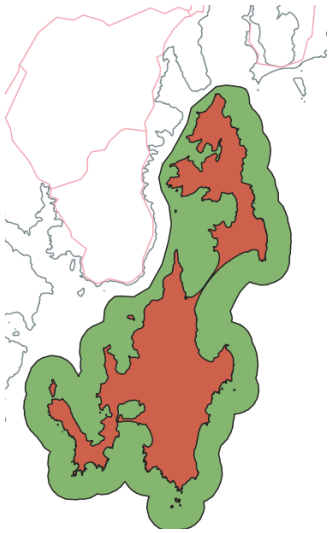
Candidate environmental-economic accounts for Bruny Island

Bruny Island environmental-economic accounting workshop, 30th April and 1st May 2019, UTas

Throughout the 2 days of the workshop many potential accounting topics and data sets were discussed. Appendix 1 is a (non-exhaustive) listing. Note that while the workshop used the lens of ***tourism***, many of the accounts would have value for answering other issues and policy challenges. The workshop proceeded to work on framing up a selected set of potential accounting topics.

From an accounting perspective, each accounting topic (subject) needs to be clearly defined. The workshop adopted the BoM's *account framing* approach, which has eight modules that must be completed for each account. At its heart, the approach requires each account to define it purpose (*why*), who will be involved (*who*), what the subject is (*what*) and have a documented description (*conceptual model*). The accounting conceptual model needs to identify (1) the *asset* and any internal flows (*intra-ecosystem flows*), (2) the *flows to* the asset, such as system change drivers, pressures and intra-ecosystem biophysical flows, and (3) the *flows from* the asset, including ecosystem services (provisioning, regulating and cultural) and intra-ecosystem biophysical flows.

For reference, the figure below indicates the area likely to be covered for accounting purposes.
Brown is the terrestrial area and **green** is the marine area, that is, the 3 km of marine waters closest to the land and, for the narrower part of the D'Entrecasteaux Channel, halfway to the far shore.



The accounting topics selected for framing cover a range of 'natural assets' including tracking changes in:

1. **marine habitats** (e.g. recreational fishing sustainability, changes in marine water quality, such as nitrogen levels)
2. **terrestrial habitats** (e.g. long-term forest cover changes, changes in area of protected/covenanted land, changes in land uses),
3. **native species**, the 'health' and value of the plant and wildlife species (e.g. a possible roadkill account, impact of cat management, value of threatened and endemic species plus more),
4. **coastal landforms and habitats** (e.g. coastal erosion, saltmarsh changes and salt intrusions into aquifers),
5. **potable water** supply (from the coastal groundwater aquifer)
6. **Bruny's 'nature' in the broad**. This one is about understanding and tracking things that represent the general sense of Bruny as a natural place for visitors and residents - how to ensure that the things that draw people to Bruny are maintained - how to strengthen the Bruny brand. In environmental accounting terms, this is about measuring the flow of ecosystem services to visitors and residents and, where possible, the stock of underlying natural assets with the capacity to provide those flows. It would draw on the other accounts for some data.

The following sections deal with each of these topics in turn, setting out a preliminary response to the *who*, *why* and *what* of each topic as well as making a start on a basic description of the system from an accounting perspective (i.e. an *accounting conceptual model*).

1. Marine habitats (the sea)

Why

Track the sustainability of recreational fishing stocks. Track the impact of aquaculture

Who

Accounts users: regulators, residents, shack owners, businesses (ecotourism, accommodation, fishing), SeaLink, Account producers: UTas, IMAS, government, aquaculture industry, fishing industry.

What

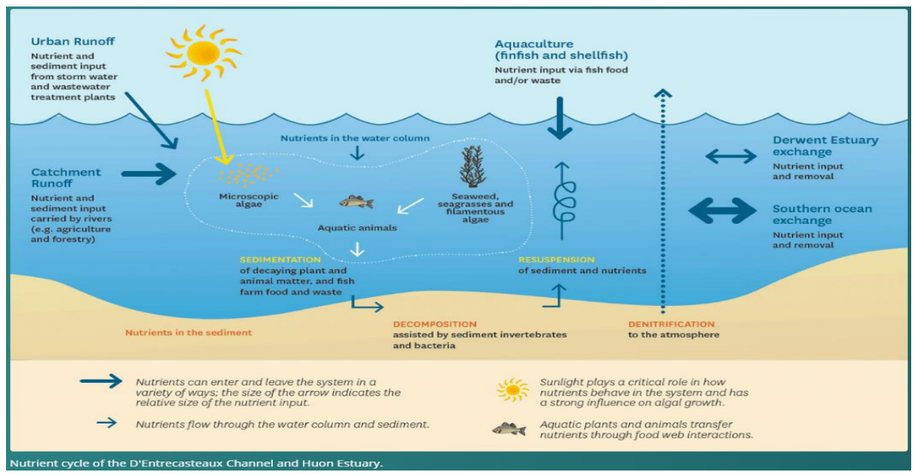
The marine habitats surrounding Bruny Island including the sea floor and the water column above

Description (accounting conceptual model)

The marine habitat asset of Bruny island is defined to include all marine habitats below the high-water mark and within 3 kilometres of Bruny's coastline, that is, down to approximately 50 metres depth. The habitats include the rocky reef, soft-sediments, sand, seagrass and water column habitats that are the ecosystems that support the exceptionally rich biodiversity in the marine waters surrounding Bruny Island. It is the ecological functioning of the biodiversity in these habitats that enable these ecosystems the capacity to provide ecosystem services to people, including bountiful recreational and commercial fishing, supporting aquaculture, clear waters for diving and swimming and a sense of being surrounded by vibrant nature. There are many things that can influence the functioning of the marine habitats, for example, changes in nutrient levels (e.g. changes in nitrogen availability) and the effects of fishing.

The table below sets out many of the flows to and flows from the marine habitats. This approach is helpful for identifying topics suitable for accounting purposes, that is, tracking change that is relevant to the management of the asset. While there are a great many potential topics that could be tracked, in reality, resources (money, people and time) are limited so pragmatic, careful choices must be made to select topics that are relevant, can credibly indicate change and, to ensure legitimacy, are understandable and meaningful to those using the account, in this case, a wide range of people.

*Table 1 Marine habitats accounting conceptual model. Potential stocks and/or flows that could be measured are highlighted in **bold.** All flows must be related to the accounting topic i.e. the asset.*

Flows to *Marine Habitats* (includes change drivers, direct pressures, activities, events, change agents, biophysical flows from other ecosystems)	*Marine Habitat* **Asset** (includes stock and intra-ecosystem biophysical flows)(you *must* identify the asset and its boundary)	**Flows from** *Marine Habitats* (includes ecosystem services and biophysical flows to other ecosystems)
❖ Human fishing ➢ **Recreational fishing pressure** ➢ Commercial fishing pressure ➢ Management controls (bag limits, **protected areas** etc.) ❖ Boating traffic ➢ Boats, jet skis, disturbance, congestion, wake impacts ❖ Aquaculture ➢ **Nutrient flows (fish food, fish waste)** ➢ Fish escapes ➢ Pest sources ➢ Noise ❖ Land based flows ➢ Storm water and sewage runoff ➢ Freshwater inputs (increased or decreased) ➢ Plastic waste ➢ Agricultural runoff (nutrients, toxicants) ❖ Climate and its variability ➢ Major events (storms, wave climate, tsunami) ➢ Shifts in climate regime ❖ Flows from other ecosystems ➢ Nutrient and toxicant inputs (Derwent and Huon Rivers, oceanic inputs) ➢ Species shifts (long spined sea urchin, 'tropical' species) ➢ Pelagic species (blue fine tuna, whales) ➢ Gene flows (endemic, native and pest species) ➢	❖ **Marine habitats** (rocky reef, soft-sediments, sand, seagrass and waters) that are the ecosystems that support the exceptionally rich biodiversity in the marine waters surrounding Bruny Island. Includes all marine habitats to approximately 50 m depth and within 3 km of the Bruny Island shoreline. ❖ The **biodiversity** that lives in the habitats ❖ The functioning of the biodiversity (habitats, wildlife, plants and seaweeds) that self-sustains the ecosystems (intra-ecosystem flows) ❖ General note: Under the influence of the *flows to* the *ecosystem asset*, the *asset* has the *capacity* to produce the *flows within* and *flows from* the asset  *Figure 1 marine nutrient cycle conceptual model, D'Entrecasteaux Channel & Huon Collaboration report card 2019*	❖ Ecosystem Services ➢ Provisioning services ▪ **Recreational fishing take** (flathead etc.) ▪ Commercial fishing take (?) ▪ Aquaculture production (salmon, **oysters**) ➢ Regulating services ▪ Wave climate (e.g. seagrass dampens of wave action) ▪ Nutrient absorption and filtering ▪ Sediment and toxicant dispersal ▪ Water exchange (tidal and current flushing rates) ➢ Cultural services ▪ Recreational fishing (shore-based, boats) ▪ Wildlife (eco) tourism (experiencing intact ecosystems etc.) ▪ Boating: sailing, kayaking, water skiing ▪ Swimming, diving ▪ Sense of place ▪ Scenic amenity ▪ Scientific research ▪ Real estate values ❖ Flows to other ecosystems ➢ Biodiversity maintenance flows ➢ Insurance and recovery population transfers ➢ Gene flows (endemic, native and pest species) ➢

Candidate accounts (in **bold** above)

Recreational fishing flow account, marine water column nutrient flow account, marine habitats stock account, protected areas

Data sources

Marine Resources, Tasmania. RED map, IMAS; fish assessments, IMAS; marine water modelling, IMAS/CSIRO; environmental impact assessments; reef life survey;

2. Terrestrial habitats (the land)

Why

To understand and better manage the challenges of maintaining healthy habitats that is the natural capital that supports the people and wildlife of Bruny Island. Tracking the changes in land use helps inform decisions about development and use of the land.

Who

Account Users: residents, shack owners, Kingborough Council, State government agencies (SST, PWS, DPIPWE), forest managers, tourism businesses, agricultural businesses, infrastructure managers (roads, tracks, power etc.). Account producers: UTas, CSIRO, Forest Practices Authority, Parks & Wildlife

What

Tracking changes in the terrestrial (land) habitats of Bruny Island including changes in management regimes (e.g. declaration of protected areas, covenanted private land, changed land uses), physical changes (e.g. land clearing, regeneration, fire).

Description (accounting conceptual model)

The terrestrial (land) habitat asset of Bruny Island includes all the land except the coastline (i.e. the intertidal zone of and the areas immediately adjacent that are strongly influenced by salt spray). The asset includes the vegetation, soil, geology and water that provide places for people and the wildlife to live and enables the ecosystems to function and maintain the extraordinary variety of environments and biodiversity. The land provides flows of ecosystem services to people from food (fish, agriculture) and fibre (timber, firewood) to pleasing places to live (including beautiful views, shelter from winds). The land is also subject to drivers and pressures of change, such as changes in vegetation management (e.g. land clearing, controlled burning), changes in the climate (rainfall, temperatures) and changes in levels of conservation protection (e.g. private protected areas and national parks).

The table below sets out many of the flows to and flows from the terrestrial (land) habitats. This approach is helpful for identifying topics suitable for accounting purposes, that is, tracking change that is relevant to the management of the asset. While there are a great many potential topics that could be tracked, in reality, resources (money, people and time) are limited so pragmatic, careful choices must be made to select topics that are relevant, can credibly indicate change and, to ensure legitimacy, are understandable and meaningful to those using the account, in this case, a wide range of people.

*Table 2 Terrestrial (land) habitats accounting conceptual model. Potential stocks and/or flows that could be measured are highlighted in **bold.** All flows must be related to the accounting topic i.e. the asset.*

Flows to *Terrestrial (land) habitats* (includes change drivers, direct pressures, activities, events, change agents, biophysical flows from other ecosystems)	*Terrestrial (land) habitats* **Asset** (includes stock and intra-ecosystem biophysical flows)(you *must* identify the asset and its boundary)	**Flows from** *Terrestrial (land) habitats* (includes ecosystem services and biophysical flows to other ecosystems)
❖ Human activities and management policies ➢ Agricultural policies ▪ Land clearing ➢ Conservation policies ▪ Private and public **protected areas** ▪ Pest management (cats, feral animals, weeds) ➢ Tourism ➢ Fire management ➢ Forestry ❖ Climate and its variability ➢ Climate variability ▪ changing rainfall patterns ▪ changing temperatures ➢ Earlier onset of fire season ❖ Flows from other ecosystems ➢ Biophysical ▪ Arrival of migratory species ➢ Gene flows ▪	❖ All the **terrestrial (land) habitats** of Bruny Island including the **forests**, heathlands, wetlands, freshwater systems and grasslands that are the basis of the ecosystems that support the rich land-based biodiversity of Bruny Island. It also includes the human habitats of farmland and residential areas. It includes threatened vegetation communities. ❖ The **biodiversity** that lives in the habitats including species-level (richness, beta diversity) and ecosystem-level biodiversity. ❖ The **functioning of the biodiversity** (habitats, plants and wildlife) that sustains the ecosystems (intra-ecosystem flows). This includes the variety of **land uses** that maintain conservation, agricultural, forestry, residential, commercial, transport and utility (water, power) functions. It includes the integrity (connectedness and condition) of landscape scale functioning (e.g. **forest integrity**). ❖ General note: Under the influence of the *flows to* the *ecosystem asset*, the *asset* has the *capacity* to produce the *flows within* and *flows from* the asset	❖ Ecosystem Services (to people) ➢ Provisioning services ▪ Meat and fibre production ▪ Water ▪ Carbon reservoir ▪ Timber ▪ Firewood ▪ Honey ➢ Regulating services ▪ Climate regulation (shading, cooling, wind shelter, carbon sequestration) ▪ Flood regulation ▪ Freshwater regulation (groundwater recharge, stream water quality) ➢ Cultural services ▪ Wildlife (eco) tourism (experiencing intact ecosystems etc.) ▪ Recreation (walking, photography, etc.) ▪ Sense of ‘nature’ (amenity) ▪ Landscape views ‘typical’ of Bruny ▪ Scientific research ▪ Cultural heritage (indigenous, European historical etc.) ▪ Real estate values ▪ Intrinsic and existence values ❖ Flows to other ecosystems ➢ Biophysical ▪ Departure of migratory species (e.g. swift parrots) ▪ Sanctuary for species at risk in other locations (insurance value) ➢ Gene flows ▪ Maintenance of threatened species genetic diversity

Candidate accounts (in **bold** above)

Terrestrial habitats stock and condition account (see Appendix 3 for an example table), forest stock account, biodiversity stock account, forest integrity stock account, land use stock account, protected areas stock account, threatened vegetation communities stock account, ecosystem service accounts (TBC)

Data sources

Satellite data (MODIS, Landsat etc.); National Forest Inventory, National Carbon Accounting System; CSIRO biodiversity modelling (beta diversity); land use data (LISTmap); vegetation mapping, TasVeg; Forest Practices Authority, Tonia Cochrane, Inala;

3. Native species (the native plants and animals)

Why

To understand and track changes in the stocks and condition of native species, including threatened species, to support improved management of the asset.

Who

Account users: State and Local government, Parks and Wildlife, citizens, BIEN, tourism operators (particularly ecotourism operators), NRM South, Forest Practices Authority

What

The native species of the plants and wildlife of Bruny Island including their population dynamics and changes in their sustainability over the long term

Description (accounting conceptual model)

The native species (plants, animals and insects etc.) are an integral part of the extraordinary variety of ecosystems on Bruny Island. They are of interest to people in their own right (swift parrots, forty-spotted pardalotes, the 12 endemic bird species, whales etc.) and are also key to continued effective functioning of the ecosystems (e.g. top predators, such as quolls on land and seals in the sea).

The table below sets out many of the flows to and flows from the native species. This approach is helpful for identifying topics suitable for accounting purposes, that is, tracking change that is relevant to the management of the asset. While there are a great many potential topics that could be tracked, in reality, resources (money, people and time) are limited so pragmatic, careful choices must be made to select topics that are relevant, can credibly indicate change and, to ensure legitimacy, are understandable and meaningful to those using the account, in this case, a wide range of people.

Table 3 Native species *accounting conceptual model. Potential stocks and/or flows that could be measured are highlighted in* ***bold.*** *All flows must be related to the accounting topic i.e. the asset.*

Flows to *Native species* (includes change drivers, direct pressures, activities, events, change agents, biophysical flows from other ecosystems)	*Native species* **Asset** (includes stock and intra-ecosystem biophysical flows)(you *must* identify the asset and its boundary)	**Flows from** *Native species* (includes ecosystem services and biophysical flows to other ecosystems)
❖ Human activities and management policies ➢ Impact on wildlife habitats (positive enhancement (e.g. installing nest boxes, protection of habitat etc.) or negative effects (e.g. destruction or modification of habitats) ➢ Disturbance, mortality and trampling (noise, traffic, people encroaching on native species) ➢ Human pest management activities ➢ Fish catch management ➢ Maintenance of Bruny Island sanctuary status (e.g. restricting introductions of damaging species (sugar gliders etc.) ➢ Enhancing survival of threatened species (threatened species programs) ❖ Pest species ➢ Pressure on native species by introduced species of interest such as weeds, **cats** and deer ❖ Climate and its variability ➢ Effect of changing climate on native species ❖ Flows from other ecosystems ➢ Biophysical ▪ Migrations or dispersal of native species to Bruny Island ➢ Gene flows ▪ Migrations or dispersal of native species to Bruny Island	❖ The **native species of Bruny Island** including all marine and terrestrial native species, including plants, animals and invertebrates. These include specific endemic species, such as the **12 Tasmanian endemics**, and **threatened species**, such as the swift parrot and 40 spotted pardalote. It also includes common species of interest, such as wallabies, **seals**, fish and **quolls,** and other species of interest, such as butterflies, orchids and frogs. ❖ The ecological **functioning** of the native species includes the population dynamics of each species (e.g. births, deaths, recruitment, **abundance** etc.) and likely persistence (survival, sustainability, resilience to change etc.). It could also include interactions between native species e.g. predator-prey relationships. ❖ General note: Under the influence of the *flows to* the *ecosystem asset*, the *asset* has the *capacity* to produce the *flows within* and *flows from* the asset	❖ Ecosystem Services (to people) ➢ Provisioning services ▪ Fish species (recreational and commercial) ➢ Regulating services ▪ Maintaining native species population dynamics (e.g. via predator-prey relationships) ➢ Cultural services ▪ Knowing about the status of threatened species ▪ Recreational activities (diving, bird watching, interactions with iconic species (e.g. eagles, white wallabies etc.) ▪ **Wildlife (eco) tourism** (bird and seal watching etc.) ❖ Flows to other ecosystems ➢ Biophysical ▪ Migrations or dispersal of native species from Bruny Island ➢ Gene flows ▪ Migrations or dispersal of native species from Bruny Island ▪

Candidate accounts (in **bold** above)

Cat stock account, roadkill flow account (see below), species stock accounts, threatened species stock account, ecotourism cultural ecosystem service flow account (note: individual species can be treated as SEEA Central Framework stock accounts; see Appendix 4 for an example Butterfly stock account, a threated species stock account for the Great Barrier Reef (ABS) and an example single species stock account table. The Wentworth Group NRM Accounting for Nature methods are useful here.)

Data sources

Cat management data; Cyril Saropam, UTas PhD student wildlife camera trapping data; Citizen science; UTas, IMAS, TLC, Birdlife Tas, Inala, festivals(?); SES

Roadkill flow account

WHY

- Management policies may be needed because: damage to cars and people in accidents; concern for animal suffering; distastefulness of roadside carnage; ecosystem impacts through increased mortality of wallabies, quolls (predator), penguins etc.

WHO

- *Accounts users*: Council; rental car firms; RACT; tourism business' saying they are "quoll/penguin friendly" (PR); Parks and Wildlife BIEN (citizens); Wilderness Society
- *Account producers*: Council; RACT; Tourism businesses; Philanthropist; citizens; BIEN; PWS

WHAT

- vehicle interactions with all road kill, perhaps with a focus on quolls, penguins etc.; perhaps impact on ecosystem population dynamics (e.g. quolls vs cats etc.)

4. Coastal landforms and habitats (the coast)

Why

How are the coastal landforms and habitats tracking? Answering the accounting question of, "Are coastal landforms and habitats being pushed outside their historically dynamic state?" Changes in coastal stability can impact on human infrastructure, dwellings and water resources. These changes can also impact on the ecological functioning of the coastal zone and related ecosystems through impacts on important breeding and nursery areas..

Who

State and Local government agencies, recreational and commercial fishers, BIEN, Parks and Wildlife

What

Tracking changes in the coastal landforms (geomorphology) and habitats including beaches, rocky shores, estuaries, lagoons and wetlands, such as saltmarshes and melaleuca swamps.

Description (accounting conceptual model)

The coastline is treated separately as it is the meeting place of the terrestrial and marine environments with many unique characteristics. The coast has very strong ecological gradients (rapidly changing from dry to wet, hot to cool, saline to fresh, and hard to soft etc.); this makes it an extremely challenging, dynamic environment, yet provides many opportunities and niches for Bruny Island's rich biodiversity. It also has many characteristics that make it highly attractive to people, including for recreational activities, such as walking, relaxing, sightseeing, camping, swimming and fishing. There is usually a price premium for real estate near the coast reflecting the high amenity value people place upon it. Highly dynamic, high energy systems can be disturbed by even small interventions in the processes maintaining the dynamic equilibrium of the system; for example, changes in sediment (sand) supply or wave energy can generate large shoreline movements.

The table below sets out many of the flows to and flows from the coastline. This approach is helpful for identifying topics suitable for accounting purposes, that is, tracking change that is relevant to the management of the asset. While there are a great many potential topics that could be tracked, in reality, resources (money, people and time) are limited so pragmatic, careful choices must be made to select topics that are relevant, can credibly indicate change and, to ensure legitimacy, are understandable and meaningful to those using the account, in this case, a wide range of people.

*Table 4 Coastal landforms and habitats accounting conceptual model. Potential stocks and/or flows that could be measured are highlighted in **bold.** All flows must be related to the accounting topic i.e. the asset.*

Flows to *Coastal landforms and habitats* (includes change drivers, direct pressures, activities, events, change agents, biophysical flows from other ecosystems)	*Coastal landforms and habitats* **Asset** (includes stock and intra-ecosystem biophysical flows)(you *must* identify the asset and its boundary)	**Flows from** *Coastal landforms and habitats* (includes ecosystem services and biophysical flows to other ecosystems)
❖ Human activities and management policies ➢ Changes to sediment supply to the coast (increases or decreases) ➢ Extraction rates of freshwater from coastal aquifers ➢ Agriculture and forestry (changing catchment runoff dynamics) ➢ Pollution (e.g. septic tanks) ➢ Illegal harvest of shellfish including from wave-cut platforms and rock pools) ➢ Replacing of native dune vegetation (e.g. spinifex) with introduced marram grass ➢ Changes to dune management (e.g. burning or grazing regimes) ➢ Illegal vegetation removal ➢ damage to cliffs destabilised by human access disturbance ❖ Climate and its variability ➢ Changing rainfall ➢ Changing climate regime (temperature, wave climate, windiness, storminess) ➢ Changing sea levels (increase rates of shoreline retreat) ❖ Flows from other ecosystems ➢ Biophysical ▪ seagrass beds buffer the waves and reduce wave energy at the shore, reducing erosional pressure ▪ sediment flows to the coastal landforms (beaches, dunes, sand bars, estuaries) from the offshore compartments and landwards, from the rivers. ➢ Gene flows ▪	❖ The **coastline** including the **beaches, rocky shores, sand dunes, coastal wetlands (saltmarshes and melaleuca swamps), coastal aquifers, the estuaries and lagoons**. It includes the intertidal areas and the immediate landward area adjacent to the shoreline strongly influenced by salty sea spray (i.e. the littoral zone). ❖ The **functioning** of the shoreline includes its physical responsiveness to changing environmental conditions such as storms, changing sea levels and changing sediment regimes. The responses include **shoreline erosion and accretion** (including longshore drift of sediments) and (typically landward) **movement of saltmarshes**. Human responses include shoreline hardening (**artificial shorelines**). The shoreline provides important breeding, nursery, hunting and refugia (e.g. roosting) areas for many wildlife species including fish, sharks and birds. ❖ General note: Under the influence of the *flows to* the *ecosystem asset*, the *asset* has the *capacity* to produce the *flows within* and *flows from* the asset	❖ Ecosystem Services (to people) ➢ Provisioning services ▪ **Potable water supply** from coastal groundwater aquifer ▪ marine and estuarine resources (sand? shellfish? flounder?) ➢ Regulating services ▪ Maintain suitable fish and bird breeding and habitat areas ▪ Maintain estuarine and lagoonal water quality ▪ Recharge of coastal groundwater aquifer ▪ Maintain dynamic stability of shorelines able to respond to sea level changes (e.g. saltmarsh is highly responsive to sea level rise and slows down the rate of erosion) ▪ protection of human buildings and infrastructure from erosion and coastal flooding, storm events ➢ Cultural services ▪ Wildlife (eco) tourism (experiencing intact ecosystems etc.) ▪ Recreation (walking, photography, etc.) ▪ Sense of 'nature' (amenity) ▪ Landscape views 'typical' of Bruny ▪ Scientific research ▪ Cultural heritage (indigenous, European historical etc.) ▪ Real estate values ❖ Flows to other ecosystems ➢ Biophysical ▪ protection of ecosystems landwards of the coastal zone ➢ Gene flows ▪ exports of native species from coastal areas

Candidate accounts (in **bold** above)

Coastal habitat stock and condition account, shoreline stability stock account, coastal margin stock accounts (see UK ONS, 2016)

Data sources

council records, evidence of illegal clearing, photos (Graham, others), evidence of coastal position change (TasMARC program, Chris Sharples shoreline analysis based on aerial photos at 4 Bruny Beaches including Adventure Bay and Cloudy Bay, reference the *First Pass Coastal Hazard Assessment for Kingborough*, 2014 by Chris Sharples, note 2nd level sediment compartments and many coastal vulnerability layers on LISTmap), water temperature (Pennicott), water extraction data (Kingborough Council, TasWater)

5. Potable water (drinking water for people)

Why

To track, understand and optimise the conservation, quality and use of potable water over the short and long term.

Who

Residents, businesses, local government, TasWater

What

The account will show the *stock* (volume of groundwater, water tanks, dams), *inflows* (precipitation, imports, springs, creeks) and *outflows* (volumes extracted and used by households and enterprises (drinking, manufacturing, reuse and sewage); exports (e.g. agricultural products); volumes evaporated and flow to sea). Units are litres and, where appropriate, dollars.

Description (accounting conceptual model)

Water is vital to life; necessary to people (as a provisioning ecosystem service), animals and plants (as inter- and intra-ecosystem flows). Water is a scarce resource and needs careful management. The source of water on Bruny Island is affected by the level of use (extractions) and the physical and climatic drivers and pressures affecting recharge and water quality. For example, changes in rainfall patterns can reduce recharge of groundwater aquifers and other water storages (dams and tanks) while rising sea levels can affect groundwater aquifers close to the coast through salt water intrusions.

The table below sets out many of the flows to and flows from potable water. This approach is helpful for identifying topics suitable for accounting purposes, that is, tracking change that is relevant to the management of the asset. While there are a great many potential topics that could be tracked, in reality, resources (money, people and time) are limited so pragmatic, careful choices must be made to select topics that are relevant, can credibly indicate change and, to ensure legitimacy, are understandable and meaningful to those using the account, in this case, a wide range of people.

*Table 5 **Potable water** accounting conceptual model. Potential stocks and/or flows that could be measured are highlighted in **bold.** All flows must be related to the accounting topic i.e. the asset.*

Flows to *Potable water* (includes change drivers, direct pressures, activities, events, change agents, biophysical flows from other ecosystems)	*Potable water* **Asset** (includes stock and intra-ecosystem biophysical flows)(you *must* identify the asset and its boundary)	**Flows from** *Potable water* (includes ecosystem services and biophysical flows to other ecosystems)
❖ Human activities and management policies ➢ changes in water-related policies and management practices (e.g. changes in groundwater aquifer extraction rates, increases in manufacturing activities; water management standards in visitor accommodation etc.) ❖ Climate and its variability ➢ **changes in rainfall patterns** (e.g. drying climate, increased high intensity events etc.) ➢ changes in climatic controls on evaporation and evapotranspiration rates ❖ Flows from other ecosystems ➢ Biophysical ▪ **recharge rate of groundwater aquifers** ▪ marine saltwater intrusions (e.g. through sea level rise) ▪ changes in water catchment vegetation cover affecting water runoff and infiltration	❖ The **quantity of potable water** of Bruny Island and the places and structures it is stored within, including groundwater aquifers, bores, reservoirs and water tanks. **Potable water quality** is defined as drinkable water and must meet health standards including chemical and disease standards (e.g. salt, heavy metal and bacterial levels). ❖ The internal functioning of the asset including processes and structures that maintain the water quality and quantity. For example, the physical and chemical processes that maintain the barriers to sea water intrusions. ❖ General note: Under the influence of the *flows to* the *ecosystem asset*, the *asset* has the *capacity* to produce the *flows within* and *flows from* the asset	❖ Ecosystem Services (to people) ➢ Provisioning services ▪ **potable water extraction** ➢ Regulating services ▪ ➢ Cultural services ▪ Clean fresh water is an important part of the ‘clean, green’ identity of ‘brand’ Bruny ❖ Flows to other ecosystems ➢ Biophysical ▪ flows of groundwater from aquifers to **groundwater dependent ecosystems (e.g. to coastal wetlands)** ▪

Candidate accounts (in **bold** above)

Rainfall flow account, potable water stock account, potable water extraction flow account, groundwater dependent ecosystem flow account (note: water accounts can be treated as SEEA Central Framework stock accounts and/or as SEEA thematic ecosystem accounts; see Appendix 5 for an example SEEA Ecosystems physical water account table.)

Data sources

TasWater records (changes in groundwater); Kingborough Council records (estimates of permanent residents vs shacks, details of permanent infrastructure); visitor estimates; ABS method for estimating household water tank volumes; BoM data;

6. Bruny's 'nature' in the broad (a general sense of being close to nature; the superb scenery, the 'islandness', the naturalness, the remoteness, the wildness, the ocean, the wind)

Why

To understand and track aspects of the environment that represent the general sense of Bruny as a natural place for visitors and residents. This will help ensure that the things that draw people to Bruny are maintained. One intended outcome will be to strengthen the Bruny brand. It would draw on the other accounts for some data

Who

Account users: businesses (e.g. ecotourism, Destination Southern Tasmania), Islanders, Kingborough Council (e.g. planners), land owners and managers, State government (e.g. Tourism Tasmania, Parks and Wildlife). *Account producers:* UTas, Kingborough Council, State Government (e.g. Tourism Tasmania, Parks and Wildlife)

What

In environmental accounting terms, this is about measuring the flow of ecosystem services to visitors and residents and, where possible, the stock of underlying natural assets with the capacity to provide those flows.

Description (accounting conceptual model)

The commonly used phrase, *Bruny's 'nature'*, is used to represent an environmental-social-economic asset that cannot be measured in a single or simple way; rather it is an amalgamation of a variety of perceptions based in a theme of naturalness. The underlying biophysical environment and ecological functioning that maintains the 'nature' of Bruny is clearly relevant as it is that which is being perceived. To this end, a series of accounting topics are proposed to attempt to represent the asset, including measures of scenery and amenity values. The other Bruny accounts will be drawn upon to contribute to understanding and tracking changes in Bruny's 'nature'. Bruny's 'nature' contributes cultural ecosystem service flows to, potentially, all the people that interact with the island. These flows are important to individuals' wellbeing, including physical and mental well-being. They are also important socially and economically and contribute to the high visitation rates and successful ecotourism and other businesses.

The table below sets out many of the flows to and flows from Bruny's 'nature'. This approach is helpful for identifying topics suitable for accounting purposes, that is, tracking change that is relevant to the management of the asset. While there are a great many potential topics that could be tracked, in reality, resources (money, people and time) are limited so pragmatic, careful choices must be made to select topics that are relevant, can credibly indicate change and, to ensure legitimacy, are understandable and meaningful to those using the account, in this case, a wide range of people.

Table 6 ***Bruny's 'nature'*** *accounting conceptual model. Potential stocks and/or flows that could be measured are highlighted in* ***bold.*** *All flows must be related to the accounting topic i.e. the asset.*

Flows to *Bruny's 'nature'* (includes change drivers, direct pressures, activities, events, change agents, biophysical flows from other ecosystems)	*Bruny's 'nature'* **Asset** (includes stock and intra-ecosystem biophysical flows)(you *must* identify the asset and its boundary)	**Flows from** *Bruny's 'nature'* (includes ecosystem services and biophysical flows to other ecosystems)
❖ Human activities and management policies ➢ 'Honeypot' effect where increased visitation to experience Bruny's 'nature' impacts on the sense of Bruny's 'nature e.g. through noise, crowds, littering, rapid development (buildings, roads), traffic increases and hazards ➢ Large scale land management activities (e.g. land clearing) ➢ Large scale marine activity (e.g. major or multi-located aquaculture) development) ➢ Maintenance of threatened species; ➢ **Impactful events** (e.g. penguin kills, roadkill, local extinctions, algal blooms, disease (e.g. POMS), oil spills, bush fires, construction, littering, marine debris etc.) ❖ Climate and its variability ➢ Impacts of climate change (drying climate, increasing temperatures) on natural systems ➢ Changing sea levels impact on coastal habitats, shoreline stability, groundwater aquifer water quality, and residential building amenity ❖ Flows from other ecosystems ➢ Biophysical ▪ ➢ Gene flows ▪	❖ The asset is, in broad terms, 'Bruny's nature', whether a sense of 'islandness', naturalness, remoteness, southerliness, quietness, wildness or the natural soundscape and superb scenery. This asset is as perceived by Bruny islanders and all the visitors to Bruny including the shack owners and holidayers, whether staying for one or more nights or day trippers. The **perception of a natural environment** is varied, though is underpinned by the physical presence and condition of the natural capital that contributes to the perception. This **natural capital** could be measured as changes in: **'natural' scenery** (viewsheds); **amenity value** (e.g. density and location of shacks); land use (e.g. conservation); marine water quality; fish quantity and quality; coastal integrity; habitat integrity; presence of threatened or special species and vegetation communities; impact on perceptions by development (e.g. visibility/presence of aquaculture, forestry, infrastructure, buildings etc.) ❖ The capacity of the asset to provide the flows to people and the other ecosystems is primarily affected by the way human activities shift the functioning of the underlying natural capital. In this, activities that disturb the ecological fabric of Bruny will negatively impact the perception of Bruny's 'nature' while activities that maintain or enhance the functioning of the natural capital will positively impact it. ❖ General note: Under the influence of the *flows to* the *ecosystem asset*, the *asset* has the *capacity* to produce the *flows within* and *flows from* the asset	❖ Ecosystem Services (to people) ➢ Provisioning services ▪ Food (fish, wild meats, domesticated meats, honey, wine, cider, cheese etc.) ▪ Fibre (timber, firewood, wool) ➢ Regulating services ▪ Bruny's 'nature' provides many regulating services including climatic moderation (reduced wind at ground level, cooling in summer, warming in winter), water and air filtration services and coastal ecosystem services, such as coastline stability. ➢ Cultural services ▪ The **perception of Bruny's 'nature'** is beneficial to many peoples' well-being including benefits to their mental and physical well-being. This includes all people who interact with Bruny whether islanders, shackies or visitors. ❖ Flows to other ecosystems ➢ Biophysical and gene flows ▪ Bruny's 'nature' is a rich and highly varied set of ecosystems that are exchanging energy and matter with all the ecosystems surrounding it, including sediments, pollen, wildlife (birds, fish). It is a source of ecological and physical 'exports' to other ecosystems.

Candidate accounts (in **bold** above)

'Natural' viewshed stock and condition account (perhaps draw on the Sustainable Timbers Tasmania Viewshed Management System methods); amenity value stock and condition account (as per Schröter et al. cabin amenity; physical and monetary); ecological naturalness stock account (using ecological condition assessments e.g. biodiversity intactness, integrity, connectedness); also draw on other Bruny natural capital accounts (land, marine, wildlife, coastal, potable water etc.); roadkill flow account; Cultural ecosystem service accounts (visitor satisfaction via social media analysis of images, posts etc.; level of ecotourism activities);

Data sources

ABS census; SeaLink (car trips); SES (vehicle accidents); PWS Visitor Survey; road counters; social media; biodiversity measures from CSIRO.

References

Accounting for Nature (Wentworth Group eCond materials): http://wentworthgroup.org/programs/environmental-accounts/

Bureau of Meteorology 2013 *Guide to environmental accounting in Australia* including account framing workbooks and support materials http://www.bom.gov.au/environment/activities/accounts.shtml

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Experimental Ecosystem Accounts for the Central Highlands of Victoria (ANU, NESP) http://www.nespthreatenedspecies.edu.au/Ecosystem%20Summary%20Report_V3b_low.pdf

Experimental Ecosystems Natural Capital Accounts: Mauritius Case Study: http://commissionoceanindien.org/fileadmin/resources/ISLANDSpdf/Experimental_Ecosystems_Natural_Capital_Accounts_Mauritius.pdf

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Schröter, Matthias, David N. Barton, Roy P. Remme, and Lars Hein. 2014. "Accounting for Capacity and Flow of Ecosystem Services: A Conceptual Model and a Case Study for Telemark, Norway." *Ecological Indicators*36: 539–551. http://www.sciencedirect.com/science/article/pii/S1470160X13003506.

SEEA-Central Framework: https://seea.un.org/content/seea-central-framework

SEEA-Ecosystems and Technical Recommendations: https://seea.un.org/ecosystem-accounting

SEEA Ecosystems technical revision workshop; lots of interesting, relevant papers: https://seea.un.org/events/forum-experts-seea-experimental-ecosystem-accounting

Tourism Research Australia

- Regional Tourism Accounts for Hobart and South Tasmania: https://www.tra.gov.au/tra/rtsa/2018/files/Hobart%20and%20the%20South%202016-17.pdf
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Appendix 1 Potential environmental-economic accounting topics generated at the workshop (in no particular order)

Topic or issue	**Included concepts – accounts to track changes in:**	**Account types (SEEA types)** (* indicates potential for monetary valuation)
Tourist/visitor/resident numbers	?bed nights?, # accommodation, # dwellings,	Tourism Satellite Account. *flow (pressure)
Impact of people (including visitors) on amenity ('liveability')	Amenity for visitors (tourists), shackies and residents; trade-offs between groups; indigenous values and world views.	Ecosystem Account. stock (extent and condition) and/or *flow (pressure, capacity and ecosystem services)
Impact of people on natural assets	Interactions of cars, buses, trucks, boats with natural assets. Crashes, roadkill	Ecosystem Account. stock (condition) or *flow (pressure)
Tourism 'carrying capacity'	How much tourism will degrade the condition of the natural assets? Infrastructure including # and condition e.g. toilets	very complicated and likely unfeasible
'Brand' Bruny natural assets	Including 'islandness', wildness, remoteness, naturalness, diversity of ecosystems, spectacular scenery, amenity value.	Ecosystem Account. stock (extent and condition and *flow (cultural ecosystem services)
Wildlife, native species	Threatened species (40 spots, swift parrots), the 12 Tasmanian endemics, white wallabies, seals, whales. Pressure topics include deer, cat management and roadkill	Central Framework and/or Ecosystem Account. stock (extent/counts and condition) and *flows (pressure and inter- and intra-ecosystem flows, capacity, cultural ecosystem services)
Biodiversity	marine and terrestrial threatened species and biodiversity; land clearing, land/marine waters use change, pests & weeds	Ecosystem Account. stock (counts and condition) and *flows (pressures, capacity, inter- and intra-ecosystem, intrinsic values, cultural and regulating ecosystem services)
Marine habitat environment and condition	Recreational and commercial fishing (legal and illegal take), nutrient levels (e.g. nitrogen)	Central Framework and/or Ecosystem Account. stock (fish populations, 'healthy' water quality) and *flows (pressures, capacity and provisioning ecosystem services)
Coastal landforms	Beaches, estuaries, lagoons, wetlands	Ecosystem Account. stock (extent and condition) and *flows (pressures, capacity and ecosystem services)
Terrestrial (land) habitat environment and condition		Central Framework and/or Ecosystem Account. stock and flows
Land Accounts (SEEA account)	Land use, cover, tenure and value changes; Protected Areas: Public (national parks), private (covenanted), marine	Central Framework Account. stocks (extent and condition)
Forest	Change in area and condition (e.g. fragmentation), forestry, ecotourism, bee keeping, wildlife species e.g. swift parrots	Central Framework and/or Ecosystem Account. *stocks (extent and condition) and *flows (pressures, capacity, ecosystem services)
Weather	Rainfall, temperatures, wind, solar inputs	Ecosystem Account. flows (change drivers, pressures, ecosystem services)
Energy	For human use: Electricity, fuel, solar, wind, firewood, tidal General natural energy balance: sun (light and heat) for plant growth, wind, waves, tidal	Central Framework and/or Ecosystem Account. *stocks (quantity and quality) and *flows (change drivers, inter- and intra-ecosystem, capacity, ecosystem services)
Carbon cycle	Emissions, sequestration, ecological cycle (fluxes in and out of ecosystems)	Ecosystem Thematic Account. *stocks (reservoirs) and *flows (sequestration rates, ecosystem services)
Water	Potable water, tanks, dams, aquaculture, agriculture, wastewater (sewage), ecosystem water balances (evapotranspiration, rainfall, runoff, storages), groundwater, stream flows, imports, exports	Central Framework and/or Ecosystem Account. *stocks (quantity and condition) and *flows (change drivers, pressures, inter- and intra-ecosystem, capacity, ecosystem services)

Appendix 2 template for framing an environmental-economic account (BoM Account Framing workbook Modules 1-4)

1. [Asset name]

Why

[from workshop sheets]

Who

[from workshop sheets]

What

[from workshop sheets]

Description (accounting conceptual model)

[authors note: something here including asset definition and description, flows to, from and within the asset.]

The table below sets out many of the flows to and flows from the marine habitats. This approach is helpful for identifying topics suitable for accounting purposes, that is, tracking change that is relevant to the management of the asset. While there are a great many potential topics that could be tracked, in reality, resources (money, people and time) are limited so pragmatic, careful choices must be made to select topics that are relevant, can credibly indicate change and, to ensure legitimacy, are understandable and meaningful to those using the account, in this case, a wide range of people.

*Table 7 [Asset name] accounting conceptual model. Potential stocks and/or flows that could be measured are highlighted in **bold.** All flows must be related to the accounting topic i.e. the asset.*

Flows to *[asset name]* (includes change drivers, direct pressures, activities, events, change agents, biophysical flows from other ecosystems)	*[asset name]* **Asset** (includes stock and intra-ecosystem biophysical flows)(you *must* identify the asset and its boundary)	**Flows from** *[asset name]* (includes ecosystem services and biophysical flows to other ecosystems)
❖ Human activities and management policies ❖ Climate and its variability ❖ Flows from other ecosystems ➢ Biophysical ➢ Gene flows	❖ The asset ❖ The internal functioning of the asset ❖ General note: Under the influence of the *flows to* the *ecosystem asset*, the *asset* has the *capacity* to produce the *flows within* and *flows from* the asset	❖ Ecosystem Services (to people) ➢ Provisioning services ➢ Regulating services ➢ Cultural services ❖ Flows to other ecosystems ➢ Biophysical ➢ Gene flows

Candidate accounts (in **bold** above)

Data sources

Appendix 3: terrestrial (land) habitats account examples

Table 8 Example account table for forests (reporting units could be types of forest communities)

		Extent (ha)	Percentage of reference extent (%)	Fragmentation (0 to 1)	Ecosystem condition (naturalness/ intactness/ integrity) (0 to 1)	Carbon reservoir (tonnes CO2e)
Reference (pre-industrial)	*Reporting unit 1*	*10*	*Not applicable*	*0.0*	*1.0*	
	Reporting unit 2	*0*	*Not applicable*	*0.0*	*1.0*	
	Reporting unit 3	*0*	*Not applicable*	*0.0*	*1.0*	
	Total	*10*	*Not applicable*	*0.0*	*1.0*	
Opening (2011)	**Reporting unit 1**	**5**	**50**	**0.9**	**0.7**	
	Reporting unit 2	**3**	**30**	**0.6**	**0.4**	
	Reporting unit 3	**2**	**20**	**0.4**	**0.3**	
	Total	**10**	**100**	**0.7**	**0.5**	
Additions	Reporting unit 1					
	Reporting unit 2					
	Reporting unit 3					
	Total					
Reductions	Reporting unit 1					
	Reporting unit 2					
	Reporting unit 3					
	Total					
Closing (2016)	**Reporting unit 1**					
	Reporting unit 2					
	Reporting unit 3					
	Total					

Appendix 4: Mock -up of proposed account tables for reporting on threatened species and individual species

RM: Here is an example of the ACT butterfly Account

Table 4: Butterfly species account for the ACT, 1978 – 2018

		Native species				Introduced species	Specialisation		
		Endemic ACT	Endemic Australia	Non-endemic Australia	Listed as threatened	Introduced Australia	Generalists~	Specialists~	Total species
Opening stock 1978		0	56	19	0	2	NA	NA	78
Additions									
	Discovery of new species	0	0	0	0	0	NA	NA	0
	Rediscovery of extinct species	0	0	0	0	0	NA	NA	0
	Addition of species	0	5	3	0	0	NA	NA	8
	Taxonomic reclassification	0	1	0	0	0	NA	NA	1
	Total	0	6	3	0	0	NA	NA	9
Reductions									
	Extinction of species (Aust)	0	0	0	0	0	NA	NA	0
	Loss of species (distribution)	0	0	0	0	0	NA	NA	0
	Taxonomic reclassification	0	0	0	0	0	NA	NA	0
	Re-evaluation of records	0	0	0	0	0	NA	NA	0
	Total	0	0	0	0	0	NA	NA	0
Closing stock 2018		0	62	23	0	2	31	36	87
Net change		0	6	4	0	0	NA	NA	9

~ Cannot assign specialisation categories to 1978 data, no comprehensive measure of distribution available

RM: …and here is an example from the ABS' GBR biodiversity accounts. It depends on a *concordance* table (also below):

Birds

TABLE 2. THREATENED BIRD SPECIES ACCOUNT FOR THE GBR REGION, 1994 - 2017

	Extinct	Endangered	Vulnerable	Near Threatened	Not Threatened	Not Listed	Total Species
Opening Stock	**1**	**6**	**6**	**6**	**5**	**4**	**28**
Additions							
From lower threat categories	0	3	0	1	0	0	4
From higher threat categories	0	0	0	3	6	0	9
Discoveries of new species	0	0	0	0	0	0	0
Rediscoveries of extinct species	0	0	0	0	0	0	0
Reclassifications	0	0	0	0	0	0	0
Updated assessments	0	0	0	0	0	0	0
New additions to list	0	1	1	1	1	0	4
Total additions	0	4	1	5	7	0	17
Reductions							
To lower threat categories	0	3	2	4	0	0	9
To higher threat categories	0	0	2	1	1	3	7
Reclassifications	0	0	0	0	0	0	0
Local extinction	0	0	0	0	0	0	0
Updated assessments	0	0	0	0	0	1	1
Total reductions	0	3	4	5	1	4	17
Closing Stock	**1**	**7**	**3**	**6**	**11**	**0**	**28**

Source: Nature Conservation Act (1992), Department of Environment and Heritage Protection, Queensland; The IUCN Red List of Threatened Species.

TABLE 1. CONCORDED CATEGORIES FOR THREATENED FAUNA

NCA	EPBC	Red List	Revised category
Extinct in the Wild	Extinct Extinct in the Wild	Extinct Extinct in the Wild Regionally Extinct	Extinct
Endangered	Critically Endangered Endangered	Critically Endangered Endangered	Endangered
Vulnerable	Vulnerable	Vulnerable	Vulnerable
Near Threatened	Conservation Dependent	Lower Risk Near Threatened	Near Threatened
Least Concern (unlisted)	(unlisted)	Data deficient Least Concern (unlisted)	Not listed

Table 9 Example account table: individual species (here for native species, but could be for pest species, such as cats)

Species	**quoll**	**skink**	**coastal heath**	**rock lobster**
Unit of measurement	Number of individuals	Relative abundance based on population density (0 to 1)	Area (ha)	Biomass (tonnes)
Reference abundance measure (pre-industrial)	*2000*	*1.0*	*600*	*2*
Opening abundance measure (2010)	**1500**	**0.7**	**320**	**1**
Additions	100	unknown	unknown	unknown
Reductions	200	unknown	unknown	unknown
Closing abundance measure (2015)	**1400**	**0.5**	**200**	**0.9**
Net change in abundance over accounting period	-100	-0.2	-120	-0.1
Relative abundance measure at 2010 (% of reference)	75%	70%	53%	50%
Relative abundance measure at 2015 (% of reference)	70%	50%	33%	45%
Net change in relative abundance from 2010 to 2015 (% of reference)	-5%	-20%	-20%	-5%
Change as a percentage of the abundance in 2010 (% of opening)	-6.7%	-29%	38%	-10%

Appendix 5: Example accounts for potable water

1. The SEEA Water (Central Framework Accounting approach) https://seea.un.org/content/seea-water: this is about water that moves into and out of the economy
2. SEEA Ecosystems water 'thematic' account (9.3 in the attached Tech Recs): Useful discussion on water accounting for stocks and flows form an ecosystem perspective
3. SEEA Ecosystems (attached) S4.62 Table 4.2 Physical Water account (see below)

Table 4.2
Physical asset account for water resources (*cubic metres*)

	Type of water resource						
	Surface water				Groundwater	Soil water	
	Artificial reservoirs	Lakes	Rivers and streams	Glaciers, snow and ice			Total
Opening stock of water resources	1 500	2 700	5 000		100 000	500	109 700
Additions to stock							
Returns	300		53		315		669
Precipitation	124	246	50			23 015	23 435
Inflows from other territories			17 650				17 650
Inflows from other inland water resources	1 054	339	2 487		437	0	4 317
Discoveries of water in aquifers							
Total additions to stock	1 478	585	20 240		752	23 015	46 071
Reductions in stock							
Abstraction	280	20	141		476	50	967
for hydropower generation							
for cooling water							
Evaporation and actual evapotranspiration	80	215	54			21 125	21 474
Outflows to other territores			9 430				9 430
Outflows to the sea			10 000				10 000
Outflows to other inland water resources	1 000	100	1 343		87	1 787	4 317
Total reductions in stock	1 360	335	20 968		563	22 962	46 188
Closing stock of water resources	1 618	2 950	4 272		100 189	553	109 583

Source: SEEA Central Framework, table 5.25.
Note: Dark grey cells are null by definition.