

# Sand Dune Hydrology Glossary

Key terms used in the Newborough Warren groundwater research summary

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## Geomorphology and habitats

Term	Definition
<b>Sand dune</b>	A mound of sand formed by wind action on the coast or inland.
<b>Dune system</b>	A complex of dunes, inter-dune hollows and associated habitats forming a coherent landscape unit.
<b>Dune slack</b>	A low-lying hollow between dunes where the water table is close to the surface; seasonally flooded, supporting wetland plant communities.
<b>Wet slack</b>	A dune slack with a summer minimum water table $\leq 0.61$ m below ground surface (threshold from Curreli et al., 2013).
<b>Dry slack</b>	A dune slack with a summer minimum $0.61\text{--}0.98$ m below ground surface; plant communities shift towards drier grassland.
<b>Coastal erosion</b>	The gradual retreat of the shoreline due to wave and current action, reducing the volume of the underlying aquifer.
<b>Managed retreat</b>	A management strategy in which areas threatened by erosion or flooding are deliberately yielded rather than repeatedly restored.
<b>Ecological threshold</b>	A critical water table depth beyond which the habitat changes character irreversibly (e.g. from wetland to grassland).

## Hydrology and groundwater

Term	Definition
<b>Groundwater</b>	Water occupying pores and fractures in rocks and sediments below the ground surface.
<b>Water table</b>	The upper boundary of the saturated zone, below which all pores are filled with water.
<b>Aquifer</b>	A geological layer capable of storing and transmitting groundwater.
<b>Recharge</b>	The process of replenishing groundwater by infiltration of rainfall through the soil surface.
<b>Recharge efficiency</b>	The percentage of rainfall that actually reaches the water table (the remainder runs off or evaporates).
<b>Drainage</b>	The outflow of groundwater from an area under the influence of the hydraulic gradient.
<b>Drainage datum</b>	A reference level (3.7 m below ground surface in this study) against which the hydrostatic head driving drainage is measured.
<b>Displacement (<math>h_{\text{disp}}</math>)</b>	The height of the water table above the drainage datum: $h_{\text{disp}} = \text{datum} + \text{depth}$ . Drives the drainage component of the model.

Term	Definition
<b>Dipwell</b>	A simple observation tube driven into the ground for manual measurement of water table depth.
<b>Summer minimum</b>	The lowest water table level in a given year, typically in September; the key indicator of habitat condition.
<b>Specific yield (<math>S_y</math>)</b>	The volume of water an aquifer releases under gravity per unit volume of material; dimensionless.

## Climate and evaporation

Term	Definition
<b>Precipitation / rainfall</b>	Atmospheric water reaching the ground surface as rain, snow, etc. Measured in mm/month.
<b>Potential evapotranspiration (PET)</b>	The maximum amount of water that could evaporate from the ground and plants given unlimited water supply. Calculated using the Thornthwaite method in this study.
<b>Temperature anomaly</b>	The difference between a given year's temperature and the long-term average (baseline).
<b>Canopy interception</b>	The proportion of rainfall caught by leaves and branches that evaporates before reaching the ground. Approximately 24% in the Newborough pine forest.
<b>Atmospheric draw / canopy share (<math>\beta_2</math>)</b>	A model coefficient measuring how strongly evaporation (PET) draws down the water table. Higher = more severe summer drying.

## Model and statistical analysis

Term	Definition
<b>State-space model (SSM)</b>	A regression model $\Delta h = \beta_1 \cdot P + \beta_2 \cdot (-PET) + \beta_3 \cdot (-h_{disp})$ describing the monthly change in water level as a function of rainfall, evaporation and drainage.
<b>Recharge sensitivity (<math>\beta_1</math>)</b>	Model coefficient: how many millimetres the water table rises per millimetre of rainfall. Higher = stronger response to rain.
<b>Evaporation draw (<math>\beta_2</math>)</b>	Model coefficient measuring the strength of PET's drawdown effect on the water table. Higher = deeper summer drying.
<b>Drainage rate (<math>\beta_3</math>)</b>	Model coefficient describing the speed of groundwater outflow in proportion to $h_{disp}$ . Unit: month <sup>-1</sup> .
<b>Cluster / zone</b>	A group of wells with statistically similar hydrological behaviour, identified by k-means clustering.
<b>BACI (Before-After Control-Impact)</b>	An experimental design comparing conditions before and after an intervention, in both affected and control wells.
<b>Intervention window</b>	The period during which management actions can still prevent ecological thresholds from being crossed (approximately 2030–2039 in this study).

## Land management

Term	Definition
<b>Dune scraping</b>	Mechanically removing the top layer of sand to bring the ground surface closer to the water table and recreate wet slack habitat conditions.
<b>Clearfelling</b>	Complete removal of all trees from a defined area. At Newborough, 8 hectares of Corsican pine were clearfelled in December 2017.
<b>Thinning</b>	Partial removal of trees to reduce canopy density, e.g. by 50%, while retaining forest cover.
<b>Broadleaf conversion</b>	Replacing a conifer plantation with deciduous broadleaf species (e.g. oak) that shed their leaves in winter, reducing interception during the winter recharge season.
<b>Buffering effect</b>	The protective role of the forest canopy: by shading the ground in summer it limits direct evaporation from the soil surface. Removing the trees eliminates this effect.
<b>Uphill propagation</b>	The spread of a hydrodynamic effect (e.g. after scraping) upslope, in the direction opposite to groundwater flow.
<b>Drying trend</b>	A long-term decline in groundwater levels observed across all zones, driven by climate change.

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Compiled by M. Hollingham (2026). Based on terminology used in *Hydrogeological Dynamics, Behavioural Clustering and Management Intervention Analysis at Newborough Warren Coastal Sand Dune Aquifer, Wales*.  
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