e.g., planning applications) but are not decision-makers. **Perceived Powerlessness**: Many residents and even members see CCs as symbolic and/or toothless, which can lead to disengagement.
	Volunteer Fatigue and Recruitment Difficulties **Aging Membership**: Many CCs and CDTs rely on older, retired volunteers who often have more time, which can limit long-term sustainability. **Low Engagement**: Recruitment of younger or more diverse members is difficult, often due to lack of awareness or perceived irrelevance. **Burnout**: A small number of active individuals often carry the bulk of the workload, leading to volunteer burnout.
	Funding Challenges **Limited Core Funding**: CCs receive small grants from local authorities and sometimes windfarms, often insufficient for meaningful projects. CDTs often depend on external grants. **Funding Uncertainty**: CDTs often face funding cycles that are short-term and competitive, making long-term planning difficult. **Lack of Capacity to Fundraise**: Smaller or newer organisations may lack the skills or time to apply for complex grants or fulfil grant reporting requirements.
	Bureaucracy and Governance Burdens **Complex Regulations**: CDTs, particularly if they are SCIOs (Scottish Charitable Incorporated Organisations), must comply with strict governance rules, which can be overwhelming for volunteers. **Administrative Load**: Financial reporting, health & safety, and project monitoring can require professional-level skills not always available locally.
	Inequality Between Communities **Capacity Gap**: Wealthier or more urban communities may have more resources and skilled volunteers than deprived or rural areas. **Digital Divide**: Some rural communities struggle with connectivity and/or digital literacy, limiting engagement and participation.
	Relationship with Unitary Authorities **Inconsistency**: Support from local councils varies greatly across Scotland, ranging from strong partnerships to minimal or adversarial relationships. **Tensions Over Decision-Making**: Local authorities may not always act on the recommendations of CCs or may dominate discussions with CDTs
	Community Engagement and Representation

	Low Public Awareness: Many people are unaware of their local CC or CDT, or don't understand their role. **Democratic Legitimacy**: Turnout for CC elections is often very low, which can weaken their credibility. **Inclusivity Issues**: Some councils and trusts struggle to reflect the diversity of their communities, particularly ethnic minorities, young people, and tenants.
	Project Delivery Challenges : Over-Reliance on One or Two Projects: Many CDTs focus heavily on a flagship project (like owning a community building or wind turbine), which can expose them to financial risk if it fails. **Asset Transfer Difficulties**: Acquiring public land or buildings through asset transfer can be slow, complex, and costly.
	Potential for Far-Right Influence: There are concerns that far-right groups may seek to gain legitimacy by infiltrating community councils. This is a serious concern, as it could undermine the democratic legitimacy of community councils and potentially lead to the promotion of harmful ideologies.

4.4.3 Cross-Cutting Structural Issues

Monitoring & data gaps	Fragmentation and lack of robust local and regional data hampers effective biodiversity action.
Land ownership	Concentrated land control impedes coordinated restoration or rewilding.
Climate impacts	Flooding, erosion, and extreme weather already affecting vulnerable ecosystems and infrastructure.
Agriculture	Current practices (e.g., sheep grazing) damage peatlands; reform is politically sensitive.
Rural depopulation	Aging, shrinking populations in remote areas make implementation difficult.

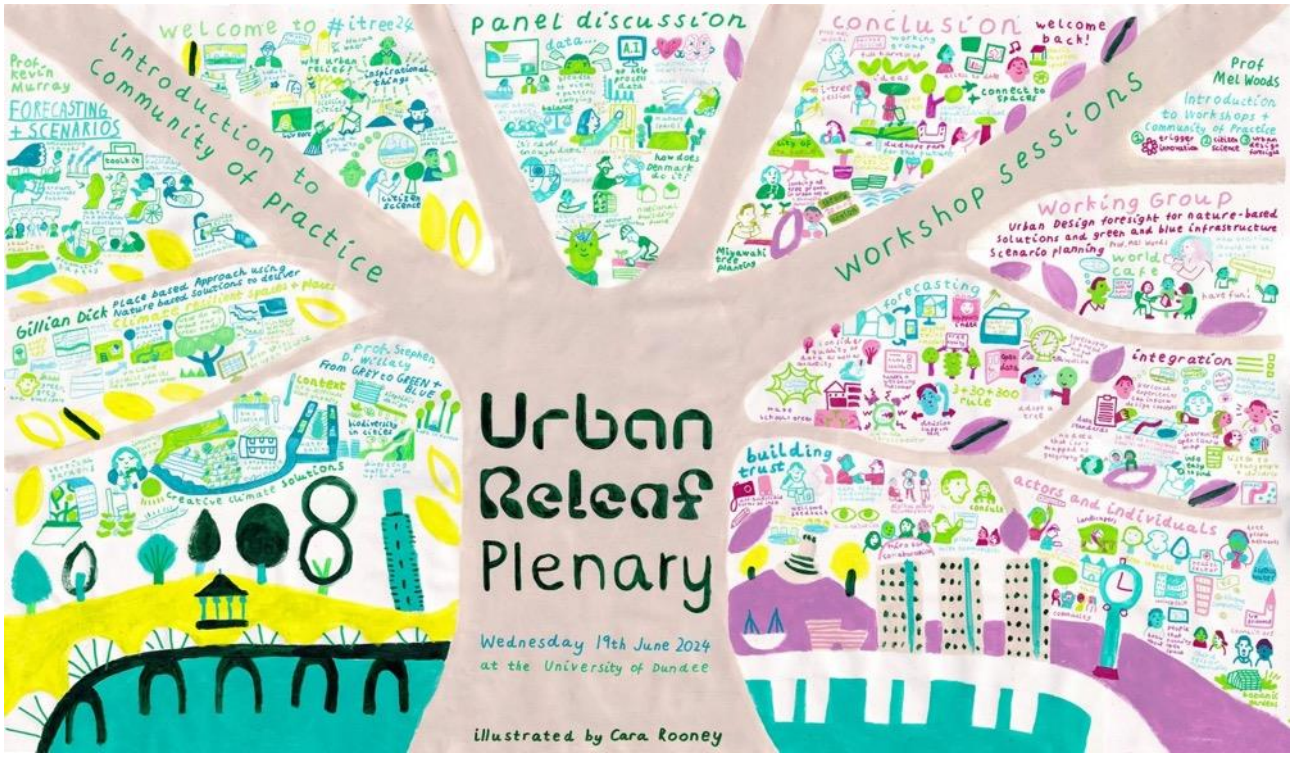
4.4.4 Rural Community Challenges

Short-Term Issues	**Housing crisis**: Affordable homes are scarce, inflated by second homes and tourism demand. **Youth outmigration**: Lack of housing and work opportunities drives younger generations away. **Transport**: Poor public transport and high fuel costs isolate residents. **Aging & services**: Older populations need better care, transport, and heating. **Digital divide**: Weak broadband and mobile signal hinder remote work and education. **Economic strain**: Farming faces ecological and market pressures; energy transition stirs local opposition. **Health & wellbeing**: Staff shortages and social isolation affect mental and physical health.

Long-Term Risks	**Net-zero upgrades**: Retrofitting old homes is expensive and difficult. **Land reform tensions**: Efforts to democratise land face opposition and red tape. **Community sustainability**: Without improved services and opportunities, depopulation will continue.

4.4.5 Urban Community Challenges (Dundee as Key Example)

Social and Economic Inequality	**Poverty**: High child poverty and food/fuel insecurity affect much of Dundee. **Fuel poverty**: Poor housing insulation worsens energy costs. **Substance abuse**: Scotland's highest drug death rate is in Dundee. **Mental health**: Demand for services has surged post-COVID.
Youth, Education & Community	**Education inequity**: Poverty impacts attainment; university financial struggles risk jobs and morale. **Youth disengagement**: Social unrest signals deeper alienation.
Infrastructure & Services	**Transport issues**: Bus services are unreliable, especially at night. **Housing shortfall**: Affordability and availability are declining. **City centre decline**: Retail shift and high street vacancies weaken community hubs. **Climate readiness**: Adaptation plans are early-stage and underfunded. **Energy inefficiency**: Many homes lack insulation; poor communities bear the brunt.



Urban Releaf, Dundee aims to use citizen science to map and improve the City's green spaces, illustration Cara Rooney

4.4.6 Future Challenges Across the Region

Economic Stability	**University risk**: Dundee University's potential decline due to financial troubles could impact the region's economy and innovation. **Skills gap**: Life sciences and digital sectors need targeted upskilling. **AI:** Displacement of jobs
Infrastructure & Inclusion	**Transport upgrades**: Better road links and expanded public transit needed. **Affordable housing**: Key to retaining families and growing communities. **Health system reform**: Community care models need scaling to relieve NHS strain. **Mental health support**: Continued investment and stigma reduction essential. **AI:** Risk of reinforcing systemic biases.
Environmental Planning	**Climate adaptation**: Urban plans must integrate resilience to flooding, heatwaves, etc. **Home retrofits**: Large-scale energy efficiency programs critical to meeting net-zero goals.

Regional Growth Gaps

Under performance	**Dundee's unemployment is high**, growth lags behind national averages.
Persistent inequality	Despite "inclusive growth" rhetoric, **disparities remain entrenched**.
Delivery risks	**Inflation, delayed approvals, and capacity** limits threaten regional deal success.
Governance needs	**Stronger regional institutions and clearer coordination are essential.**
Digital inclusion	**Gaps in rural broadband and 5G** limit access and growth.
AI	**Risk of widening rural/urban divide.**
A strategy for 'Thriving Within Limits' is still forming	A cohesive environmental action plan is still nascent.

Undernourished Culture

Art, culture, and spirituality ground bioregioning in the human heart and soul, not just in maps and policies. They create the inspirational, imaginative, emotional and ethical scaffolding for communities to reinhabit their places in regenerative, meaningful ways.

In the Tay Bioregion, many longstanding rural cultural practices remain strong, such as agricultural shows, traditional dancing and community theatre, especially musicals. Food and drink events and festivals of various kinds are also very much part of the rural and urban cultural life of the region, although largely generated as a visitor attractor rather than a celebration of key moments in the seasonal year and a way to build community and social interaction, as they were in past times. The 'regeneration through culture' narrative has enabled significant investment in capital infrastructure in both Perth and Dundee, but in both rural and urban areas artists and arts organisations remain overextended and undercapitalised'

V&A Dundee, photo Wikimedia Commons

Key drivers for this fragility are:

Funding and Financial Sustainability	**Significant capital spends on flagship cultural buildings in main urban centres** (V&A Dundee, proposed Eden project, new Perth Museum[67]), **but day-to- day operating funding has not kept pace** **Difficulties in generating sustainable income** from ticket sales, commissions, or donations. **Cuts to local authority budgets** affecting arts provision and support especially in rural areas. **Reliance on volatile public funding** (e.g., Creative Scotland, local councils) which is often limited or uncertain
Access to Space and Infrastructure	**Lack of affordable, accessible rehearsal, studio, and performance spaces** for artists and creative practitioners of all kinds. **Pressures from rising property costs** or regeneration (especially in urban areas like Dundee). **Rural cultural venues and libraries being closed** by Unitary Authorities[68]
Audience Development and Engagement	**Reaching diverse or disengaged audiences**, including younger people, minorities, and low-income communities. **Few arts education or creative opportunities in schools'** limits future artist and audience development. **Cost of living crisis** is leading to decreased attendance at many arts events.

[67] See this report here in the Museum Journal.

[68] See this report here from the Museums Journal.

Visibility and Promotion	**Difficulty getting coverage** in national media or gaining recognition beyond the local region. **Limited marketing budgets** or expertise in digital promotion.
Rise in secularism	**As in much of the western world, interest in mainstream Christian religions is dwindling** because of the dominance of scientific materialism, changing demographics and social values and a cultural shift away from organised religion. Many Church of Scotland Kirks, once key hubs of community life are being closed and sold.

Continued Urban Rural Disconnection

A disconnection from place	**The urban populations of the Bioregion often live with little awareness of the ecological systems (e.g., watersheds, foodsheds, climate patterns) that sustain them**. Urban and rural areas are treated as separate subsystems (economically, socially, politically), yet they are deeply interdependent. Cities cannot survive without the ecosystem services and resources from rural lands, yet these flows are rarely coordinated holistically.
Loss of feedback loops	**Bioregioning values direct relationships between people and their environment**. When cities are distant from their bioregional context, their impacts - such as pollution or overextraction - are externalized to rural areas, breaking natural feedback mechanisms that might otherwise regulate behaviour.
Cultural fragmentation	**Rural communities often preserve traditional ecological knowledge and practices tied to land stewardship**. As urbanisation dominates culture, these lifeways can be undervalued or lost.
Resource and power imbalances	**Urban areas often hold economic and political power**, while rural areas are exploited for resources without adequate reinvestment or local control.
Leverage points ignored	**Opportunities for transformation (e.g., integrating rural stewardship with urban planning, decentralising resource systems) are overlooked** due to siloed thinking and governance.

4.4.7 Response initiatives underway

To respond effectively to the complex, interwoven crises described - climate change, biodiversity loss, social inequality, governance dysfunction, and community disempowerment - we must adopt a bioregional and systems-based approach that foregrounds place, human-biotic interdependence, and systemic transformation.

Reframing the Problem: Seeing the Whole System

From a systems thinking perspective, the polycrisis is not a series of isolated challenges but a network of reinforcing feedback loops - economic systems drive ecological degradation, which weakens social cohesion, which in turn impedes effective governance and adaptive capacity. Addressing individual symptoms in isolation (e.g., housing, flooding, education) without tackling root causes and system interdependencies will not yield lasting change.

Examples of initiatives that are exemplifying this

SPOTLIGHT: **Climate Ready Tayside (Regional Adaptation Partnership)** is a new partnership bringing together public, private and community organisations to prepare people and places for a thriving future, in our changing climate. It is embedding a systems approach by looking at regional scale adaptation via multi-stakeholder collaboration, holistic stakeholder engagement and inclusive governance, undertaking cross sector risk and vulnerability assessments, building leadership and shared learning and integrating nature-based and community-led solutions.

SPOTLIGHT: Aberfeldy Healthiest Town is a community-driven initiative dedicated to improving physical, mental, social and environmental wellbeing for everyone in the town of Aberfeldy. Inspired by the Blue Zones approach, their work aims to create a place where it's easy for everyone to live a healthy, fulfilling life.

Bioregional Stewardship: Grounding Solutions in Place

A **bioregional lens** reframes governance, development, and adaptation within the unique ecological, cultural, and economic realities of the region. Rather than applying generic top-down policies, it emphasizes:

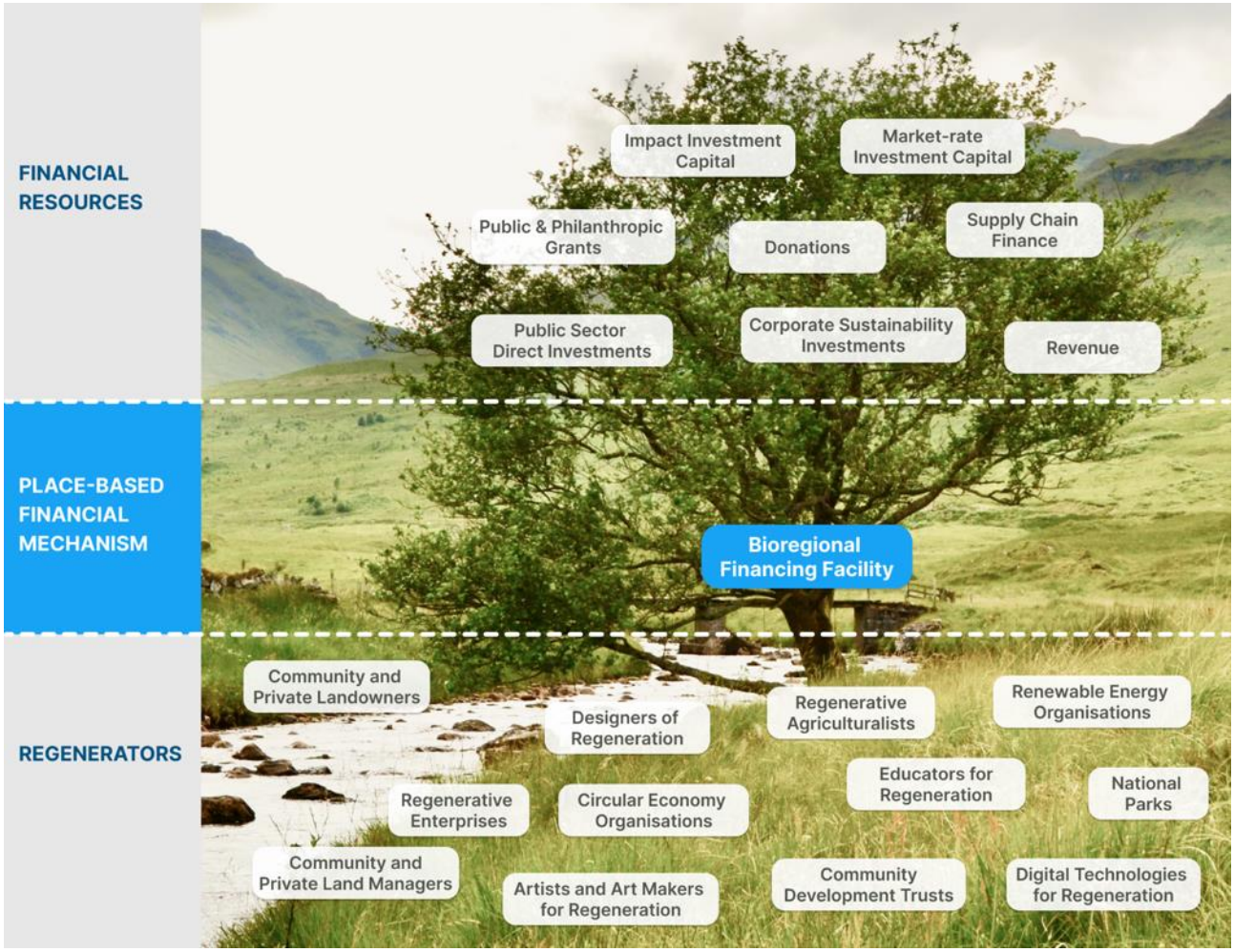
- **Ecological literacy** at all levels (schools, communities, planning processes).
- **Land-based identity** and stewardship, linking people's wellbeing with local ecosystems.
- **Living within ecological limits**: Shifting economic priorities from GDP growth to biocapacity, regeneration, common wealth (in the true meaning of the word) and sufficiency.

Examples of initiatives that are exemplifying this

SPOTLIGHT: **Comrie Croft** is a farm, reimagined for the 21st Century, comprising 231 acres of wild woods, flower meadows, a market garden and repurposed farm buildings. The Croft describes itself as a family of twelve collaborating nature-based micro-enterprises employing over forty local people. Five of these businesses are owner managed. Comrie Croft Ltd - the mothership in the family - is a certified B-Corp owned by fifty local people, employees, family and friends.

SPOTLIGHT: Dundee Eco-Schools: Eco Schools is a global programme designed to encourage a whole school approach to Learning for Sustainability, encouraging young people to engage in their environment by allowing them the opportunity to actively protect it. As part of the Dundee Climate Action Plan, the City are actively increasing participation in the Eco Schools programme through improved local support and engagement.

SPOTLIGHT: Bioregioning Tayside's Bioregional Financing Facility (BFF): See Part 3 of the Framework For Action for further detail on the proposed new governance structure for the Tay Bioregion. BFF's are a new layer in the global financial architecture that stewards financial resources to support strategically coordinated portfolios of regenerative projects and organisations working to shift systems.



The architecture of a Bioregional Finance Facility, graphic Dark Matter Labs

Transforming Governance: From Extractive to Regenerative

Governance structures rooted in extractivist logic that privilege territorial control and hierarchical authority need to evolve toward **distributed, polycentric systems** that honour ecological boundaries, reflect local knowledge and empower communities.

This involves:

- **Decentralising power** and enabling communities to make place-based decisions.
- **Reforming funding models** to support long-term, integrated and regenerative outcomes.
- **Embedding systems thinking in policymaking**, to reduce fragmentation and policy contradiction.
- Investing in Augmented and Assistive AI that supports wise action in the service of life

Regional structures (like City Deals) must be redesigned to serve **ecological resilience** and **community wellbeing**, not just economic growth.

Examples of initiatives that are exemplifying this

SPOTLIGHT: Local Place Plans are community-led plans that outline how land should be developed and used within a specific area. Introduced by the Planning (Scotland) Act 2019, these plans empower communities to actively shape the future of their places by expressing their aspirations

for development and land use. Once registered with the local council, LPPs are taken into account during the preparation of the local development plan. See Blairgowrie & Rattray's Local Place Plan as an example.

Empowering Local Communities as System Actors

Community Councils and Development Trusts need to be supported not as token stakeholders but as **core agents in systems change**:

- Build **long-term capacity**, not just project-based support.
- Increase **democratic legitimacy** and representation.
- Foster **inter-community learning** and regional coordination for shared ecosystem challenges.
- Address **inequities in digital, financial, and technical resources** to ensure all communities can participate meaningfully.

Examples of initiatives that are exemplifying this

SPOTLIGHT: Strathmore Resilience Alliance, a new network made up of community resilience groups from the towns and villages of Alyth (Development Trust), Eassie Nevay and Kirkinch (Community Hall), Blairgowrie & Rattray (Community Council), Meigle & Ardler (Development Trust) and Kettins (Community Hub) who share learning and support.

SPOTLIGHT: Transition Dundee is a community-led social enterprise on a mission to help make Dundee a more sustainable, healthy and happy place to live, enabling future generations and the environment to flourish. They do this through various climate-focussed projects, building knowledge, awareness & community.

Culture Shift Through Education and Participation

A just transition requires a **cultural transformation**, which starts with:

- **Education for systems thinking** and ecological citizenship at all levels.
- **Narratives of interdependence** and regeneration replacing consumerist norms.
- Support for **culture and heritage work** that connects people to place.

Public awareness must evolve into **deep ecological understanding** and agency to act, individually and collectively.

Examples of initiatives that are exemplifying this?

SPOTLIGHT: Climate Café's, an initiative which began in the Tay Bioregion and which is now spreading across the world, are open, inclusive spaces for people to get together to talk and act on climate change. They are community led, informal spaces where everyone is welcome to join the conversation and get involved, creating a space to bring people together from across communities, work places and campuses to focus on solutions. Many people find them inspiring and positive spaces to connect with others. There are currently around 15 Climate Cafe's in the Bioregion.

SPOTLIGHT: The Cateran Ecomuseum is a 'museum without walls' set across 1,000 sq. km's of eastern Perthshire and western Angus. It tells the story of this part of Bioregion across 6,000 years

of human history and 400 million years of geological history. Made and managed by the local community, in addition to offering 24 pre-designed (mostly) walking and cycling itineraries, from 2021 - 2024 it ran a ground breaking programme that linked heritage to climate action. Called the 'Museum of Rapid Transition', the programme aimed to showcase the huge, currently under-utilised potential that our heritage has to help people build more regenerative and resilient lifestyles and mobilise climate action - "Not only are they a knowledge & learning resource which can help contextualise what is happening, they are a participative force which can bring people together, challenge the status quo and, create spaces both physically and in our minds to imagine that anything is possible."

Scenes from The Awakening, a special multimedia landscape scale art commission for Glasgow's COP26, where local communities gathered in Glenshee for a symbolic ceremony to awaken the giant Finn mac Cumhaill, closely linked with the Glen. At this event, a Pictish war horn, the Carnyx, was sounded three times - the signal Scottish giant Lore tells us will awaken the giant to come to our aid, Photos Dylan Drummond.

SPOTLIGHT: Bioregioning Tayside's Communities Monitoring Landscape Change work, which aims to chart how communities in Tayside can help monitor landscape change through community science practices.

Catalysing Regenerative Economies

Economic systems must shift from extractive growth toward **regenerative local economies** grounded in the region's ecological capacity. This means:

- Localising food systems and supporting agroecology.
- Restoring land and watersheds through **community-led rewilding and land reform**.
- Developing **inclusive, low-carbon industries** tailored to local skills and needs (e.g., repair economies, renewable energy cooperatives).

Examples of initiatives that are exemplifying this

SPOTLIGHT: **The James Hutton Institute's new New Crop Innovation Centre** located at Invergowrie, will futureproof crop production and enhance food security for the UK and beyond. The CIC is home to the Advanced Plant Growth Centre (APGC) and the International Barley Hub (IBH), which were created in partnership with the University of Dundee Plant Sciences Division. The Centre offers a unique combination of world leading science and state of the art facilities for field, farm and lab that deliver technological and digital innovation focussed on future proofing crop production, enhancing food and drink security, managing our natural resources sustainably and supporting thriving rural communities in Scotland and across the globe.

SPOTLIGHT: Feeding Tayside Through The Climate Crisis is a programme of work co-ordinated by Bioregioning Tayside that aims to support food systems transformation in the Tay Bioregion. Begun in 2023, it has identified and is taking action on:

- the goals and vision needed in Tayside
- the enabling conditions for triggering systemic social tipping points (where behaviour change spreads quickly from a minority to a majority)
- the positive/reinforcing behaviours throughout society we will need to activate
- the interventions that will drive behaviour change
- the actors who can accelerate or hamper the change we need

SPOTLIGHT: The River Ericht Catchment Restoration Initiative is a landscape-scale nature restoration initiative in the heart of Tayside, Scotland. Working alongside landowners, farmers, businesses, communities, educational institutions, and relevant statutory bodies, our aim is to sequester carbon, increase biodiversity, improve water quality, mitigate extreme weather and save the Salmon, enabling the lives and livelihoods of all those that depend on the waters of the Ericht to thrive now and in the future.

SPOTLIGHT: Bell Street Green Travel Hub Dundee is a new green travel facility which will be operated by Angus Cycle Hub CIC and designed to help support people to change travel habits for the future. A bike and wheeled sports skill park, regional bike reuse centre and cycle lending scheme will all be available to the public. Planned facilities and programmes will include:

- Bike and Wheeled Sports Skills Park: Indoor modular cycle training space and pump track for bicycles, BMX, scooters, adaptive bikes, and early years cycling education.
- Regional Bike Reuse Centre: Refurbishment, sale and redistribution of up to 4,000 bikes annually through existing recycling agreements.
- Public Bike Library & Leasing Scheme: Affordable subscription model for residents, students, visitors and low-income users.
- Cycle Shop & Servicing: Retail and repair services to support local cycling and generate income to make the project sustainable.
- Secure Public Cycle Storage and Amenities: 150+ secure bike spaces.
- Cargo Bike and Ebike Hire: Low-carbon urban logistics and mobility options.

SPOTLIGHT: Perthshire Artisans is a curated platform promoting local, ethical small creative businesses and offering peer mentoring and support.

Integrated Action Across Scales

Bioregional governance works by aligning **top-down support with bottom-up initiative**, through nested systems:

- National governments must **enable local action**, not overrule or under-resource it.

- Regional entities must act as **integrators** - weaving ecological, social, and economic threads into cohesive strategies.
- Communities must be **empowered as stewards**, not recipients of distant policies.

Cross-scale coordination and **feedback mechanisms** (e.g., participatory monitoring, adaptive learning) are vital.

Examples of initiatives that are exemplifying this

SPOTLIGHT: Bioregioning Tayside is a new platform which is bringing people in Tayside together to build community resilience in the face of:

- global heating – with major implications for survival of life as we know it,
- a sixth mass extinction of plants and animals driven by us, which is collapsing biodiversity and threatening the food webs we depend on
- a broken economic model – which is fuelling the climate crisis and biodiversity collapse and resulting in increasing social injustice and mental ill health

This first draft of Part 1 of the Framework For Action For The Tay Bioregion was completed in December 2025. It marks the first iteration of a Bioregional approach to regenerating the Tay Bioregion.

Parts 2 and 3 are still in development.

Each part is being offered as a living framework - dynamic, evolving, and responsive to new knowledge and changing conditions.

We are now actively seeking responses to Part 1 from a wide range of communities of interest and place in Bioregion.

Please contact us on bioregioningtayside@gmail.com if you would like to share your views.