

HYDREF 2016

# Opsiynau ar gyfer Fframwaith Monitro Adnoddau Naturiol Integredig Newydd ar gyfer Cymru

## Adroddiad Prosiect – Cyfnod I

## Adroddiad Cryno

Rhif Contract Llywodraeth Cymru C147/2010/2011

Gwaith Ychwanegol Cytûn yn Ofynnol Dyddiedig 8 Mawrth 2016

Prosiect NERC CEH: NEC05945

*Sut i ddyfynnu'r adroddiad hwn:* Emmett, B.A., Bell, C., Chadwick, D., Cheffings, C., Henrys, P., Prosser, H., Siriwardena, G., Smart, S., Williams, B., (2016) **Opsiynau ar gyfer Fframwaith Monitro Adnoddau Naturiol Integredig Newydd ar gyfer Cymru; Cyfnod 1, Adroddiad Cryno** i Lywodraeth Cymru (Cyfeirnod contract: C147/2010/11; Gwaith Ychwanegol Cytûn Gofynnol Dyddiedig 8 Mawrth 2016). NERC/Canolfan Ecoleg a Hydroleg (Prosiect NERC CEH: NEC05945)

## Opsiynau ar gyfer Fframwaith Monitro Adnoddau Naturiol Integredig Newydd ar gyfer Cymru

### Adroddiad Prosiect Cyfnod 1 – Adroddiad Cryno

Rhif Contract Llywodraeth Cymru C147/2010/2011  
Gwaith Ychwanegol Cytûn Dyddiedig 8 Mawrth 2016  
Rhif Prosiect NERC CEH: NEC05945

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<sup>13</sup>WRc plc

Yn wag yn fwriadol

## Opsiynau ar gyfer Fframwaith Monitro Adnoddau Naturiol Integredig Newydd ar gyfer Cymru

### ADRODDIAD CRYNO

Cafodd tîm Gorchwyl a Gorffen Opsiynau'r Dyfodol y gwaith o nodi opsiynau a datblygu argymhellion ar gyfer fframwaith monitro adnoddau naturiol integredig newydd (y cyfeirir ato o hyn ymlaen fel NRMF) ar gyfer Cymru gan adlewyrchu uchelgais ac egwyddorion integreiddio Deddf yr Amgylchedd a Deddf Llesiant Cenedlaethau'r Dyfodol. Byddai'r gweithgareddau archwilio'n cynnwys cyfres o weithdai thematig a dilyniannol gydag aelodau'r grŵp llywio a rhanddeiliaid ehangach a nodir gan grŵp llywio yn eu mynychu ac yn cyfrannu atynt. Yn ogystal, byddai cyfres o gyfarfodydd dwyochrog yn canolbwyntio ar y sector tir ar draws Llywodraeth Cymru (LIC) a Chyfoeth Naturiol Cymru (NRW) yn cael eu cynnal.

Cafodd y Grŵp Llywio Gorchwyl a Gorffen ei benodi gan LIC a chafodd ei Gadeirio gan NRW gyda chynrychiolwyr ar draws adrannau gwahanol yn Llywodraeth Cymru a NRW. Roedd tîm y prosiect o dan arweiniad y Ganolfan Ecoleg a Hydroleg (CEH) yn cynnwys sefydliadau oedd yn gysylltiedig ag arolygiadau maes proffesiynol a gwirfoddol ac sydd â phrofiad yn manteisio ar dechnolegau fel arsylwi'r ddaear a geneteg foleciwlaidd. Maent yn weithgar yn monitro ar lefel Cymru a'r DU ac mae ganddynt brofiad yn modelu sefyllfa, dadansoddi data ac ystadegau yn ogystal â phrofiad blaenorol mewn polisi, cyngor a datblygu yn LIC.

Roedd yr amcanion yn cynnwys:

- Mapio anghenion tystiolaeth ar draws Adrannau LIC a NRW
- Adolygu gweithgaredd monitro a chael tystiolaeth bresennol
- Mapio gorgyffwrdd rhwng gweithgareddau a nodi gormodedd
- Nodi ac asesu risg bylchau mewn tystiolaeth
- Nodi cyfle a rhyngwyneb aliniad, e.e. GMEP<sup>2</sup>, Natura 2000<sup>3</sup>, WFD<sup>4</sup>
- Nodi llwybrau adrodd e.e. SoNaRR<sup>5</sup>, WFG<sup>6</sup>, RDP<sup>7</sup>.
- Nodi cyfleoedd a thechnolegau newydd, e.e. arsylwi'r ddaear, gwyddor dinasyddion, gweithgaredd NGO<sup>8</sup> a Chanolfannau Cofnodi Lleol (LRC)
- Mapio cyfleoedd a heriau ariannu
- Archwilio modelau adnoddau i'r dyfodol, cael data a gweithgaredd dadansoddi/dehongli data
- Archwilio llywodraethu Rhaglen Monitro Adnoddau Naturiol i'r dyfodol

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<sup>2</sup> GMEP: Rhaglen Monitro a Gwerthuso Glastir

<sup>3</sup> Natura 2000: Rhwydwaith Ewropeaidd o safleoedd wedi eu diogelu (o dan y Gyfarwyddiaeth Adar a'r Gyfarwyddiaeth Cynefinoedd)

<sup>4</sup> WFD: Cyfarwyddiaeth Fframwaith Dŵr

<sup>5</sup> SoNaRR: Adroddiad Cyflwr Adnoddau Naturiol

<sup>6</sup> WFG: Deddf Llesiant Cenedlaethau'r Dyfodol

<sup>7</sup> RDP: Rhaglen Datblygu Gwledig

<sup>8</sup> NGO: Sefydliadau Anllywodraethol

Oherwydd hyd cyfyngedig y prosiect, cafodd y ffocws ar sectorau'r tir ei gytuno ar gyfer y prosiect gan y Grŵp Llywio, er ei fod yn cydnabod pwysigrwydd rhyngwyneb â'r sectorau aer, dŵr a morol. Roedd y gweithgareddau a wnaed i gyflawni'r amcanion yn cynnwys ymgysylltu eang â defnyddwyr a darparwyr tystiolaeth ar draws LIC, NRW a'r gymuned ehangach. Roedd dros 71 o unigolion a 25 o sefydliadau yn gysylltiedig â gweithgareddau Opsiyau'r Dyfodol yn ystod y 4 mis o weithgaredd yn cynnwys:

- 38 o unigolion o 14 o sefydliadau mewn cyfarfodydd dwyochrog ar draws adrannau LIC a NRW a rhanddeiliaid allanol;
- 66 o unigolion o 22 o sefydliadau mewn gweithdai Rhanddeiliaid;
- 50 o unigolion o 14 o sefydliadau yn drafftio Papurau Briffio ar Arsyllwadau'r Ddaear, Gwyddor Dinasyddion, Moleciwlaidd/eDNA<sup>9</sup>, Monitro Dŵr Croyw, Data a Gwybodeg ac Ymateb Brys
- 11 o unigolion o 5 sefydliad mewn astudiaeth beilot.

Daeth set o ddeg argymhelliad i'r amlwg o'r gweithgareddau hyn a ddangoswyd wedyn i weithdy buddiannau a risg i asesu'r buddion, y peryglon a'r strategaethau rheoli risg tebygol fyddai'n deillio o'r argymhellion arfaethedig. Cytundeb cyffredinol y gymuned oedd y byddai'r buddion yn werthfawr ac y gellid eu gwireddu er y cafodd peryglon amrywiol eu nodi y byddai angen mynd i'r afael â nhw.

Cafodd y deg argymhelliad terfynol eu mireinio a'u cymeradwyo gan y grŵp Llywio ar 14 Gorffennaf 2016. Mae'r rhain fel a ganlyn isod, ynghyd â rhesymeg fer gan dîm y prosiect sydd yn crynhoi rhywfaint o'r dystiolaeth sy'n cefnogi pob argymhelliad:

1. **Gan weithio'n gydweithredol, dylai cymuned fonitro Cymru ddatblygu Fframwaith Monitro Adnoddau Naturiol Integredig (NRMF). Dylai'r fframwaith newydd allu cael ei addasu, dylai ymateb i flaenoriaethau polisi a pheryglon sy'n dod i'r amlwg tra'n cynnal rhaglen systematig o fonitro stoc a chyflwr adnoddau naturiol. Bydd hyn yn gwneud defnydd mwy effeithiol o bobl a chyllid ac yn rhoi buddion cynyddol.**

*Rhesymeg a Chyflawniad:*

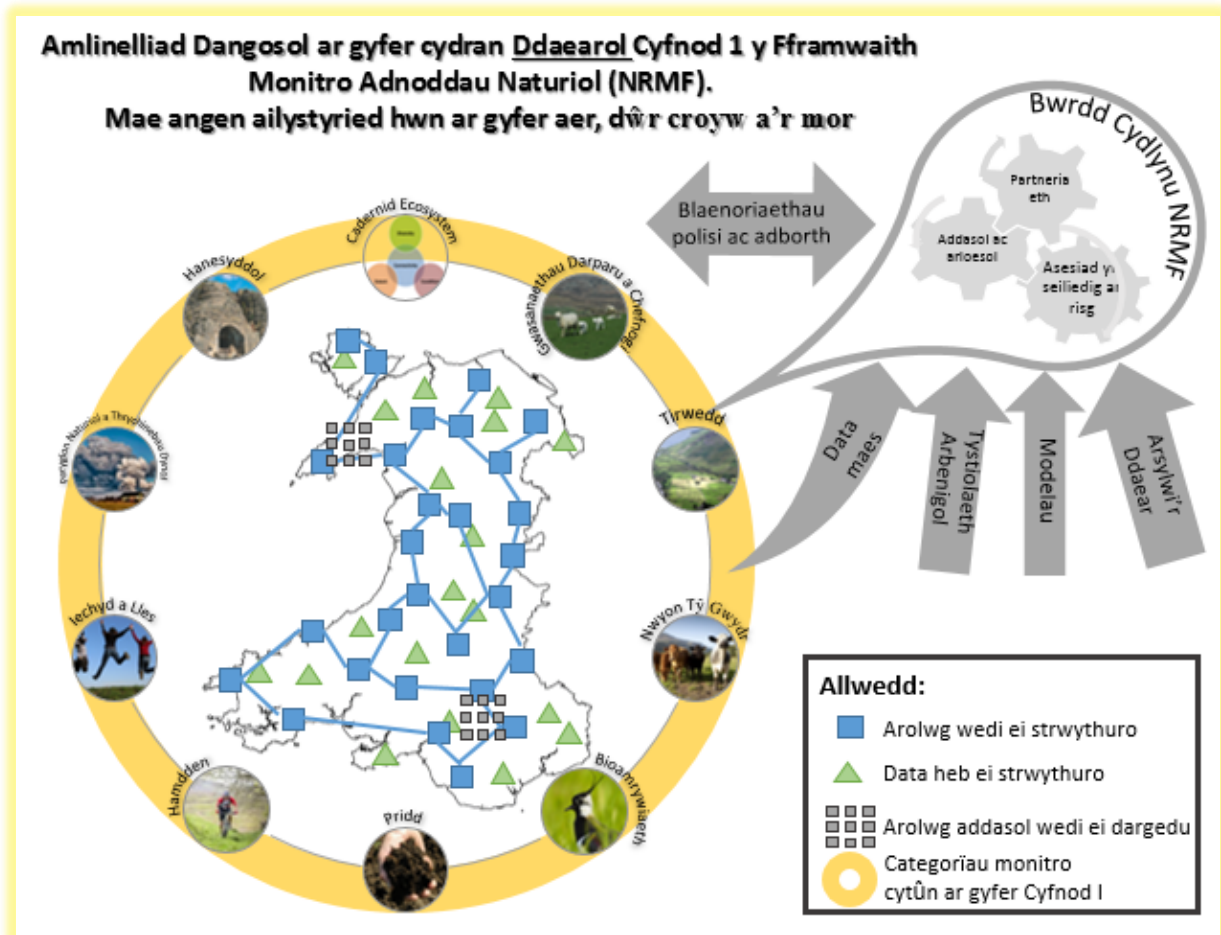
*Dylai buddion cynyddol gyda chostau cyffredinol llai gael eu cyflawni trwy bartneriaeth well sydd yn manteisio ar adnoddau ac arbenigedd ar y cyd ar draws LIC, NRW, diwydiant, y trydydd sector a'r sectorau ymchwil yng Nghymru. Dylai fframwaith newydd (a nodir yn Ffigur 1), gynnwys:*

1. *Rhaglen wylidwriaeth systematig integredig i olrhain newid parhaus yn stoc a chyflwr Adnoddau Naturiol gydag elfen addasol, hyblyg yn cael ei hargymell. Dylai hyn fod yn gymysgedd o arolygon proffesiynol a gwirfoddol wedi eu strwythuro, a chofnodion heb eu strwythuro, yn defnyddio cryfderau'r tri.*

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<sup>9</sup> eDNA: DNA Amgylcheddol

- II. Dylai'r elfen addasol gael ei llywio gan dystiolaeth o'r peryglon sy'n dod i'r amlwg a'r pwysau ar adnoddau naturiol penodol o ddata arolwg maes, arsylwi'r ddaear a modelu sefyllfa, a blaenoriaethau polisi ar draws y Cabinet.
- III. Dylai trosi data o ystod o ffynonellau i dystiolaeth gadarn a pherthnasol fod yn flaenoriaeth a chael ei gyfuno â ffynonellau tystiolaeth eraill i lywio penderfyniadau rheoli i'r dyfodol mewn fframwaith ailadroddus, fel sy'n ofynnol gan Ddeddf yr Amgylchedd.



Ffigur 1: Amlinelliad Dangosol ar gyfer cydvan Ddaearol, Cyfnod 1 NRMF.

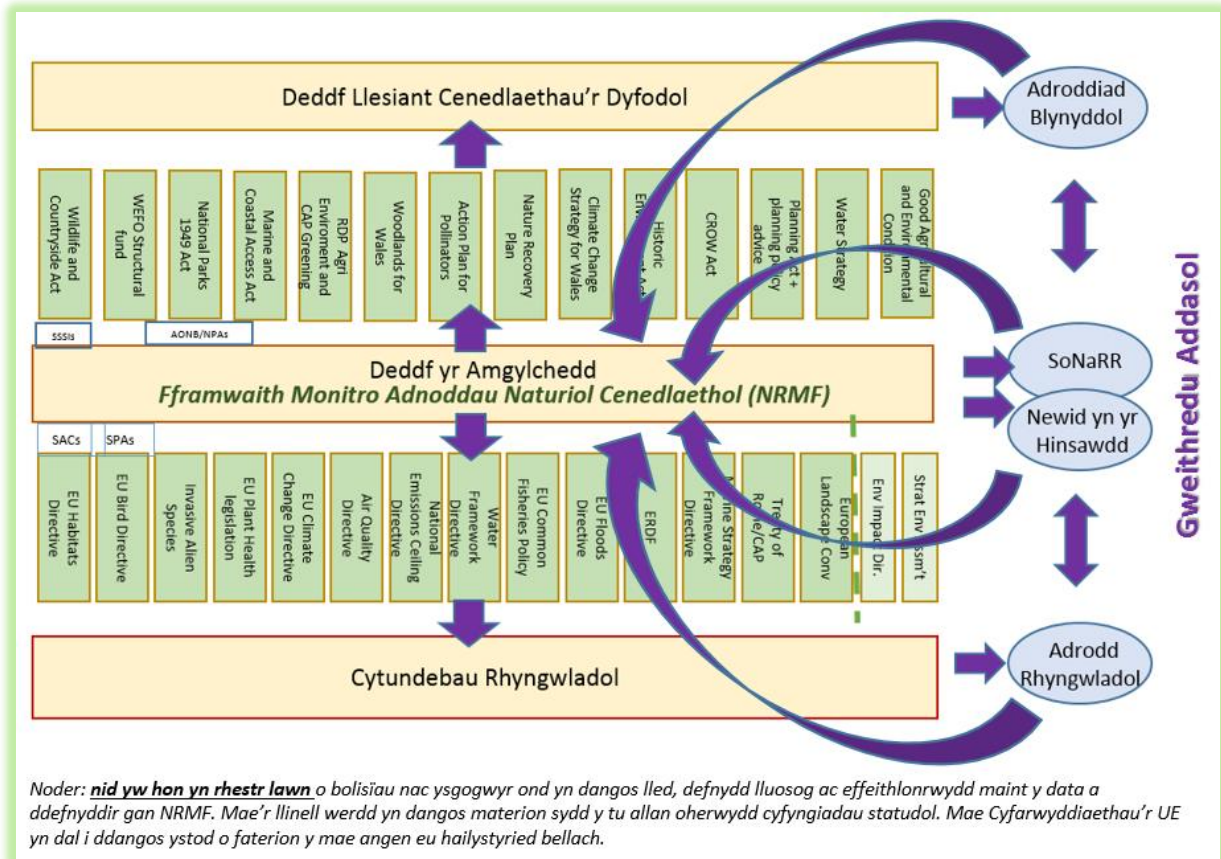
2. Dylai NRMF wasanaethu anghenion sylfaen cwsmeriaid ehangach ar gyfer tystiolaeth adnoddau naturiol ar draws y Cabinet, NRW a phartneriaid i gydnabod y buddion cymdeithasol ac economaidd sy'n deillio o adnoddau naturiol iach a chydnerth.

Rhesymeg a Chyflawniad:

Mae adnoddau naturiol yn ategu nifer o sectorau yn cynnwys amaethyddiaeth, pysgodfeydd, twristiaeth a choedwigaeth, maent hefyd yn gwneud cyfraniad sylweddol ar draws polisiâu'r Cabinet yn cynnwys yr agenda iechyd a lles. Mae angen i'r gweithgareddau gynnwys:

- I. Gwasanaethu ystod eang o anghenion tystiolaeth ar draws nifer fawr o bolisiâu ac ysgogwyr rhyngwladol, y DU a domestig (a nodir yn fynegol yn Ffigur 2).

- II. *Alinio llwybrau adrodd lle y bo'n bosibl ond dylid hefyd cydnabod gofynion penodol ar gyfer polisiau unigol lle y bo'n bosibl e.e. adrodd Rhyngwladol (gweler adroddiad Gweithdy 1).*



Ffigur 2: Amlinelliad mynegol rhai o'r polisiau a'r ysgogwyr ar gyfer data a thystiolaeth NRMF.

3. Dylai **Bwrdd Cydlynu** gael ei sefydlu sydd yn gynrychioliadol o ddefnyddwyr a darparwyr tystiolaeth. Dylai'r Bwrdd hwn gael y dasg o gynghori ar **wneud y gorau o a thargedu** adnoddau arolwg, monitro, dadansoddi a dehongli yng Nghymru. Bydd hyn yn cyflwyno dull addasol o fonitro, cynyddu effeithlonrwydd, gwella gwaith partneriaeth a helpu i lywio penderfyniadau rheoli i'r dyfodol er mwyn gwella cadernid ein hadnoddau naturiol a'n hecosystemau a chynyddu'r buddion.

**Rhesymeg a Chyflawniad:**

Er mwyn sicrhau optimeiddio a thargedu gwell a defnydd mwy effeithlon o adnoddau, argymhellir sefydlu Bwrdd Cydlynu sydd yn adlewyrchu sylfaen cwsmeriaid ehangach newydd yn ogystal â'r gymuned darparwyr tystiolaeth. Mae angen i weithgareddau'r Bwrdd gynnwys:

- I. Adolygiad cadarn o dystiolaeth sy'n dod i'r amlwg o arsylwi'r Ddaear (EO), modelu a monitro data o fewn cyd-destun blaenoriaethau polisi i lywio elfen addasu NRMF sy'n seiliedig ar risg.



- II. *Cyfuno'r dystiolaeth hon gyda ffynonellau eraill fel astudiaethau arbrofol, treialon rheoli, arolygon cymdeithasol ac economaidd a thystiolaeth o'r tu allan i Gymru i ddatblygu opsiynau rheoli ar gyfer Polisi Adnoddau Naturiol Cenedlaethol.*
- III. *Ymgysylltu â threfnwyr arolwg, perchennogion data a darparwyr data i gydlynu cyfraniadau monitro newydd a pharhaus, ymdrech ddadansoddol a dehongli targedau monitro a rennir, a sicrhau bod pob grŵp yn cael ei gefnogi'n ddigonol yn y gweithgareddau hyn.*
- IV. *Arwain wrth asesu technolegau newydd a'u haddasrwydd ar gyfer eu mabwysiadu yn yr NRMF a hwyluso mwy o rannu data fel rhan o raglen welliant barhaus i'r NRMF.*
- V. *Helpu i gydlynu adnoddau NRMF posibl yn effeithiol ar draws sefydliadau mewn ymateb i argyfyngau naturiol neu wedi eu creu gan ddyn fel achosion o glefydau, llosgfynyddoedd a digwyddiadau sylweddol o lygredd (gweler Papur Briffio Ymateb i Argyfyngau).*

*Cafodd effeithiolrwydd y Bwrdd Cydlynu hwn ei nodi fel un o'r blaenoriaethau a'r peryglon uchaf o'r argymhellion arfaethedig gan y gymuned. Byddai'n gofyn am eglurder rheoli effeithiol ac effeithlon o gerrig milltir ac elfennau i gael eu darparu a phroses adolygu annibynnol.*

**4. Dylai'r gymuned fanteisio ar yr NRMF yn ddomestig ac yn rhyngwladol i feithrin gallu, cynyddu cydariannu a buddsoddi yng Nghymru, a defnyddio a datblygu atebion a chynnyrch newydd gyda diwydiant gan fanteisio ar botensial economaidd llawn yr NRMF ar gyfer datblygu'r economi.**

***Rhesymeg a Chyflawniad:***

*Dylid manteisio ar y sgiliau a'r technolegau uwch a ddatblygwyd i gyflenwi'r fframwaith arloesol hwn i ategu ystod o gyfleoedd i gefnogi'r economi werdd a phrif ffrydio'r amgylchedd ym mhob agwedd ar economi Cymru. Yn benodol:*

- I. *Mae angen ymgysylltu'r Economi ac Isadeiledd a'u cynrychioli yn NRMF y dyfodol, ynghyd â chynrychiolaeth BBaCh, er mwyn sicrhau y manteisir ar gyfleoedd.*
- II. *Mae angen i NRMF y dyfodol feithrin gallu yng Nghymru o ran sgiliau, arbenigedd a thechnoleg e.e. trwy raglenni prentisiaeth, astudiaethau ôl-radd a gwaith partneriaeth gyda diwydiant. Gallai'r testunau gynnwys dylunio meddalwedd a chaledwedd a dadansoddiadau data (gweler papur Briffio Data a Gwybodeg), technolegau synwryddion a synhwyro ar gyfer rhybuddion cynnar (Gweler papur Briffio Arsylwi'r Ddaear), cynnyrch data gwell i hysbysu'r sectorau peirianeg ac isadeiledd (gweler adroddiad Map Tir Dwyochrog), cynnyrch y cyfryngau cymdeithasol i wella'r profiad hamdden (gweler CADW ac adroddiad Map Tir Dwyochrog) a manteisio ar dechnegau moleciwlaidd ar gyfer olrhain clefydau a rhywogaethau ymosodol yn fwy effeithiol (gweler papur Briffio Geneteg Foleciwlaidd).*
- III. *Dylai'r NRMF hefyd hyrwyddo ac annog gweithgareddau ymchwil wedi eu cyfeirio'n fwy i ategu'r fframwaith monitro trwy e.e. ymgysylltu â RCUK<sup>10</sup>. Dylai hefyd ddarparu llwyfan ar gyfer manteisio ar ddata a gwybodaeth gan Raglenni Arloesi RCUK.*

<sup>10</sup> RCUK: Cynghorau Ymchwil y DU

5. **Dylai'r NRMF goresawu, gwella ac integreiddio dulliau a thechnolegau monitro ac wrth wneud hynny, cyflenwi a chael budd o arloesi, cyfleoedd newydd a gwneud defnydd mwy effeithiol o adnoddau. Dylai hyn gynnwys asesiad cadarn a systematig o dechnolegau a dulliau newydd cyn y posibilrwydd o'u mabwysiadu. Bydd y dull hwn yn gwella defnydd strategol o adnoddau gan sicrhau rhaglen wella barhaus.**

*Rhesymeg a Chyflawniad:*

*Dylai'r dulliau gyd-fynd lle mae hyn yn ymarferol i gynyddu effeithlonrwydd, i hwyluso rhannu data a galluogi cymhariaeth deg o ran perfformiad rhwng llwybrau adrodd gwahanol. Fodd bynnag, ni ddylai hyn atal arloesi gyda thechnolegau newydd rhag cael ei asesu fel rhan o raglen welliant barhaus, gan gydnabod na all unrhyw dechnoleg nac ymagwedd weithredu yn effeithiol yn ynysig a bod bias a chyfyngiadau yn gysylltiedig â dulliau newydd neu draddodiadol. Dylai'r materion canlynol lywio penderfyniadau i'r dyfodol:*

- I. Y defnydd mwyaf effeithiol o'r holl dechnolegau a'r ymagweddau yw eu cyfuniad, gan fanteisio ar eu cryfderau unigol. Mae'r ymagweddau y dylid manteisio arnynt yn cynnwys arolwg maes systematig ac addasol, arsylwi'r ddaear, eDNA a dulliau genetig moleciwlaidd eraill, a gwyddor dinasyddion. Caiff astudiaethau achos eu disgrifio yn y papurau Briffio sy'n arddangos cyfuniadau newydd yn cynnwys arsylwi'r ddaear ac ymagweddau moleciwlaidd ar gyfer sgrinio cyflym i wella targedu gweithgareddau arolwg maes a gwyddor dinasyddion (gweler Geneteg Foleciwlaidd, Gwyddor Dinasyddion, papur Briffio Arsylwi'r Ddaear).*
- II. Yn seiliedig ar yr adolygiadau hyn a'r dystiolaeth a gafwyd yn ystod yr adroddiadau dwyochrog gydag ystod eang o ddefnyddwyr tystiolaeth, dylai ystod o fethodolegau arolwg ac asesu gael eu datblygu i gyfleu tueddiadau yn yr amgylchedd ehangach a safleoedd penodedig. Dylid defnyddio data i sefydlu'r sail dystiolaeth ar gyfer tueddiadau yn stoc a chyflwr y dirwedd ehangach, yn ogystal â'r buddion o ddynodi/trefnu ar gyfer e.e. nodweddion tirwedd, bioamrywiaeth a hanesyddol. Dylai'r dulliau gynnwys methodolegau arolwg cyflym a manwl (gweler yr adroddiadau Dwyochrog a'r papurau Briffio).*
- III. Dylid cytuno ar y methodolegau safonol hyn a'u darparu gyda hyfforddiant a chymorth priodol i'r gymuned ehangach, rhanddeiliaid a busnesau i alluogi cymariaethau â thueddiadau cenedlaethol parhaus ac i helpu i rannu data. Mae prosiect peilot wedi cael ei wneud i archwilio'r ymagwedd hon (gweler yr adroddiad Arolwg Peilot).*
- IV. Dylai'r Bwrdd Cydlynw newydd adolygu cyfraniadau posibl technolegau newydd i'r NRMF yn rheolaidd. Dylai hyn gynnwys asesiad o e.e. eu perthnasedd i flaenoriaethau polisi, dadansoddiad o fudd o ran cost, costau sefydlu tebygol, gofynion ar gyfer adrodd statudol (e.e. achrediad), a chymhariaeth ddigonol â dulliau presennol os ydynt i gael eu disodli i gynnal y cofnod o'r duedd barhaus. Dylid gwneud y rhain ac ystyriaethau eraill cyn eu mabwysiadu fel rhan o raglen welliant barhaus (gweler y Papurau Briffio ar Eneteg Foleciwlaidd, Arsylwi'r Ddaear a Gwyddor Dinasyddion).*

6. Dylai'r NRMF ddilyn yr egwyddor o gasglu unwaith – ailddefnyddio'n aml. Dylai fod yn ffynhonnell allweddol o ddata a thystiolaeth yn ategu Deddfau'r Amgylchedd a Llesiant Cenedlaethau'r Dyfodol, Adroddiad Cyflwr Adnoddau Naturiol, Polisi Adnoddau Naturiol Cenedlaethol, ac ystod o ofynion deddfwriaethol yn cynnwys ymrwymiadau rhyngwladol.

*Rhesymeg a Chyflawniad:*

Mae gweithgareddau monitro presennol o ansawdd amrywiol, nid ydynt yn cyd-fynd yn ddiogol â'r dirwedd ddeddfwriaethol a pholisi newydd, maent yn ddigyswllt ac, wrth gael eu hystyried yn eu cyfanrwydd, efallai nad ydynt mor gost effeithiol ag y gallent fod. Mae'r blaenoriaethau canlynol wedi cael eu nodi:

- I. *Mae deg categori o dystiolaeth ar gyfer y sector daearol wedi cael eu cytuno gan y gymuned trwy ymarfer mapio yn erbyn anghenion polisi ac adrodd. Mae'r gweithgareddau presennol wedi cael eu mapio yn erbyn y categorïau hyn wedi ei ddilyn gan asesiad o'u haddasrwydd at y diben ar gyfer adrodd ar raddfa genedlaethol (gweler adroddiad Gweithdy 1). Mae angen gweithredu ar gyfleoedd, synergeddau a bylchau mewn gweithgareddau monitro presennol a nodwyd trwy'r broses hon er mwyn sicrhau bod y rhaglen fonitro yn y dyfodol yn adlewyrchu'r gofynion tystiolaeth ar gyfer y ddeddfwriaeth ddomestig newydd tra'n sicrhau bod gofynion statudol eraill yn cael eu cyflawni'n effeithiol.*
  - II. *Mae ailgydbwysu ymdrechion yn debygol o fod yn angenrheidiol rhwng y sectorau daearol (yn cynnwys gollyngiadau aer a nwyon tŷ gwydr), y sectorau dŵr croyw a morol yn seiliedig ar lefelau gweithgaredd presennol. Er enghraifft mae ca. 80% o'r ymdrechion monitro yn NRW ar hyn o bryd yn canolbwyntio ar systemau dŵr croyw a morol, heb unrhyw raglen ar hyn o bryd ar gyfer asesu safleoedd daearol neilltuol (gweler Adroddiad Gweithdy 1 a'r Papur Briffio ar ddŵr). Yn dilyn refferendwm yr UE, mae'r cwmpas i wireddu portffolio mwy cytbwys o bosibl yn fwy hydrin nag o'r blaen.*
7. I leihau dyblygu a chynyddu effeithlonrwydd, dylai NRMF fabwysiadu dull clir o rannu data yn effeithlon ac yn effeithiol i alluogi troi data yn gynnyrch tystiolaeth cadarn. Mae angen ailgydbwysu adnoddau i ffwrdd o gasglu data i gydlynu, dadansoddi a dehongli data. Dylai'r dull hwn fanteisio ar dechnolegau newydd sydd yn galluogi rhwydweithio data, gwybodaeth ac offer dadansoddi i gynyddu gwerth a'r defnydd o ddata.

*Rhesymeg a Chyflawniad:*

Mae cynllun clir a chynhwysfawr ar gyfer llywio casglu, rheoli, defnyddio a rhannu data a gwybodaeth yn hanfodol. Mae'n rhaid i'r cynllun hwn gydnabod yr angen cynyddol ar gyfer integreiddio data er mwyn i ddeddfwriaeth ddomestig newydd gael ei gwasanaethu'n effeithiol tra'n cydnabod cyfyngiadau defnydd sy'n deillio o ofynion cyfreithiol sy'n gysylltiedig â rheoleiddio, cyfrinachedd, trwyddedu neu gydymffurfio (gweler Papur Briffio Data a Gwybodeg). Ar yr un pryd, mae'n rhaid iddo hefyd gydnabod buddiannau cydberchnogion NRMF, darparwyr data a threfnwyr arolygon, sydd yn ysgogi'r casgliad o samplu sy'n cael ei ariannu'n annibynnol. Mae angen i'r gweithgareddau gynnwys:

- I. *Argymhellir ymarfer mapio i nodi'r cysylltiadau blaenoriaeth y mae angen eu sefydlu i wella rhannu data a chydgyhyrchu tystiolaeth gan gynlluniau proffesiynol a gwyddor dinasyddion, wedi ei oruchwylio o bosibl gan Is-grŵp Cydlynu Data a Gwybodeg newydd.*
- II. *Ystyriaeth ynghylch pryd i ddefnyddio ffynhonnell agored a meddalwedd am ddim ar gyfer tasgau fel cyfleu a modelu data yn erbyn defnyddio cynnyrch masnachol. Mae angen i hyn ystyried materion fel dibynadwyedd cynnal a chadw parhaus, cymorth sylfaenol cronfa ddata, mwy o fabwysiadu ac effeithiolrwydd cost gwella systemau presennol yn hytrach na datblygu a chyflwyno rhai newydd, ac ati.*
- III. *Mae angen ystyried hygyrchedd hefyd, y defnydd a hyrwyddo safonau, cadw a gallu i archwilio data presennol (yn cynnwys y ffordd y mae data'n cael ei droi'n dystiolaeth (h.y. ffrydiau gwaith)) a tharddiad tystiolaeth a defnydd o dechnolegau cyfleu data a rhannu ar y we newydd. Bydd y gwahaniaethau rhwng mynediad i ddata ac argaeledd tystiolaeth ddibynadwy yn hanfodol yma.*
- IV. *Dylid cydnabod na all pob data fod ar gael i'w rannu oherwydd cyfyngiadau ariannu, cyfreithiol a/neu IPR. Gallai rhannu mewn rhai achosion olygu 'ar gael i'w brynu'.*
- V. *Mae angen i weithgareddau ddatblygu profiad yn y gorffennol a manteisio ar fentrau parhaus, yn genedlaethol ac yn rhyngwladol, ac felly osgoi dyblygu.*
- VI. *Dylai datblygu dulliau effeithiol o droi data'n dystiolaeth (h.y. ffrydiau gwaith) sydd yn ystyried cadernid y ffynonellau data gwahanol i greu cynnyrch data effaith uchel y gellir ei aildefnyddio sy'n berthnasol i ystod eang o adrannau a rhanddeiliaid, gael ei annog. Gallai hyn ofyn am ailgydbwysu o ran dyrannu adnoddau o gipio data i drawsnewid data a chynhyrchu metrigau effeithiol mewn rhai achosion.*

*Er nad oes unrhyw honiad o ormodedd o ran casglu data presennol a chaiff ei gydnabod y gallai gweithgaredd monitro gael ei lywio gan ffactorau nad ydynt yn gysylltiedig â blaenoriaethau polisi LIC, byddai adolygiad o ddyrannu adnoddau LIC tuag at ddefnyddio data, yn hytrach na'i gasglu, yn werthfawr er mwyn datgelu effeithlonrwydd posibl. Gallai disodli ymdrech fonitro bresennol posibl trwy ddadansoddi data heb ei strwythuro gael ei ystyried mewn rhai enghreifftiau, ond nid yw wedi ei ragbennu.*

8. **Dylai'r NRMF gynnwys cydran modelu a phrofi sefyllfa i ategu dehongli data, datblygu gallu rhagfynegol a galluogi adborth cyflym i bolisi a rheolaeth. Bydd hyn yn cefnogi datblygiad parhaus polisiâu mwy cadarn sydd yn cynyddu i'r eithaf y buddion cymdeithasol ac economaidd sydd yn deillio o'n hadnoddau naturiol a'n hecosystemau yn yr hirdymor.**

**Rhesymeg a Chyflawniad:**

*Mae modelau yn offer hanfodol i integreiddio ac uwchraddio data a galluogi sefyllfaoedd i gael eu harchwilio ar gyfer Polisi Adnoddau Naturiol Cenedlaethol i'r dyfodol. Mae arfer da yn defnyddio cyfuniad o sawl model i asesu lefelau hyder, yn gwneud defnydd effeithiol o ddata monitro ac yn datblygu sefyllfaoedd economaidd-gymdeithasol cyffredin e.e. fel y defnyddir yn Adroddiadau Asesu'r Panel Rhyngwladol Newid yn yr Hinsawdd (IPCC).*

- I. *Dylai'r NRMF gynyddu gallu yn y maes hwn gan nodi cyfres o fodelau perthnasol sydd wedi eu dylunio ar gyfer cymwysiadu ymarferol i ddarparu atebion amserol. Dylai gwerthuso modelau presennol fod yn fan cychwyn oherwydd y gofynion o ran cost datblygu model.*

- II. *O ran data, dylai rhannu ffrydiau gwaith model gael ei annog i gynyddu tryloywder a'r gallu i ailadrodd.*
- III. *Dylai'r holl weithgareddau ddatblygu mentrau modelu cenedlaethol a rhyngwladol parhaus yn cynnwys safonau.*
- IV. *Datblygu modelau fel y gellir eu cyplu a/neu eu defnyddio o fewn fframweithiau modelu integredig wedi eu sefydlu.*
- V. *Yn dilyn refferendwm yr UE, gallai'r fframwaith modelu hwn fod yn gyfle gwerthfawr i ddatblygu asesiad integredig o opsiynau polisi ar draws ystod o ganlyniadau amgylcheddol, cymdeithasol ac economaidd. Mae ystod o fodlau eisoes wedi cael eu datblygu ar gyfer eu cymhwyso ar y raddfa genedlaethol yng Nghymru ar gyfer y sectorau tir a dŵr croyw fel rhan o brosiect GMEP. Mae modelau Asesu Integredig hefyd ar gael yn helaeth bellach fel adnoddau cymunedol ar y we y gallai'r NRMF eu treialu a'u datblygu.*

**9. I wireddu buddion sylweddol y fframwaith integredig hwn, mae angen dull tri chyfnod dros 5 mlynedd i droi'r uchelgais yn rhaglen ymarferol a chyd-fynd â gweithgareddau a mentrau parhaus:**

- a. **Cyfnod I – cyfnod archwilio cychwynnol oedd yn canolbwyntio'n bennaf ar systemau daearol (cwblhawyd);**
- b. **Cyfnod II – yn cynnwys rhaglen gyflenwi a gwella yn rhoi'r cyfleoedd ymarfer a nodwyd yng Nghyfnod I ar waith a datblygu fframwaith cynhwysfawr ar draws monitro pob adnodd naturiol ac ecosystem yn rhychwantu systemau aer, tir a dŵr croyw a morol a'u rhyngwyneb;**
- c. **Cyfnod III – gweithredu fframwaith monitro integredig sy'n cael ei adnewyddu mewn cylch parhaus.**

Rhesymeg a Chyflawniad:

*Mae'r NRMF yn gofyn am newidiadau diwylliannol a sefydliadol fydd yn cymryd amser i'w gweithredu er mwyn cynnal a datblygu ymrwymiad ac ymgysylltiad yr holl bartneriaid. Ceir hefyd cyfyngiadau ymarferol i sicrhau nad oes unrhyw doriadau o ran monitro a fyddai'n peryglu'r gofynion adrodd pwysig.*

*Perygl mawr a nodir yw colli momentwm ac ymrwymiad y darparwyr tystiolaeth o ganlyniad i gyfres o doriadau ad hoc i raglenni monitro presennol. Mae arweinyddiaeth glir ac arweinyddiaeth effeithiol a darparu adnoddau gan LIC yn ystod y broses gyfnodau hon yn hanfodol.*

*Mae rhai gweithredoedd / cyfleoedd uniongyrchol a nodwyd yng Nghyfnod I ar gyfer eu gweithredu yng Nghyfnod II (gweler nodiadau'r Cyfarfod Dwyochrog) yn cynnwys:*

**Alinio polisi ac adrodd**

- I. *Alinio gwell i'r fframwaith deddfwriaethol domestig sylfaenol e.e. Polisi Adnoddau Naturiol Cenedlaethol, Adrodd ar Gyflwr Adnoddau Naturiol, Deddf Llesiant Cenedlaethau'r Dyfodol a Deddf yr Amgylchedd.*
- II. *Alinio a chyflenwi gwell i gyfres ehangach o bolisiâu a rhaglenni ar draws y Cabinet. Mae enghreifftiau penodol a enwir yn ystod sesiynau dwyochrog yn cynnwys y rheiny*

*sy'n ymwneud â Deddf yr Amgylchedd Hanesyddol; Cyfarwyddiaethau Rhywogaethau Ymledol ac Anghynhenid yr UE; Cyfarwyddiaeth Iechyd Planhigion yr UE; polisiau'n ymwneud â'r agenda iechyd a lles.*

- III. *Cyflenwi tystiolaeth i Raglenni RDP ehangach e.e. dangosyddion cyd-destun cyffredin.*
- IV. *Alinio adrodd ar gategoriâu/strwythurau NRMF ac NRW yn well e.e. dosbarthiadau cynefinoedd.*

Manteisio mwy ar ddata/gwaith arolwg presennol a llenwi bylchau

- V. *Dadansoddi data GMEP a NRW ar y cyd ar gyfer asesu cyflwr ystod o safleoedd neilltuol am fioamrywiaeth (e.e. SSSIs<sup>11</sup>, SACs<sup>12</sup>, SPAs<sup>13</sup>), tirwedd (Parciau Cenedlaethol) a nodwedd hanesyddol (SAMs<sup>14</sup>, HEFs<sup>15</sup>) ac felly caniatáu buddion neilltuo/trefnu i gael eu hasesu ac olrhain gwaith arolwg maes i gael ei flaenoriaethu.*
- VI. *Manteisio ar arolwg maes ac archif sampl NRMF i olrhain achosion o glefydau a lledaeniad rhywogaethau ymledol ac anghynhenid.*
- VII. *Ymestyn Arolwg Ymarfer Ffermwyr GMEP i gynnwys cwestiynau ar y defnydd o blaladdwyr (data ond ar gael ar lefel y DU ar hyn o bryd) ac ymagwedd tuag at reoli plâu.*
- VIII. *Gwaith partneriaeth i adnabod opsiynau i lenwi bylchau mewn tystiolaeth e.e. trefol, cadernid ecosystem.*
- IX. *Manteisio ar ddata sydd ar gael i ddatblygu'r dangosyddion mwyaf cadarn a pherthnasol, e.e. ar gyfer bioamrywiaeth ac ecosystemau iach, sydd yn adlewyrchu uchelgais Deddf Llesiant Cenedlaethau'r Dyfodol a Deddf yr Amgylchedd, gan weithio gyda phartneriaid y DU lle mae'r uchelgeisiau hyn yn cyd-fynd.*

Alinio ac integreiddio dulliau

- X. *Integreiddio EO, modelu a thuenniadau parhaus o weithgareddau arolwg maes i dargedu ymdrech arolygon maes yn well yn y dyfodol i feysydd risg uchel tra'n cynnal elfen systematig i adrodd ar newid o ran graddau a chyflwr.*
- XI. *Rhannu protocolau a methodolegau i alluogi tuenniadau o ran stoc a chyflwr i gael eu cymharu rhwng tir a ddelir gan bartneriaid a busnes a'r cyd-destun cenedlaethol (e.e. Yr Ymddiriedolaeth Genedlaethol, Parciau Cenedlaethol ac ati. – gweler adroddiad yr Arolwg Peilot).*
- XII. *Archwilio potensial cyfuno cofnodion gwirfoddolwyr gydag ymdrech broffesiynol, er enghraifft mewn ardaloedd pellennig. Mae cyfuno gwyddor dinasyddion gydag arsylwi'r ddaear hefyd yn cyflwyno cyfleoedd sylweddol.*
- XIII. *Gwaith partneriaeth i ddatblygu dulliau i ddiweddarau'r asesiad o'r dirwedd trwy Fap Tir gan ddefnyddio data newid NRMF ac felly cefnogi rheoli datblygiad.*
- XIV. *Manteisio ar Fynegai Ansawdd Gweledol y GMEP i greu haen amgyffrediad cyhoeddus i'r map Tir.*

Data, technolegau a chynnyrch data

<sup>11</sup> SSSI: Safle o ddiddordeb gwyddonol arbennig

<sup>12</sup> SAC: Ardal Gadwraeth Arbennig

<sup>13</sup> SPA: Ardal Gwarchodaeth Arbennig

<sup>14</sup> SAM: Henebion Rhestredig.

<sup>15</sup> HEF: Nodwedd o'r Amgylchedd Hanesyddol

- XV. *Cytundeb ar y data allweddol sydd ei angen yn NRMF y gellir ei addasu ‘yn ôl yr angen’ ar gyfer dangosyddion newidiol wrth i bolisiau newid dros amser heb effeithio ar ddata tueddiadau hirdymor ar gyfer ein hadnoddau naturiol.*
- XVI. *Mwy o rannu data trwy dechnolegau rhannu ar y we, wedi eu hintegreiddio gydag amddiffyn eiddo deallusol ac adnoddau ar gyfer perchenogion data. Defnydd gwell o safonau data, gallu i archwilio a dulliau tarddiad ac asesiad mwy cadarn o’r ffynonellau data gwahanol.*
- XVII. *Mwy o ymdrech yn troi data yn effeithlon i gynnyrch tystiolaeth y gellir eu hailddefnyddio gan ddefnyddwyr lluosog.*
- XVIII. *Yn dilyn buddsoddiad Llywodraeth Cymru yn datblygu Archif Landsat wedi ei brosesu ymlaen llaw ar gyfer Cymru, byddai dull cydlynus o gaffael, prosesu ymlaen llaw, a chynhyrchu cynnyrch canolradd a dosbarthu data EO arall o fantais. Dylai hyn ganolbwyntio ar ddata o Sentinel 1 a 2 yn y lle cyntaf ac archwilio dichonolrwydd a chost sicrhau gwasanaeth Lidar ar gyfer Cymru, trwy ychwanegu caffaeliadau Lidar i ymgyrch ffotograffiaeth awyr 3 blynedd Cymru.*
- XIX. *Byddai hyb cenedlaethol canolog sydd yn caffael, yn storio, yn prosesu ymlaen llaw ac yn dosbarthu data EO safonol gyda’r fersiwn wedi ei reol a chynnyrch canolradd sydyn berthnasol i fonitro cenedlaethol yn osgoi dyblygu ymdrech, yn torri costau ac yn cyflymu’r defnydd o ddata EO. Bydd cynnyrch derbyn penodol fel map generig defnydd o dir y DU, map cymeriad Cymru, model tir digidol, map ardaloedd o newid yn cynorthwyo amrywiaeth o ddefnyddwyr ac felly byddai’n manteisio ar ddull canolog o reoli data. Roedd enghreifftiau eraill o gynnyrch EO i gael eu cynhyrchu unwaith ar gyfer eu hailddefnyddio sawl gwaith a gynigiwyd yn ystod y sesiynau dwyochrog yn cynnwys:*
- NDVI (gwyrddni biomas) i’w cymhwyso mewn diweddariadau Map Tir; amcangyfrifon cynhyrchu llystyfiant; asesu straen a chadernid.*
  - Graddau’r prysgwydd i asesu’r perygl posibl i nodweddion hanesyddol; cyflwr glaswelltir a gwlyptir; perygl i isadeiledd a rhwydweithiau hamdden.*
  - Straen dŵr o ran cymwysiadau sy’n gysylltiedig ag iechyd pridd; rheoleiddio cyflenwad dŵr ar gyfer cynhyrchu amaethyddiaeth; perygl o ddŵr yn llifo o gaeau ac erydu.*
  - Cysylltedd ar gyfer asesu cadernid bioamrywiaeth; perygl o ledaenu clefydau.*
  - Nodweddion coediog – cysylltedd coetir; trosglwyddo clefydau; cadernid.*
  - Mapiau draeniad ar gyfer asesu cyflwr pridd a mawn.*

#### *Ymchwil a datblygu technolegau newydd*

- XX. *Mae angen cyfnewid gwybodaeth effeithiol rhwng Llywodraeth Cymru, rhanddeiliaid a’r gymuned academiaidd ar ddatblygiadau methodolegol blaenllaw mewn dulliau geneteg foleciwlaidd. Dylai Cymru barhau i ymgysylltu â gweithgor eDNA y DU (a sefydlwyd ca. 2014) sydd yn cyfarfod yn flynyddol ac yn cynnwys y rhan fwyaf, os nad holl, sefydliadau DEFRA<sup>16</sup> a nifer o labordai ecoleg foleciwlaidd ar draws y DU.*
- XXI. *Mae hefyd yn bwysig nodi meysydd blaenoriaeth fydd yn elwa’n bennaf ar ddefnyddio offer genetig moleciwlaidd ar gyfer asesu bioamrywiaeth. Lle bo angen, mae angen astudiaethau prawf egwyddor newydd er mwyn cymharu dulliau traddodiadol â dulliau moleciwlaidd, yn cynnwys budd o ran cost ac ystyriaethau economaidd-gymdeithasol.*

<sup>16</sup> DEFRA: Adran yr Amgylchedd, Bwyd a materion Gwledig

Dadansoddi budd o ran cost

XXII. *Er mwyn gwireddu llawer o'r cyfleoedd hyn, mae angen ymgysylltu ehangach o fewn sefydliadau er mwyn cyflawni'r ymrwymiad ymarferol a chanfod y dull mwyaf cost effeithlon o gyflenwi yn ystod Cyfnod II. Nid oedd hyn yn bosibl yn ystod Cyfnod I oherwydd cyfyngiadau amser a diffyg data cost.*

**10. Dylai'r NRMF gynyddu ymgysylltu ar draws Llywodraeth Cymru, y sectorau cyhoeddus, preifat a gwirfoddol; gan gyfleu pwysigrwydd hanfodol adnoddau naturiol Cymru i'w heconomi a llesiant cenedlaethau'r dyfodol.**

Rhesymeg a Chyflawniad:

*Er mwyn cael y budd mwyaf o NRMF, mae'n rhaid i gyfnewid gwybodaeth fod yn rhan annatod o'r gweithgareddau parhaus.*

- I. *Mae angen cyfnewid gwybodaeth a chyfathrebu ar bedair lefel wahanol - llywodraeth, busnes, rhanddeiliaid a'r cyhoedd.*
- II. *Mae angen i'r cynnyrch a mynediad i ddata a gwybodaeth fod yn berthnasol i'r holl gymunedau hyn, mae angen iddynt fod yn hygyrch ac yn ymgysylltu.*
- III. *Mae angen targedu pob gweithgaredd ymgysylltu'n dda gydag amcanion clir ac mae angen iddynt gynnig budd da o ran cost.*

Mae'r weledigaeth gyffredinol y byddai hyn yn ei chyflenwi fel a ganlyn:

***Bydd Fframwaith monitro Adnoddau Naturiol Cenedlaethol yn cael ei ddatblygu i wasanaethu anghenion sylfaen eang o gwsmeriaid ar draws portffolios y Cabinet, a chyflawni potensial economaidd llawn ein hadnoddau naturiol. Caiff hyn ei gyflwyno dros 5 mlynedd o dan arweiniad Bwrdd Cydlynw fydd yn cynrychioli defnyddwyr a darparwyr tystiolaeth. Bydd yn gwella ac yn targedu adnoddau monitro, dadansoddi a dehongli yng Nghymru ac yn caniatáu adborth cyflym i bolisi a rheolaeth. Bydd y fframwaith hwn yn ffynhonnell data a thystiolaeth allweddol yn ategu Polisi Adnoddau Naturiol, yn cynnwys Adrodd ar Adnoddau Naturiol ac ystod ehangach o ofynion deddfwriaethol yn cynnwys ymrwymadau rhyngwladol. Bydd yn croesawu gwellad yn, ac integreiddio dulliau a thechnolegau monitor, ac yn ailgydbwysu adnoddau i alluogi data i 'gael ei gasglu unwaith a'i aildefnyddio'n aml' trwy rannu data'n fwy effeithiol. Bydd cydran modelu a phrofi sefyllfa yn ategu dehongli data ac yn darparu gallu rhagfynegol. Bydd lefelau ymgysylltu ar draws Llywodraeth Cymru, y sectorau cyhoeddus a phreifat yn cynyddu, gan helpu i hybu safle blaenllaw Cymru o ran gwaith cydweithredol ac arloesol.***

I grynhoi, bydd yr argymhellion hyn:



- yn cyfrannu at ddatblygu'r economi;
- yn gwneud defnydd gwell o adnoddau ar draws y gymuned fonitro;
- yn llywio polisi Llywodraeth Cymru yn well ar draws portffolios y Cabinet;
- yn galluogi rheolaeth fwy addasol, ymatebol ac wedi ei thargedu o adnoddau naturiol ac ecosystemau;
- yn ffynhonnell dystiolaeth allweddol ar gyfer Polisi Adnoddau Naturiol Cenedlaethol yn cynnwys yr Adroddiad Cyflwr Adnoddau Naturiol ac ystod ehangach o ofynion deddfwriaethol yn cynnwys ymrwymadau rhyngwladol;
- yn cyflenwi data, dystiolaeth a gwybodaeth yn fwy cywir, amserol ac effeithlon;
- yn integreiddio arbenigedd, data a thechnolegau;
- yn gwneud Cymru yn flaenllaw mewn gwaith cydweithredol ac arloesol.

Yn wag yn fwriadol

OCTOBER 2016

# Options for a New Integrated Natural Resource Monitoring Framework for Wales

## Project Report - Phase I

## Report Summary

Welsh Government Contract No. C147/2010/2011

Agreed Additional Work Requirement Dated 8th March 2016

NERC CEH Project: NEC05945

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# Options for a New Integrated Natural Resources Monitoring Framework for Wales

## Phase 1 Project Report - Report Summary

Welsh Government Contract No. C147/2010/2011  
Agreed Additional Work Requirement Dated 8<sup>th</sup> March 2016  
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## Options for a New Integrated Natural Resources Monitoring Framework for Wales

### REPORT SUMMARY

The Future Options Task and Finish team was tasked with identifying options and developing recommendations for a new integrated natural resources monitoring framework (hereafter referred to as NRMF) for Wales reflecting the ambitions and integrating principles of the Environment Act and Well Being of Future Generations Act. Exploration activities were to include a series of thematic and sequential workshops attended and contributed to by steering group members and wider stakeholders as identified by a steering group. In addition, a series of bilateral meetings focussed on the land-based sector across the Welsh Government (WG) and Natural Resources Wales (NRW) was to be carried out.

The Task and Finish Steering Group appointed by WG was Chaired by NRW with representatives from across different departments in Welsh Government and NRW. The project team led by the Centre for Ecology and Hydrology (CEH) involved organisations involved in professional and volunteer based field surveys and have experience exploiting technologies such as earth observation and molecular genetics. They are active in monitoring at both Wales and UK level and have experience in scenario modelling, data analytics and statistics as well as having past experience in policy advice and development within WG.

Objectives included:

- Mapping evidence needs across WG Departments and NRW
- Reviewing current monitoring and evidence capture activity
- Mapping of activity overlap and identification of redundancy
- Identification and risk assessment of evidence gaps
- Identification of alignment opportunity and interfaces, e.g. GMEP<sup>18</sup>, Natura 2000<sup>19</sup>, WFD<sup>20</sup>
- Identification of reporting pathways e.g. SoNaRR<sup>21</sup>, WFG<sup>22</sup>, RDP<sup>23</sup>.
- Identification of opportunities and new technologies, e.g. earth observation, citizen science, NGO<sup>24</sup> activity and Local Record Centres (LRCs)
- Mapping funding opportunities and challenges
- Exploring future resourcing models, data capture and data analysis/interpretation activity
- Exploring future governance of a Natural Resources Monitoring Programme

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<sup>18</sup> GMEP: Glastir Monitoring & Evaluation Programme

<sup>19</sup> Natura 2000: European network of protected sites (under the Birds Directive and the Habitats Directive)

<sup>20</sup> WFD: Water Framework Directive

<sup>21</sup> SoNaRR: State of Natural Resources Report

<sup>22</sup> WFG: Well Being of Future Generations Act

<sup>23</sup> RDP: Rural Development Programme

<sup>24</sup> NGO: Non-governmental organisations

Due to the limited duration of the project, a focus on the land-based sectors was agreed for the project by the Steering Group, although recognising the importance of interfaces with air, freshwater and marine sectors. Activities carried out to achieve the objectives included wide ranging engagement with evidence users and providers across WG, NRW and the wider community. More than 71 individuals and 25 organisations were involved in Future Options activities over during the 4 months of activity including:

- 38 individuals from 14 organisations in bilateral meetings across WG and NRW departments and external stakeholders;
- 66 individuals from 22 organisations in Stakeholder workshops;
- 50 individuals from 14 organisations drafting Briefing Papers on Earth Observation, Citizen Science, Molecular/eDNA<sup>25</sup>, Freshwater Monitoring, Data & Informatics and Emergency Response
- 11 individuals from 5 organisations in a pilot study.

A set of ten recommendations emerged from these activities which were then exposed to a benefits and risks workshop to assess the likely benefits, risks and risk management strategies arising from the proposed recommendations. The overall consensus of the community was that the benefits would be valuable and could be realised although various risks were identified which would need to be addressed.

The final ten recommendations were refined and signed off by the Steering group on 14<sup>th</sup> July 2016. These are as follow below, together with a brief rationale provided by the project team which summarises some of the evidence that supports each recommendation:

1. **Working collaboratively the Welsh monitoring community should develop an Integrated Natural Resources Monitoring Framework (NRMF). The new framework should be adaptive, responsive to policy priorities and emerging risks whilst maintaining a systematic programme of monitoring the stock and condition of natural resources. This will make more effective use of people and funding and deliver increased benefits.**

*Rationale and Realisation:*

*Increased benefits with reduced overall costs should be realised through greater partnership working which exploit the joint resources and expertise across WG, NRW, industry, third sector and research sectors in Wales. A new framework (illustrated as Figure 1), should include:*

- IV. *An integrated systematic surveillance programme to track ongoing change in stock and condition of Natural Resources with a flexible adaptive element is recommended. This should be a mix of professional and volunteer structured surveys, and unstructured records, exploiting the strengths of all three.*

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<sup>25</sup> eDNA: Environmental DNA



- V. *The adaptive element should be informed by evidence of emerging risks and pressures to specific natural resources from field survey data, earth observation and scenario modelling, and policy priorities across Cabinet.*
- VI. *Conversion of data from a range of sources into robust and relevant evidence should be prioritised and combined with other sources of evidence and knowledge to help to guide future management decisions in an iterative framework, as required by the Environment Act.*

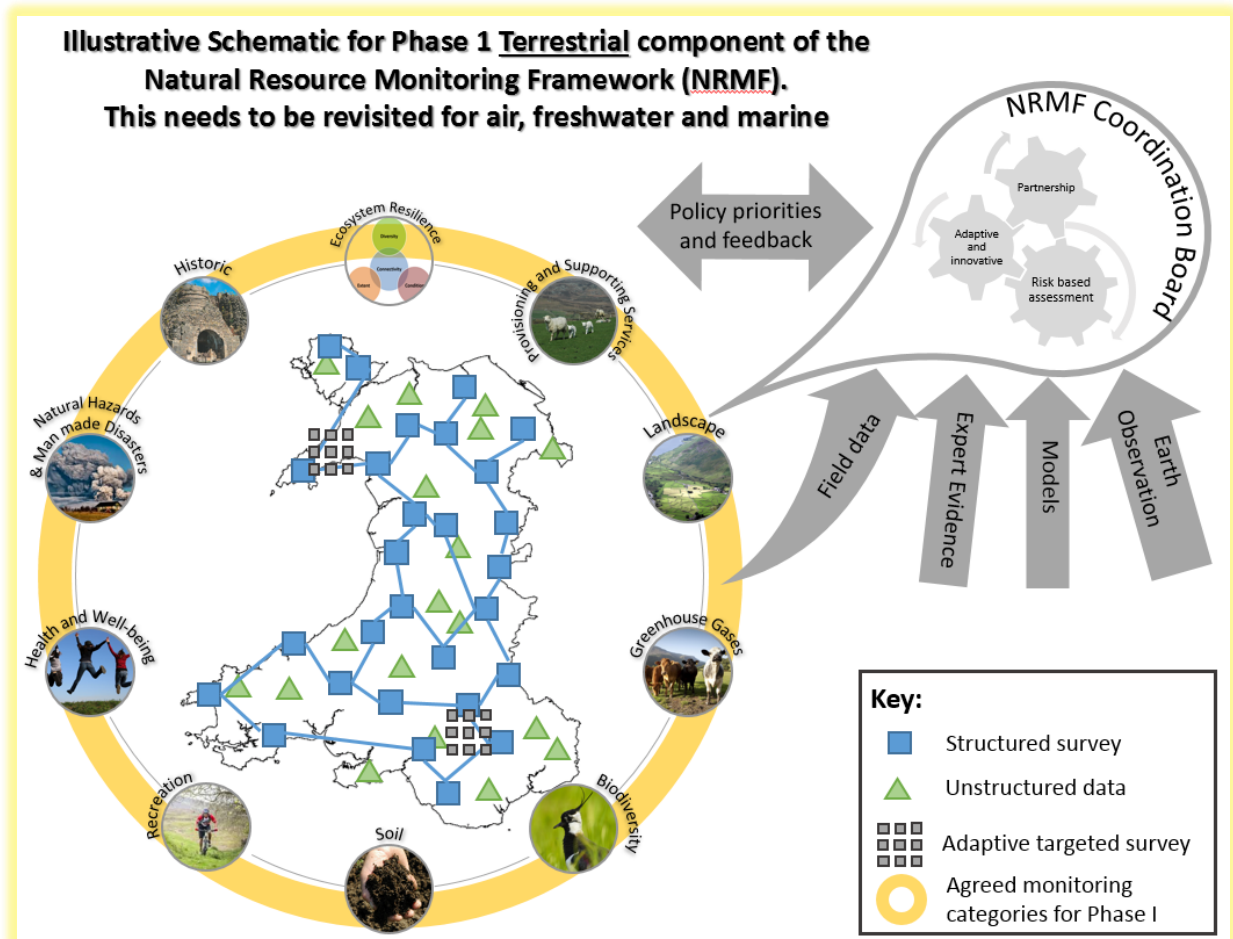


Figure 1: Illustrative Schematic for the Phase 1, Terrestrial component of NRMF.

2. **NRMF should service the needs of a wide customer base for natural resources evidence across Cabinet, NRW and partners in recognition of the social and economic benefits arising from healthy and resilient natural resources.**

**Rationale and Realisation:**

*Natural resources underpin a number of sectors including agriculture, fisheries, tourism and forestry, they also make a significant contribution across Cabinet policies including the health and well-being agenda. Activities need to include:*

- III. *Servicing a wide range of evidence needs across a large number of international, UK and domestic policies and drivers (indicatively illustrated in Figure 2).*

- IV. *Aligning reporting pathways where possible but specific requirements for individual policies should also be recognised e.g. International reporting (see Workshop 1 report).*

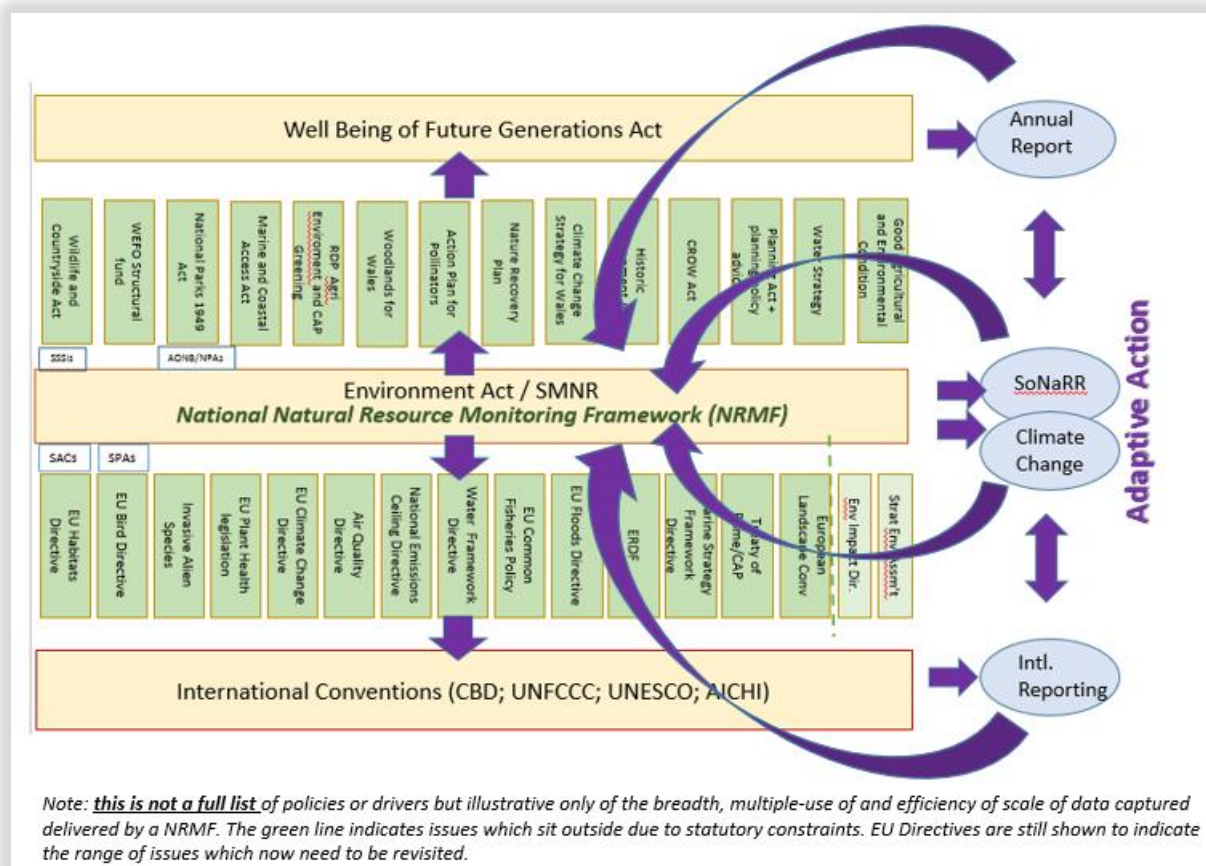


Figure 2: Indicative schematic of some of the policies and drivers for NRMF data and evidence.

3. A **Coordination Board** should be established that is representative of evidence users and providers. This Board should be tasked with advising on the **optimisation and targeting** of the collective survey, monitoring, analytical and interpretation resources in Wales. This will deliver an adaptive approach to monitoring, increase efficiencies, improve partnership working and help guide future management decisions to improve the resilience of our natural resources and ecosystems and increase benefits.

**Rationale and Realisation:**

To ensure better optimisation and targeting and more efficient use of resources, the establishment of a Coordination Board is recommended that reflects the new wider customer base as well as the evidence provider community. Activities of the Board need to include:

- VI. A robust review of emerging evidence from Earth observation (EO), modelling and monitoring data within the context of policy priorities to inform the risk-based adaptive element of the NRMF.

- VII. *Combining this evidence with other sources such as experimental studies, management trials, social and economic surveys and evidence from outside of Wales to develop management options for National Natural Resource Policy.*
- VIII. *Engaging with survey organizers, data owners and data providers to co-ordinate the contributions of ongoing and new monitoring, analytical and interpretation effort to shared monitoring targets, and ensuring that all groups are adequately supported in these activities.*
- IX. *Taking a lead on the assessment of new technologies and their suitability for adoption into the NRMF and facilitate greater data sharing as part of an ongoing improvement programme to the NRMF.*
- X. *Helping to coordinate potential NRMF resources effectively across organisations in response to natural or man-made emergencies such as disease outbreak, volcanoes and major pollution incidents (see Emergency Response Briefing Paper).*

*The effectiveness of this Coordination Board was identified as one of the highest priorities and risks of the proposed recommendations by the community. It would require effective and efficient management clarity of milestones and deliverables and an independent review process.*

**4. The community should take advantage of the NRMF domestically and internationally to build capacity, increase co-funding and investment into Wales, and use and develop novel solutions and products with industry exploiting the full economic potential of the NRMF for developing the economy.**

*Rationale and Realisation:*

*The enhanced skills and technologies developed to deliver this innovative framework should be exploited to underpin a range of opportunities to support the green economy and mainstream the environment into all aspects of the Welsh economy. Specifically:*

- IV. *Economy and Infrastructure need to be engaged and represented with the future NRMF, together with SME representation, to ensure that opportunities are exploited.*
- V. *The future NRMF needs to build capacity within Wales in terms of skills, expertise and technology e.g. through apprenticeship programmes, postgraduate studies, and partnership work with industry. Topics could include software and hardware design and data analytics (see Data and Informatics Briefing paper), sensor and sensing technologies for early warnings (See Earth Observation Briefing paper), enhanced data products to inform the engineering and infrastructure sectors (see Landmap Bilateral report), social media products to enhance recreational experience (see CADW and Landmap Bilateral report) and exploiting molecular techniques for more effective tracking of disease and invasive species (see Molecular Genetics Briefing paper).*
- VI. *NRMF should also promote and encourage more directed research activities to underpin the monitoring framework through e.g. engagement with RCUK<sup>26</sup>. It should also provide a platform for data and knowledge exploitation by RCUK Innovation Programmes.*

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<sup>26</sup> RCUK: Research Councils UK

5. **The NRMF should embrace, improve and integrate monitoring methods and technologies and in so doing deliver and benefit from innovation, new opportunities and make more effective use of resources. This should include a robust and systematic assessment of new technologies and methods prior to their potential adoption. This approach will improve strategic deployment of resources ensuring an ongoing improvement programme.**

*Rationale and Realisation:*

*Methods should be aligned where this is practical to increase efficiency, to facilitate data sharing and to enable equitable comparison of performance between different reporting pathways. However, this should not stop innovation with new technologies being assessed as part of an ongoing improvement programme, recognising that no technology or approach can operate effectively in isolation and that neither new nor traditional methods are without bias or limitations. The following issues should inform future decisions:*

- V. *The most effective use of all technologies and approaches is their combination, exploiting their individual strengths. Approaches to be exploited include systematic and adaptive field survey, earth observation, eDNA and other molecular genetic methods, and citizen science. Case studies are described in the Briefing papers that demonstrate novel combinations including using earth observation and molecular approaches for rapid screening to improve targeting of field survey and citizen science activities (see Molecular Genetics, Citizen Science, Earth Observation Briefing papers).*
- VI. *Based on these reviews and the evidence captured during the bilaterals with a wide range of evidence users, a range of survey and assessment methodologies should be developed to capture trends in both the wider environment and designated sites. Data should be used to establish the evidence base for trends in stock and condition of the wider landscape, as well as the benefits derived from designation/scheduling for e.g. landscape, biodiversity and historic features. Methods should include both rapid and in-depth survey methodologies (see Bilateral reports and Briefing papers).*
- VII. *These standard methodologies should be agreed and made available with appropriate training and support to the wider community, stakeholders and businesses to enable more effective comparisons to ongoing national trends and help data sharing. A pilot project has been carried to explore this approach (see Pilot Survey report).*
- VIII. *The new Coordination Board should regularly review the potential contributions of new technologies to the NRMF. This should include an assessment of e.g. their relevance to policy priorities, a cost-benefit analysis, likely start-up costs, requirements for statutory reporting (e.g. accreditation), and an adequate comparison to current methods if they are to be replaced to maintain the ongoing trend record. These and other considerations should all be carried out prior to their adoption as part of an ongoing improvement programme (see Briefing Papers on Molecular Genetics, Earth Observation & Citizen science).*

- 6. The NRMF should follow the principle of collect once – reuse often. It should be a key source of data and evidence underpinning the Environment and the Well Being of Future Generations Acts, the State of Natural Resources Report, the National Natural Resource Policy, and a range of legislative requirements including international commitments.**

*Rationale and Realisation:*

Current monitoring activities are of varying quality, not sufficiently aligned to the new legislative and policy landscape, disjointed and, when considered as a whole are, may not be as cost effective as they could be. The following priorities have been identified:

- III. *Ten categories of evidence for the terrestrial sector have been agreed by the community through a mapping exercise against policy and reporting needs. A mapping of current activities against these categories has been undertaken followed by an assessment of their fitness for purpose for national-scale reporting (see Workshop 1 report). Opportunities, synergies and gaps in current monitoring activities identified through this process need to be acted upon to ensure that the future monitoring programme reflects evidence requirements for the new domestic legislation whilst ensuring effective delivery of other statutory requirements.*
- IV. *A re-balancing in effort is likely to be required between terrestrial (including air and greenhouse gas emissions), freshwater and marine sectors based on current levels of activity. For example ca. 80% of monitoring effort in NRW is currently focussed on freshwater and marine systems, with no current programme for assessment of terrestrial designated sites (see Workshop 1 Report and the Briefing Paper on water). Post EU referendum the scope to realise a more balanced portfolio is potentially more tractable than before.*
- 7. To reduce duplication and increase efficiencies, NRMF should adopt a clear approach to efficient and effective sharing of data to enable the conversion of data into robust evidence products. A rebalancing of resources away from data collection to data coordination, analysis and interpretation is needed. This approach should exploit new technologies which allow for networking of data, information and analytical tools to increase the value and utility of data.**

*Rationale and Realisation:*

*A clear and comprehensive plan to steer the collection, management, use and sharing of data and information is essential. This plan must recognise the increased need for data integration if new domestic legislation is to be served effectively whilst recognising usage restrictions arising from legal requirements linked to regulation, confidentiality, licensing or compliance (see Data and Informatics Briefing Paper). Concurrently, it must also recognise the interests of NRMF co-owners, data providers and survey organizers, which drive the collection of independently funded sampling. Activities need to include:*

- VII. *A mapping exercise to identify the priority linkages that need to be established to enhance sharing of data and co-production of evidence by both professional and citizen science schemes is recommended, potentially overseen by a new Data Coordination and Informatics Sub-Group.*

- VIII. *Consideration of when to use open source and free software for tasks such as data capture and modelling versus use of commercial products. This needs to take into consideration issues such as reliability of ongoing maintenance, underlying database support, greater adoption and cost-effectiveness of enhancing existing systems rather than developing and rolling out new ones, etc.*
- IX. *Consideration also needs to be made of data accessibility, the use and promotion of existing data standards, preservation and auditability (including how data are converted into evidence (i.e. workflows)) and provenance of evidence and use of new data capture and web-sharing technologies. Differences between access to data and availability of reliable evidence will be critical here.*
- X. *It should be recognised that not all data can be available for sharing due to funding, legal and/or IPR constraints. Sharing may in some cases mean 'available for purchase'.*
- XI. *Activities need to build on past experience and to exploit ongoing initiatives, both nationally and internationally, thus avoiding duplication.*
- XII. *Development of effective methods of conversion of data into evidence (i.e. workstreams) which takes account of robustness of the different data sources to produce high impact and re-useable data products relevant to a wide range of departments and stakeholders should be encouraged. This may require a re-balance in resource allocation from data capture to data transformation and production of effective metrics in some cases.*

*While there is no presumption of redundancy in current data collection and it is recognized that monitoring activity may be driven by factors unrelated to WG policy priorities, a review of WG resource allocation towards the use of data, as opposed to its collection, would be valuable to reveal possible efficiencies. Potential replacement of current monitoring effort by analyses of unstructured data may be considered in certain instances, but is not predetermined.*

- 8. The NRMF should include a modelling and scenario testing component to underpin data interpretation, develop a predictive capacity and enable rapid feedback to policy and management. This will support the ongoing development of more robust policies which optimise the social and economic benefits derived from our natural resources and ecosystems in the long term.**

*Rationale and Realisation:*

*Models are critical tools both to integrate and to upscale data and to allow exploration of scenarios for future National Natural Resource Policy. Good practice uses a combination of several models to assess confidence levels, makes effective use of monitoring data and develops common socio-economic scenarios e.g. as used in the International Panel for Climate Change (IPCC) Assessment Reports.*

- VI. *NRMF should increase capacity in this area identifying a suite of relevant models which are designed for practical applications to provide timely solutions. Evaluation of existing models should be a starting point due to cost requirements of model development.*
- VII. *As for data, sharing of model workflows should be encouraged to increase transparency and repeatability.*
- VIII. *All activities should build on ongoing national and international modelling initiatives including standards.*

- IX. *Development of models such that they can be coupled and/or used within established integrated modelling frameworks should be encouraged.*
- X. *Post EU referendum, this modelling framework could provide a valuable opportunity to develop an integrated assessment of policy options across a range of environmental, social and economic outcomes. A range of models have already been developed for application at the national scale in Wales for the land- and freshwater based sectors as part of the GMEP project. Integrated Assessment models are also now becoming freely available as web-based community resources which the NRMF could trial and develop.*
- 9. To realise the significant benefits of this integrated framework a three phased approach over 5 years is required to convert the ambition into a practical programme and align with ongoing activities and initiatives:**
- d. Phase I – an initial exploration period which was primarily focussed on terrestrial systems (completed);**
- e. Phase II - including a delivery and improvement programme putting into practice opportunities identified in Phase I and developing a comprehensive framework across all natural resource and ecosystem monitoring spanning air, land and freshwater and marine systems and their interface;**
- f. Phase III - implementing an integrated monitoring framework which is refreshed on an ongoing cycle.**

*Rationale and Realisation:*

*The NRMF requires cultural and organisational changes that will take time to implement if commitment and engagement by all partners is to be maintained and grown. There are also practical constraints to ensure that there are no breaks in monitoring that would compromise important reporting requirements.*

*A major risk identified is a loss of momentum and commitment by the evidence providers resulting from a series of ad hoc cuts to current monitoring programmes. Clear leadership and effective leadership and resourcing by WG during this phasing process is critical.*

*Some immediate actions / opportunities identified in Phase I for implementation in Phase II (see Bilateral Meeting notes) include:*

Policy and reporting alignment

- XXIII. *Improved alignment to primary domestic legislative framework e.g. National Natural Resource Policy, State of Natural Resources Reporting, Well Being of Future Generations Act and Environment Act.*
- XXIV. *Improved alignment and delivery to a wider suite of policies and programmes across Cabinet. Specific examples named during bilaterals included those relating to the Historic Environment Act; EU Invasive and Non-Native Species Directives; EU Plant Health Directive; policies relating to the health and well-being agenda.*
- XXV. *Evidence delivery to wider RDP Programmes e.g. common context indicators.*
- XXVI. *Stronger alignment of NRMF and NRW reporting categories/structures e.g. habitat classes.*

### Better exploitation of existing data/survey work and gap filling

- XXVII. *Joint analysis of GMEP and NRW data for assessing condition of a range of designated sites for biodiversity (e.g. SSSIs<sup>27</sup>, SACs<sup>28</sup>, SPAs<sup>29</sup>), landscape (National Parks) and historic feature (SAMs<sup>30</sup>, HEFs<sup>31</sup>) and therefore allowing and benefits of designation/scheduling to be assessed and follow-up of field survey work to be prioritised.*
- XXVIII. *Exploitation of NRMF field survey and sample archive to track disease outbreaks and spread of invasive and non-native species.*
- XXIX. *Expansion of the GMEP Farmer Practice Survey to include questions on pesticide use (data only available at UK level currently) and approach to integrated pest management.*
- XXX. *Partnership working to identify options to fill identified gaps in evidence e.g. urban, ecosystem resilience.*
- XXXI. *Exploitation of available data to develop the most robust and relevant indicators, for e.g. biodiversity and healthy ecosystems, which reflect the ambitions of the Well Being of Future Generations Act and the Environment Act, working with UK partners where these ambitions align.*

### Alignment and integration of methods

- XXXII. *Integration of EO, modelling and ongoing trends from field survey activities to better target future field survey effort to areas of high risk whilst maintaining a systematic element to report on change in extent and condition.*
- XXXIII. *Sharing of protocols and methodologies to enable comparison of trends in stock and condition between land holdings held by partners & business and the national context (e.g. National Trust, National Parks etc. – see Pilot Survey report).*
- XXXIV. *Exploration of the potential of combining volunteer recording with professional effort, for example in remote areas. Combining citizen science with earth observation also presents significant opportunities.*
- XXXV. *Partnership working to develop methods to update landscape assessment by Landmap using NRMF change data therefore supporting development control.*
- XXXVI. *Exploitation of the GMEP Visual Quality Index to create a public perception layer to Landmap.*

### Data, technologies and data products

- XXXVII. *Agreement on key data required within the NRMF which can be adapted on an ‘as needed’ basis for changing indicators as policies change over time without impacting on the long-term trend data for our natural resources.*
- XXXVIII. *Increased data sharing through web-sharing technologies, integrated with protection of intellectual property and resourcing for data owners. Better use of data standards, auditability and provenance approaches and more robust assessment of the different data sources.*

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<sup>27</sup> SSSI: Site of special scientific interest

<sup>28</sup> SAC: Special Area of Conservation

<sup>29</sup> SPA: Special Protection Area

<sup>30</sup> SAM: Scheduled Ancient Monument.

<sup>31</sup> HEF: Historic Environment Feature



- XXXIX. *More effort into efficient conversion of data into evidence products which can be re-used by multiple users.*
- XL. *Following the Welsh Government's investment in developing a pre-processed Landsat Archive for Wales, a coordinated approach to the acquisition, pre-processing, and production of intermediate products and distribution of other EO data would be advantageous. This should concentrate on data from Sentinel 1 and 2 in the first instance and investigate the feasibility and cost of securing Lidar coverage for Wales, by adding Lidar acquisitions to the Welsh rolling 3 year aerial photography campaign.*
- XLI. *A centralised national hub that acquires, stores, pre-processes and distributes standardised and version controlled EO data and intermediate products relevant to national monitoring would avoid duplication of effort, cut cost and expedite the use of the EO data. Certain downstream products such as a generic UK land cover map, Wales character map, a digital terrain model, a hotspot map of change will assist a variety of users and so would benefit from a centralised data management approach. Other examples of EO products to be produced once for re-use multiple times proposed during bilaterals included:*
- a. NDVI (greenness of biomass) for application in Landmap updates; vegetation production estimates; stress and resilience assessments.*
  - b. Scrub-cover to assess potential risk to historic features; condition of grassland and wetlands; risk to infrastructure and recreation networks.*
  - c. Water stress for applications linked to soil health; regulation of water supply for agriculture production; runoff and erosion risk.*
  - d. Connectivity for assessing resilience of biodiversity; risk of diseases spread.*
  - e. Woody features – connectivity of woodland; disease transfer; resilience.*
  - f. Drainage maps for assessing soil and peat condition.*

#### *Research and development of new technologies*

- XLII. *There is the need for effective knowledge exchange between the Welsh Government, stakeholders and the academic community on the leading edge of methodological developments in molecular genetic approaches. Wales should remain engaged with the UK eDNA working group (established ca. 2014) which meets yearly and features most, if not all, of the DEFRA<sup>32</sup> organizations and a number of molecular ecology labs around the UK.*
- XLIII. *It is also important to identify priority areas that will most benefit from the utility of molecular genetic tools for biodiversity assessment. Where necessary, new proof of principle studies are required to compare traditional approaches with molecular approaches, including cost-benefit and socio-economic considerations.*

#### *Cost-benefit analysis*

- XLIV. *For many of these opportunities to be realised, wider engagement within organisations to achieve the practical commitment and most cost-efficient method for delivery needs to be undertaken during Phase II. This was not possible during Phase I due to time constraints and lack of cost data.*

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<sup>32</sup> DEFRA: Department for Environment, Food & Rural Affairs

**10. The NRMF should increase engagement across Welsh Government, public, private and voluntary sectors; communicating the fundamental importance of Wales’ natural resources to its economy and the well-being of future generations.**

*Rationale and Realisation:*

*To derive maximum benefits from NRMF, knowledge exchange must be an integral part of the ongoing activities.*

- IV. *Knowledge exchange and communications are required at four different levels – government, business, stakeholders and the public.*
- V. *Outputs and access to data and information need to be relevant to all of these communities, easily accessed and engaging.*
- VI. *All engagement activities need to be well targeted with clear objectives and offer good cost-benefit outcomes.*

The overall vision this would deliver is:

***A National Natural Resources Monitoring Framework will be developed to service the needs of a wide customer base across Cabinet portfolios, and to deliver the full economic potential of our natural resources. This will be phased in over 5 years guided by a Coordination Board representative of evidence users and providers. It will optimise and target monitoring, analytical and interpretation resources in Wales and enable rapid feedback to policy and management. This framework will be a key source of data and evidence underpinning National Natural Resource Policy including State of Natural Resource Reporting and a wider range of legislative requirements including international commitments. It will embrace, improve and integrate monitoring methods and technologies and rebalance resources to enable data to be ‘collected once–reused often’ through more effective sharing of data. A modelling and scenario testing component will underpin data interpretation and provide a predictive capacity. Levels of engagement across Welsh Government, public and private sectors will be increased, helping to promote Wales’ position at the forefront of collaborative and innovative working.***

In summary, these recommendations will:

- contribute to the development of the economy;
- make better use of resources across the monitoring community;
- better inform wider Welsh Government policy across Cabinet portfolios;
- enable more adaptive, responsive and targeted management of natural resources and ecosystems;

- **be a key evidence source for National Natural Resource Policy including the State of Natural Resources Report and a wider range of legislative requirements including international commitments;**
- **provide more accurate, timely and efficient delivery of data, evidence and information;**
- **deliver integration of expertise, data and technologies;**
- **put Wales at the forefront of collaborative and innovative working.**

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