



**Cyfoeth
Naturiol**
Cymru
**Natural
Resources**
Wales

A process for implementing an Ecosystem Approach to Fisheries Management in Wales: a literature review

Helen J. Bloomfield, Thomas Stamp and Harry Goudge

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Glossary

| | |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CBD | Convention on Biological Diversity |
| CFP | Common Fisheries Policy |
| EA | Ecosystem Approach |
| EAF(M) | Ecosystem Approach to Fisheries (Management) |
| EBA | Ecosystem Based Approach |
| EB(F)M | Ecosystem Based (Fisheries) Management |
| Ecosystem | Dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Convention on Biological Diversity, 1992). |
| ES(s) | Ecosystem service(s) |
| EU | European Union |
| Ex-ante | Before the event (i.e. an ex-ante assessment occurs before an event) |
| Ex-post | After the event (literal translation, “after the fact”) |
| FAO | UN FAO, United Nations Food and Agricultural Organisation |
| FMM | FishMap Môn |
| GES | Good Environmental Status (under the MSFD) |
| HPMCZ | Highly Protected Marine Conservation Zone |
| IEA | Integrated Ecosystem Assessment |
| IMP | Integrated Maritime Policy (EU) |
| LWP | Living Wales Programme |
| MCZ | Marine Conservation Zone(s) |
| MES(s) | Marine Ecosystem Service(s) |
| MS | Member States (European) |
| MSFD | Marine Strategy Framework Directive |
| NGO | Non-Governmental Organisation |

| | |
|--------------|--------------------------------------------------------------------|
| NRW | Natural Resources Wales |
| ODEMM | Options for Delivering Ecosystem-Based Marine Management (project) |
| RAC | Regional Advisory Council(s) |
| SDM | Structured Decision Making |
| WFA | Welsh Fishermen's Association |
| WG | Welsh Government |
| WSSD | World Summit on Sustainable Development |
| WWF | World Wildlife Fund for Nature |

Crynodeb Gweithredol

Cynhaliwyd yr adolygiad llenyddiaeth hwn fel rhan o Brosiect FishMap Môn (FMM) er mwyn deall proses i roi Dull o Reoli Pysgodfeydd ar Lefel yr Ecosystem (EAFM) ar waith yng Nghymru. Prosiect peilot ar y cyd rhwng Cyfoeth Naturiol Cymru (CNC) a'r gymuned bysgota (at ddibenion hamdden a physgota masnachol) yn y Gogledd yw FMM. Y rheswm dros ddatblygu FMM oedd helpu i reoli'r amgylchedd morol yn gynaliadwy drwy inni ddeall yn well beth yw'r rhyngweithio rhwng gweithgarwch pysgota a chynefinoedd gwely'r môr yn nyfroedd Cymru. Ysgogwyd hyn gan ddiffyg gwybodaeth am hyd a lled a dwyster gwahanol weithgareddau pysgota yn nyfroedd Cymru, a sut mae gweithgareddau pysgota o'r fath yn effeithio o bosib ar gynefinoedd gwely'r môr, sy'n gallu bod yn sensitif. O ganlyniad, nod cyffredinol prosiect FMM oedd treialu dulliau o gasglu a mapio gwybodaeth am weithgarwch pysgota a chyfuno hynny â'r wybodaeth bresennol am y mathau o gynefinoedd a geir ar wely'r môr a'u sensitifrwyd i weithgareddau pysgota. Gwnaed hyn drwy ddefnyddio offer Systemau Gwybodaeth Ddaearyddol.

Ar ôl cyflawni'r nod hwn, aeth tîm prosiect FMM ati i ystyried sut y byddai modd defnyddio canlyniadau'r prosiect a'r gwersi a ddysgwyd i gyfrannu tuag at reoli pysgodfeydd morol Cymru yn well. Roedd hyn yn digwydd yr un pryd ag y cafwyd ymrwymiad cynyddol ar wahanol lefelau i drefn fwy holistaidd o reoli pysgodfeydd ar lefel yr ecosystem, ac o ran rheoli'r amgylchedd morol yn fwy cyffredinol. Mae cysyniad y dull o reoli ar lefel yr ecosystem yn deillio o Gonfensiwn 1992 ar Amrywiaeth Fiolegol a datganiad Uwchgynhadledd y Byd 2002 ar Ddatblygu Cynaliadwy wedi hynny. Mae cysyniad y dull ecosystem wedi cael ei fabwysiadu fel egwyddor ganolog yng Nghod Ymddygiad y Sefydliad Bwyd ac Amaeth ar Ddatblygu Cynaliadwy ac mewn nifer o bolisiâu Ewropeaidd, yn cynnwys y Polisi Morol Integredig, Cyfarwyddeb Fframwaith y Strategaeth Forol, y Polisi Pysgodfeydd Cyffredin diwygiedig a strategaeth Twf Glas. Ar lefel y Deyrnas Unedig, mae cysyniad y dull ecosystem wedi cael ei ymgorffori ym Mil y Môr a Mynediad i'r Arfordir 2009, ac yng Nghymru mae'n sail i Fil Amgylchedd Cymru 2013, a'r Cynllun Gweithredu Strategol ar gyfer Môr a Physgodfeydd Cymru 2013 a gyhoeddwyd yn ddiweddar.

O ystyried yr ymrwymadau hyn, mae cryn lawer o ddiddordeb yn sut y gallai'r dull ecosystem gael ei roi ar waith yng Nghymru, a beth fyddai gweithredu yn ei olygu i'r bobl dan sylw (yn cynnwys llywodraethau, awdurdodau a defnyddwyr y môr) a'r amgylchedd morol. Cytunwyd y byddai prosiect FishMap Môn (FMM) yn comisiynu adolygiad llenyddiaeth i archwilio a chynnig proses er mwyn rhoi Dull o Reoli Pysgodfeydd ar Lefel yr Ecosystem (EAFM) ar waith yng Nghymru.

Er bod yr adolygiad yn canolbwyntio ar EAFM, defnyddiwyd gwybodaeth a gwersi a ddysgwyd o ganllawiau'n ymwneud ag amryw o themâu cysylltiol (e.e. y dull ecosystem, rheoli ar sail ecosystem, rheoli pysgodfeydd ar lefel yr ecosystem) hefyd i gyflawni tri amcan allweddol yr adolygiad:

1. Adolygu Prosesau Gweithredu'r Dull Rheoli ar Lefel yr Ecosystem (o ran Rheoli Pysgodfeydd), gan nodi'r elfennau cyffredin a'r gwahaniaethau, a'r cryfderau a'r gwendidau;
2. Amlinellu proses er rhoi EAFM ar waith yng Nghymru, gan nodi ystyriaethau a sialensiau allweddol i'r rhai sy'n ymwneud â'r broses EAFM, a thynnu sylw at declynnau a dulliau sydd wedi cael eu datblygu er mwyn helpu i wneud cynnydd; a

3. Ystyried sut y gallai prosiectau a chynlluniau cyfredol yng Nghymru, fel FMM, helpu i roi EAFM ar waith yng Nghymru.

Mae rhinweddau a dichonoldeb rhoi EAFM ar waith yng Nghymru, a gweithredu felly o ran rheolaeth forol yn fwy cyffredinol, yn cael eu hystyried gan y diwydiant pysgota, cyrff anllywodraethol a chyrff statudol ar hyn o bryd. Gwneir hynny drwy adroddiad “*Striking the Balance*” Ffederasiwn Pysgotwyr Cymru, gwaith prosiect *PISCES* yn y Môr Celtaidd a chyhoeddiad Rhaglen Cymru Fyw, “*Using the Ecosystem Approach – A Framework for Natural Resources Wales*”. Y prif nodweddion sy’n diffinio’r tri fframwaith hwn yw:

- **Graddfa:** Roedd *Striking the Balance* yn canolbwyntio ar Barthau Cadwraeth Morol ar raddfa leol neu is-ranbarthol; edrychodd *PISCES* ar ddichonoldeb rhoi dull ecosystem ar waith drwy Gyfarwydddeb Fframwaith y Strategaeth Forol yn ei ardal brosiect ar raddfa ranbarthol draws-sector fwy (y Môr Celtaidd); tra cafodd fframwaith Rhaglen Cymru Fyw ei ysgrifennu fel canllawiau cyffredinol i holl weithgareddau CNC a Llywodraeth Cymru (LIC).
- **Cyd-reoli:** Mae denu rhanddeiliaid i gymryd rhan yn elfen dyngedfennol yn y tri fframwaith. Fodd bynnag, nid yw’r lefel o gyfranogiad gan rhanddeiliaid yn cael ei disgrifio’n fanwl yn fframweithiau *PISCES* na *Rhaglen Cymru Fyw* ac nid yw’r naill na’r llall yn egluro a fyddai rhanddeiliaid yn cael llais wrth wneud penderfyniadau ac, os felly, sut. Mewn cyferbyniad, mae cyd-reoli yn gysyniad allweddol yn *Striking the Balance* ac yn cael ei ddiffinio fel Llywodraeth a rhanddeiliaid yn cydweithredu fel partneriaid cydradd wrth wneud penderfyniadau.
- **Adolygu:** Mae’r tri fframwaith yn cynnwys cam adolygu lle caiff gwybodaeth a gwersi a ddysgwyd o gamau blaenorol eu defnyddio i ddylanwadu ar gamau dilynol, a hefyd wrth fynd drwy’r cylch rheoli eto yn y dyfodol. Fodd bynnag, mae gwahaniaethau o ran amlder yr adolygiadau rhwng fframweithiau *Striking the Balance* a *PISCES* ac nid yw fframwaith *Rhaglen Cymru Fyw* yn pennu amserlen adolygu.
- **Ariannu:** Nid oes yr un o’r tri fframwaith yn rhoi sylw manwl i gost economaidd (uwch) bosibl rhoi dull ecosystem ar waith, a phwy ddylai dalu am gostau cysylltiol cynyddu capasiti lleol, cefnogi gweithgareddau grŵp cyd-reoli, anghenion data a gwybodaeth ehangach, a phrosesau monitro, gorfodi a/neu werthuso. Er bod ariannu EAFM y tu hwnt i gwmpas yr adolygiad hwn, rydym wedi tynnu sylw at drafodaeth ynglŷn ag ariannu mewn dogfennau ymgynghori diweddar gan Lywodraeth Cymru (LIC) a’r dulliau ariannu arloesol sy’n cael eu harchwilio mewn mannau eraill er mwyn rhoi dull ecosystem ar waith.

Gan adeiladu ar y tri fframwaith, a llenyddiaeth fyd-eang arall ar fframweithiau gweithredu ar gyfer EA(FM) o’r degawd diwethaf, rydym yn awgrymu proses er rhoi EAFM ar waith yng Nghymru, gan adlewyrchu elfennau arwyddocaol o debygrwydd a nodwyd. Mae’r broses weithredu wedi’i seilio ar gylich gweithredu chwe cham, ac mae wedi’i chrynhofio isod:

- Cam 1: Deall y cyd-destun - “*Ble’r ydyn ni’n awr?*”
- Cam 2: Gosod amcanion - “*Ble’r ydyn ni eisiau bod?*”
- Cam 3: Archwilio opsiynau rheoli - “*Sut gallwn ni gyrraedd yno?*”
- Cam 4: Rhoi’r dull rheoli sy’n cael ei ffafrio ar waith - “*Amdani!*”
- Cam 5: Monitro - “*Ydy pethau’n newid?*”
- Cam 6: Gwerthuso ac addasu - “*Sut ydyn ni’n gwneud (yn erbyn yr amcanion)?*”

Nid y bwriad yw i'r broses weithredu sy'n cael ei hawgrymu ddisodli'r camau gweithredu yn y gwahanol ddogfennau canllawiau a adolygwyd. Yn hytrach, mae'r camau'n ymgorffori camau priodol o bob un o'r fframweithiau allweddol a adolygwyd.

Mae gofynion trosfwaol cyffredin yn perthyn i brosesau gweithredu dull ecosystem:

- Maent yn cael eu gyrru gan Amcanion Polisi Lefel Uchel ac amcanion ehangach cymdeithas o ran yr amgylchedd morol;
- Maent yn addasol ac yn gweithredu ar sail y dystiolaeth orau sydd ar gael; ac
- Maent yn cynnwys cyfranogiad gan rhanddeiliaid o'r dechrau i'r diwedd.

Er mwyn cyflawni'r gofynion hyn, dylai'r drefn benderfynu mewn EA(FM):

- Gael ei seilio ar wyddoniaeth (y dystiolaeth orau sydd ar gael, e.e. empirig, wedi'i modelu, barn arbenigol, gwybodaeth draddodiadol ac ati) ond nid proses wedi'i seilio'n gyfan gwbl ar wyddoniaeth a dim byd arall mohoni;
- Defnyddio dulliau sy'n golygu bod modd ystyried effeithiau posibl gwahanol opsiynau rheoli yn erbyn amcanion ecolegol, cymdeithasol ac economaidd mewn ffordd glir a thryloyw. Bydd y rhai sy'n gwneud penderfyniadau wedyn yn gallu ystyried cyfaddawdu rhwng amcanion a'i gilydd er mwyn cefnogi gwerthoedd yn ymwneud â defnydd dynol; a
- Cael ei datganoli i'r lefel isaf bosibl a chynnwys y rhanddeiliaid i gyd wrth rannu gwybodaeth, gwneud penderfyniadau a rheoli.

Mae cysylltiad rhwng y disgrifiadau o'r chwe cham yn y cylch gweithredu arfaethedig a'r camau gweithredu perthnasol yn y gwahanol ddogfennau canllawiau, ac maent hefyd yn adlewyrchu llenyddiaeth ehangach i ddisgrifio'r camau gweithredu a'r pwysu a mesur sy'n ofynnol. Lle mae'n briodol rydym hefyd wedi cynnwys gwybodaeth (a dolenni at ddeunydd darllen pellach) am declynnau a dulliau sydd wedi cael eu datblygu i helpu i symud y gwaith yn ei flaen ar gamau penodol.

Yn olaf, mae'r adroddiad hwn yn ystyried detholiad o brosiectau a chynlluniau cyfredol yng Nghymru a allai gyfrannu at roi EAFM ar waith yn llwyddiannus yng Nghymru: prosiect *FishMap Môn*; prosiect *Sustainable Use of Fisheries Resources in Welsh Waters* (yn cael ei gyd-drefnu gan Brifysgol Bangor); ac ymrwymiad Llywodraeth Cymru (drwy *Gynllun Gweithredu Strategol y Môr a Physgodfeydd 2013*) i bwysu a mesur dulliau cydreoli. Mae gwneud hynny wedi dangos mai cyfyngedig yn gyffredinol yw cyfraniad y gweithgareddau cyfredol at Gam 1 y broses weithredu (deall y cyd-destun). Fodd bynnag, mae llawer o botensial i ddatblygu'r dulliau sy'n cael eu defnyddio yn y prosiectau hyn ymhellach, er mwyn iddynt fwydo i gamau eraill a helpu mewn modd effeithlon i roi EAFM ar waith yng Nghymru (a helpu o ran rheolaeth forol yn fwy cyffredinol).

Mae cyfraniadau allweddol i Gam 1, a'r broses EA(FM) yn fwy cyffredinol, yn deillio o'r rhwydweithiau a'r perthnasau gwaith cydweithiol sydd eisoes wedi cael eu sefydlu ym mhrosiectau *FishMap Môn* (FMM) a *Sustainable Use of Fisheries Resources in Welsh Waters*. Mae bod rhanddeiliaid yn cymryd rhan yn elfen allweddol o EA(FM), ac mae'r prosiectau hyn yn cynnig gwersi pwysig sydd wedi'u dysgu ynglŷn â chynnwys rhanddeiliaid a chydweithio. Byddai ymrwymiad LIC i edrych yn fanwl ar ddulliau cydreoli yn adeiladu ar y profiad hwn, gan alluogi rhanddeiliaid nid yn unig i gyfrannu at bob cam o'r cylch gweithredu ond hefyd i rannu perchenogaeth o'r drefn reoli sy'n deillio o hynny. Mae'n werth nodi yma fod yr adolygiad hwn yn canolbwyntio ar bysgodfeydd, ac felly ar

randdeiliaid pysgodfeydd. Fodd bynnag, dylid ystyried effaith gweithgareddau pysgota ar ddefnyddwyr eraill y môr a'r cyhoedd yn ehangach, a hefyd ystyried effaith defnyddwyr eraill y môr ar weithgareddau pysgota, fel sy'n gweddu i ddull ecosystem.

Gallai'r data sydd wedi cael ei gasglu gan FMM, ac sydd ar hyn o bryd yn cael ei gasglu gan *Sustainable Use of Fisheries Resources in Welsh Waters*, wneud cyfraniad pwysig at Gam 1 y broses weithredu drwy ddisgrifio hyd a lled y gweithgareddau cyfredol neu gyflwr elfennau ecolegol. Gallai'r dulliau sydd wedi cael eu datblygu yn y ddau brosiect gael eu hehangu i gynnwys rhagor o weithgareddau neu ragor o elfennau ecolegol, gan wneud mwy o gyfraniad i Gam 1. Yn y dyfodol, gallai'r data hwn gyfrannu hefyd at Gam 2 drwy ei gwneud yn bosibl dethol dangosyddion a throthwyon i'r amcanion; ac at Gam 5 o ran monitro sut mae'r system yn newid yn sgil rhoi'r drefn reoli ar waith. Fodd bynnag, mae angen ystyriaeth fanwl er mwyn blaenoriaethu a chrisialu ble mae angen rhagor o wybodaeth, a defnyddio dulliau a all ymdopi â'r dystiolaeth orau sydd ar gael, neu'r diffyg tystiolaeth, i sicrhau nad oes oedi pellach cyn rhoi EAFM ar waith yng Nghymru oherwydd yr angen am "ragor o ddata". Mae angen dyrannu adnoddau sylweddol hefyd er mwyn i ddulliau casglu data cymdeithasol ac economaidd gael eu datblygu ymhellach a'u gweithredu ar lefel ddigon manwl yn ofodol. Mae angen i'r data cymdeithasol ac economaidd fod cystal ag elfennau ecolegol y system a bod yn gyson ag amcanion cyffredinol y dull ecosystem sy'n ystyried lles ecolegol a dynol.

O ystyried nifer y prosiectau posibl sy'n ceisio denu rhanddeiliaid i gymryd rhan yn unol ag egwyddorion y dull ecosystem, mae cyfathrebu effeithiol rhwng prosiectau a'i gilydd yn dyngedfennol, a lle mae hynny'n bosibl rhaid ymdrechu i osgoi dyblygu tasgau ac adnoddau (ar ffurf amser ac arian), gan eu bod yn debygol o fynd yn fwy a mwy prin. Un pwynt olaf y mae'n werth ei nodi yw pwysigrwydd rheoli disgwyliadau pobl yn briodol o ran eglurder rôl y gwahanol bartion yn y broses, ac o ran yr amserlenni (hir) o bosibl a fydd yn ofynnol i gyflawni amcanion. Nid yw'r dull ecosystem yn ateb sydyn mewn termau ecolegol, cymdeithasol nac economaidd, a dylai prosiectau sy'n cael eu gyrru gan ddull ecosystem ystyried amcanion tymor hir a thymor byr (a chyfnodau adolygu), a'r rheini wedi'u gosod mewn fframwaith rheoli addasadol.

Executive Summary

This literature review was undertaken as part of the FishMap Môn (FMM) Project in order to understand a process for implementing an Ecosystem Approach to Fisheries Management (EAFM) in Wales. FMM is a collaborative pilot project between Natural Resources Wales (NRW) and the recreational and commercial fishing community in North Wales. The rationale for developing FMM was to contribute towards the sustainable management of the marine environment by better understanding interactions between fishing activity and seabed habitats in Welsh waters. This was motivated by a lack of knowledge about the extent and intensity of different fishing activities in Welsh waters and how such fishing activities may be impacting upon potentially sensitive seabed habitats. As a result, the overarching aim of the FMM project was to pilot methods of collecting and mapping information about fishing activity and combining it with existing information on seabed habitat types and their sensitivity to fishing activities using Geographic Information Systems tools.

Having achieved this aim, the FMM project team sought to consider how the project outputs and lesson learned could be used to contribute to improved management of marine fisheries in Wales. This coincided with growing commitments at various levels to a more holistic ecosystem approach (EA) to fisheries management, and management of the marine environment more generally. The concept of an ecosystem approach (EA) derives from the 1992 Convention on Biological Diversity and the subsequent declaration of the 2002 World Summit on Sustainable Development. The EA concept has been adopted as a central tenet of the FAO Code of Conduct for Responsible Fisheries and a number of European policies, including the Integrated Maritime Policy, the Marine Strategy Framework Directive, the reformed Common Fisheries Policy and the Blue Growth strategy. At the UK level, the EA has been incorporated into the Marine and Coastal Access Act 2009, and in Wales, underlies the Environment Bill for Wales 2013, and the recently published Wales Marine and Fisheries Strategic Action Plan 2013.

Given these commitments, there is significant interest as to how an EA could be implemented in Wales, and what implementation would mean for both the people involved (including governments, authorities and sea users) and the marine environment. It was agreed that the FishMap Môn (FMM) project would commission a literature review to explore and propose a process for implementing an Ecosystem Approach to Fisheries Management (EAFM) in Wales.

Whilst the focus of the review is on an EAFM, information and lessons learned from guidance on the various related themes (e.g. ecosystem approach, ecosystem based management, ecosystem based fisheries management) were also utilised to meet the review's three key objectives:

1. Review of Ecosystem Approach (to Fisheries Management) Implementation Processes, identifying commonalities and differences, and strengths and weaknesses;
2. Outline a process for implementing an EAFM in Wales, identify key considerations and challenges for those involved in the EAFM process, and highlight tools and approaches that have been developed to assist in achieving progress; and
3. Consider how current projects and initiatives in Wales, such as FMM, could assist in implementing an EAFM in Wales.

The merits and practicalities of implementing an EAFM in Wales, and to marine management more generally, are currently being explored by the fishing industry, non-governmental organisations, and statutory bodies through the Welsh Fishermen's Federation "*Striking the Balance*" report, the *PISCES* project work in the Celtic Sea and the Living Wales Programme's (LWP) "*Using the Ecosystem Approach – A Framework for Natural Resources Wales*" respectively. The main defining features of these three frameworks are:

- **Scale:** *Striking the Balance* focused on Marine Conservation Zones (MCZs) at a local or sub-regional scale; *PISCES* explored the feasibility of implementing an EA through MSFD within their project area at a larger cross-sectoral regional (Celtic Sea) scale; whilst the *LWP* framework was written as general guidance for all NRW and Welsh Government (WG) activities.
- **Co-Management:** Stakeholder participation is a fundamental component of all three frameworks; however the level of stakeholder participation is not described in detail in the *PISCES* or *LWP* frameworks and neither clarifies *if* or *how* stakeholders would be involved in decision-making. In contrast, co-management is a key concept of *Striking the Balance* which it defines as, "*Government and stakeholders cooperating together as equal partners in decision making*".
- **Review:** All three frameworks include a review stage in which information and lessons learned from previous steps, are used to inform successive steps and future iterations of the management cycle. However there are differences in the frequency of review between *Striking the Balance* and the *PISCES* frameworks and the *LWP* framework does not specify a timeframe for review.
- **Financing:** Discussion on the potential (increased) economic cost of implementation an EA, and who should pay for the associated costs of increasing local capacity, supporting co-management group activities, broader data and information needs, monitoring, enforcement and/or evaluation processes, is not addressed in detail in any of the three frameworks. Whilst, financing an EAFM in Wales is beyond the scope of this review, we have highlighted discussion on financing from recent Welsh Government (WG) consultation documents and innovative financing approaches that are being explored elsewhere for EA implementation.

Building on the three frameworks, and further global literature on implementation frameworks for EA(FM) from the last decade, we propose a process for implementing an EAFM in Wales, drawing on the significant similarities identified. The implementation process is based on a six-phase implementation cycle, summarised as:

- Phase 1: Understanding the context - "*Where are we now?*"
- Phase 2: Objective setting - "*Where do we want to be?*"
- Phase 3: Explore management options - "*How can we get there?*"
- Phase 4: Implement preferred management - "*Do it!*"
- Phase 5: Monitor - "*Are things changing?*"
- Phase 6: Evaluate and adapt - "*How are we doing (against objectives)?*"

The implementation process proposed is not intended to supersede the implementation steps within the different guidance documents reviewed. Instead the phases incorporate appropriate steps from each of the key frameworks reviewed.

Common overarching requirements of EA implementation processes include that it is:

- Driven by High Level Policy Objectives and wider societal objectives for the marine environment;
- Adaptive and operate based on the best available evidence; and
- Involves stakeholder participation throughout.

In meeting these requirements, decision-making in EA(FM) should:

- Be informed by science (based on the best available evidence, e.g. empirical, modelled, expert judgement, traditional knowledge etc.) but is not an exclusive science-based process;
- Utilise approaches that enable simultaneous consideration of the potential impacts of different management options against ecological, social and economic objectives in a clear and transparent way to enable decision-makers to consider trade-offs among objectives in support of human use values; and
- Be decentralised to the lowest possible level and involve all stakeholders in knowledge sharing, decision-making and management.

Descriptions of each of the six phases of the proposed implementation cycle link to the relevant implementation steps from the different guidance documents, and draws upon wider literature to describe the actions and considerations required. Where appropriate we have also included information (and links to further reading) on tools and approaches that have been developed to assist progress in particular phases.

Finally, this report considers a selection of relevant current Welsh projects and initiatives that could contribute to the successful implementation of an EAFM in Wales: the *FishMap Môn* project; the *Sustainable Use of Fisheries Resources in Welsh Waters* Project (co-ordinated by Bangor University); and the Welsh Government's commitment (through the *Wales Marine and Fisheries Strategic Action Plan 2013*) to explore co-management approaches. Reflection on this selection of existing projects and initiatives in Wales demonstrates that current activities are generally limited to making contributions to Phase 1 (understanding the context) of the implementation process. However there is significant potential to further develop approaches being used within these projects to feed into other phases and efficiently assist in the implementation of an EAFM (and to marine management more generally) in Wales.

Key existing contributions to Phase 1, and the EA(FM) process more generally, stem from the networks and collaborative working relationships that have already been established in the *FishMap Môn* (FMM) and the *Sustainable Use of Fisheries Resources in Welsh Waters* projects. Stakeholder participation is deemed to be a key ingredient of an EA(FM), and these projects provide important lessons learned, about stakeholder engagement and collaborative working. The commitment of the WG to explore co-management approaches would build upon this experience, and enable stakeholders, not only to be involved in all phases of the implementation cycle, but also to have shared ownership of the resultant management. Of note here, is that the focus of this review is on fisheries, and thus fisheries stakeholders. However, consideration of the impacts on fishing activities on other sea-users and the wider public, and impacts of other sea users on fishing activities should also be considered in keeping with an EA.

The data that has been collected by FMM, and is currently being collected by the *Sustainable Use of Fisheries Resources in Welsh Waters*, could make valuable contributions to Phase 1 of the implementation process in describing the current extent of activities or state of ecological components. The methods developed in both projects could be expanded to include more activities or more ecological components and make a wider contribution to Phase 1. In the future, these data could also contribute to Phase 2 in enabling indicators and thresholds for objectives to be selected; and Phase 5 in monitoring how the system is changing following management implementation. However, careful consideration needs to be given to prioritise and streamline where further information is required, and utilise approaches that are able to deal with the best available evidence, or lack thereof, to ensure that implementation of an EAFM in Wales is not stalled by the need for “more data”. Significant resources also need to be allocated to further develop and implement approaches to collect social and economic data at appropriate spatial resolution, comparable to information on ecological components of the system, congruent with the overarching objectives of an EA of both ecological **and** human well-being.

Given the number of potential projects seeking to secure stakeholder participation in line with the principles of an EA, it is crucial that there is effective communication among projects, and that where possible efforts are made to avoid duplication of tasks and resources (time and financial), which are likely to become increasingly stretched. A final point worth noting is the importance of appropriate management of people’s expectations both in terms of clarity of the role of the different parties in the process, and in terms of the potential (long) timeframes that will be required to achieve objectives. An EA is not a quick fix in ecological, social or economic terms, and projects driven by an EA should consider both long and short-term objectives (and review periods), centred within an adaptive management framework.

1. Introduction

1.1. Background

This literature review was undertaken as part of the FishMap Môn (FMM) Project in order to understand a process for implementing an Ecosystem Approach to Fisheries Management (EAFM) in Wales.

FishMap Môn (FMM) is a collaborative pilot project between Natural Resources Wales (NRW) and the recreational and commercial fishing community in North Wales. FMM is funded by the European Fisheries Fund and Welsh Government (WG), and Project Partners include The North Wales Fisherman's Cooperative Limited, Bangor Mussel Producers Limited and The Welsh Federation of Sea Anglers. The FMM project area covers the Welsh Territorial Waters between Porth Dinllaen on the Llŷn peninsula and the Great Orme, Llandudno.

The rationale for developing FMM was to contribute towards the sustainable management of the marine environment by better understanding interactions between fishing activity and seabed habitats in Welsh waters. This was motivated by a lack of knowledge about the extent and intensity of different fishing activities in Welsh waters and how such fishing activities may be impacting upon potentially sensitive seabed habitats. As a result, the overarching aim of the FMM project was to pilot methods of collecting and mapping information about fishing activity and combining it with existing information on seabed habitat types and their sensitivity to fishing activities using Geographic Information Systems tools. To this aim, the project has:

- Developed and trialled a method for gathering fishing activity data from the recreational and commercial fishing community in the project area;
- Carried out a series of one to one interviews with commercial fishers, charter boat operators and recreational fishers within the project area in order to collect fishing activity data;
- Collated fishing activity data into a Geographical Information System (GIS) and developed maps illustrating habitat sensitivity with fishing activity and intensity data;
- Piloted an approach of combining fishing activity data gathered from fishers with habitat sensitivity information;
- Developed and tested an indicative, interactive guidance tool using Geographic Information Techniques; and
- Contributed lessons learned in stakeholder engagement and collaborative working.

Having achieved these objectives, NRW and the Project Partners sought to consider how the project outputs and lesson learned could be used to contribute to improved management of marine fisheries in Wales. This coincided with a number of European, UK and Welsh policies being adopted that strive for a more holistic ecosystem approach (EA) to fisheries management, and management of the marine environment more generally (Table 1).

Table 1 Key policy drivers for an Ecosystem Approach to Fisheries Management (EAFM) and management of the wider marine environment in Wales.

| | |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| International | Convention on Biological Diversity 1992 FAO Code of Conduct for Responsible Fisheries 1995 World Summit on Sustainable Development 2002 |
| European | Integrated Maritime Policy (IMP) 2007 Marine Strategy Framework Directive (MSFD) 2008 Blue Growth Strategy* 2012 Common Fisheries Policy (CFP) 2013 |
| UK | Marine and Coastal Access Act 2009 |
| Wales | Environment Bill for Wales 2013 Wales Marine and Fisheries Strategic Action Plan 2013 |

* Url1¹ JNCC; Url2 EC IMP

Following significant interest as to how an EAFM could be implemented in Wales, and what implementation would mean for both the people involved (including governments, authorities and sea users) and the marine environment, it was agreed that FMM would commission a literature review to explore and propose a process for implementing an EAFM in Wales. The review also explores how FMM can, in combination with a variety of tools and information, contribute towards the successful implementation of an EAFM.

1.2. What is an Ecosystem Approach?

As a broad concept, an ecosystem approach (EA) seeks to address society's multiple objectives for the marine environment (ecological, social and economic) (FAO 1995; Charles 2001; Shin and Shannon 2010), based on the protection (and where possible restoration) of ecosystem structure and function, and maintenance of associated ecosystem benefits for resource users of current and future generations (Brodziak & Link 2002; Jennings 2004; Leslie & McLeod 2007). This concept has been recognised in a number of international agreements, and derives from the 1992 Convention on Biological Diversity (Url3 CBD 1992) and the subsequent declaration of the 2002 World Summit on Sustainable Development (WSSD) (UN 2002). The CBD (1992) defines an EA as “A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way” based on 12 core principles (Box 1.2).

A number of related terms have developed (see examples in Box 1.3; also Staples & Funge-Smith 2009; Nguyen 2012 and Atkins et al. 2013 for review) and there is no single universal definition (Pitcher et al. 2009) but the CBD definition (and associated principles) is commonly used, and underlies recent single- (e.g. Common Fisheries Policy 2013) and cross-sector policies (e.g. Integrated Maritime Policy 2007; Marine Strategy Framework Directive 2008) and projects (e.g. PISCES 2012) in Europe. Internationally, the principles of an EA are embedded in a growing number of developed nation's marine policies (e.g. Canada's Oceans Act 1997; Australia's Oceans Policy 1998; US National Oceans Policy 2010). The principles of an EA have also been adopted in developing nations, through top-down and community-led initiatives (Pitcher et al. 2009), and examples of elements of

¹ “URL” is used in this document to reference website addresses; full details of websites can be found in Section 5.1.

successful EA implementation now exist at a range of spatial scales (e.g. see Grieve & Short 2007 and Woo & Woolmer 2014 for review).

Box 1.2 The 12 Malawi principles of an Ecosystem Approach (Url3 CBD 1992)

1. The objectives of management of land, water and living resources are a matter of societal choices.
2. Management should be decentralised to the lowest appropriate level.
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4. Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should: (a) reduce those market distortions that adversely affect biological diversity; (b) align incentives to promote biodiversity conservation and sustainable use; (c) internalise costs and benefits in the given ecosystem to the extent feasible.
5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of The Ecosystem Approach.
6. Ecosystems must be managed within the limits of their functioning.
7. The Ecosystem Approach should be undertaken at the appropriate spatial and temporal scales.
8. Recognising the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9. Management must recognise that change is inevitable.
10. The Ecosystem Approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11. The Ecosystem Approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
12. The Ecosystem Approach should involve all relevant sectors of society and scientific disciplines.

Despite the range of terminology and political, philosophical and technical origins, there are many common elements of an EA and its variants (see Arkema et al. 2006 and Atkins et al. 2013 for review). Crucially, an EA should not be viewed as a new appraisal mechanism for management of natural resources (Spode et al. 2013) but as a mechanism to encourage a more joined up approach to management, and integration of management objectives, commitments and approaches across different policies and legislative frameworks (Garcia & Cochrane 2005; Spode et al. 2013). Key advantages of an EA over other approaches to natural resource management (Atkins et al. 2013) include:

- (1) Integration of ecological, economic and social considerations within a single framework helping to identify potential conflicts, interactions and trade-offs from the outset;
- (2) Recognition that humans, with their cultural diversity, are an integral component of ecosystems, and should be involved in application of an EA; and
- (3) Emphasis on flexible and integrated methods, and adaptive management.

Box 1.3 Example definitions of an ecosystem approach to fisheries (management), and of an ecosystem approach, based on a selection of the key references reviewed (see Section 2 for further details).

Ecosystem-Based Management of Fisheries (EBMF) *“makes ecological sustainability the primary goal of management, as well as recognising the critical interdependence between human well-being and ecological health”* (Ward et al. 2002).

The goal of an **Ecosystem Approach to Fisheries (EAF)** is to *“balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic, and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries.”* (FAO 2003; Garcia & Cochrane 2005).

The **Ecosystem Approach to Fisheries (EAF)** is to *“plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems.”* (FAO 2005).

Ecosystem Based Management (EBM) *“..differs from conventional resource management in that it defines management strategies for entire systems, not simply individual components of the ecosystem. As a consequence, EBM takes into account interactions among ecosystem components and management sectors, as well as cumulative impacts of a wide spectrum of ocean-use sectors. Importantly, EBM considers humans as an integral part of the ecosystem, since humans derive a portfolio of services from the ecosystem and also act as a driver influencing ecosystem processes”* (Levin et al. 2009).

An **Ecosystem Approach (EA)** is *“based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems”* (Woolmer 2012).

An **Ecosystem Approach (EA)** is *“a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way”*. (From the Convention on Biological Diversity (CBD), cited in PISCES 2012; Spode et al. 2013).

An **Ecosystem Approach (EA)** is *“the comprehensive integrated management of human activities based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity”*. (From International Council for the Exploration of the Sea (ICES), cited in PISCES 2012; Url4 OSPAR).

The Welsh Fishermen’s Association (Woolmer 2012) claim that an EA has frequently been interpreted too narrowly, focussing purely on the ecological elements of the ecosystem and highlight the value of a social-ecological system (SES) approach to management to better integrate the human dimension of managing the marine environment. The systems approach (SA) (e.g. the Systems Approach Framework; see Tomlinson et al. 2011) has common elements with an EA. Firstly, it takes a holistic view of the components of the system and the interrelationships among them, and adopts an ecosystem perspective that

explicitly includes humans (Berkes and Folke 1998). Secondly, a SA calls for co-operation and consultation between all relevant stakeholders throughout the process; the term stakeholder being used to incorporate end-users, policy makers, scientists, governance agencies, other relevant institutions, and non-governmental organizations (Tomlinson et al. 2011). Finally, through an iterative process, a SA seeks to provide scientifically defensible information on potential changes under different scenarios through monitoring, assessment and review of the relevant parts of the SES (Tomlinson et al. 2011), and to use feedback following policy and management interventions to inform future action in keeping with the concept of adaptive management (Resilience Alliance 2007).

Integration of social, economic and environmental demands and pressures on the marine environment is clearly complex and there is increasing interest in incorporating the concept of ecosystem goods and services to meet the requirements of an EA (and SA) (e.g. as outlined in the Living Wales Programme, Spode et al. 2013) (Beaumont et al. 2007; Url5 VALMER). Ecosystem services (ESs) are the benefits people derive from the environment, broadly defined as the direct and indirect contributions of ecosystems to human well-being (De Groot et al. 2010). It has been argued that one of the reasons that natural resources have not been used sustainably is because the benefits people derive from nature are not always as obvious as the benefits derived from economic development (Url5 VALMER). Approaches for assessing social and economic changes resulting from management actions to inform decision-making that are comparable to ecological methods have, until recently, been lacking.

Whilst detailed analysis of these approaches is beyond the scope of this review, it is worth noting that there has been significant progress in the last decade in the development of frameworks for classifying (e.g. Millennium Ecosystem Assessment 2003) and methodologies for assessing ecosystem services (ESs) (e.g. see Url6 TEEB and Linquete et al. 2013 for review), particularly since the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2005). The majority of approaches have focussed on terrestrial systems but there is increasing attention on marine ecosystem services (MESs) due to commitments through, for example, the Marine Strategy Framework Directive (e.g. see Bohnke-Hendricks et al. 2013). The UK is a forerunner in the development of MES assessment (e.g. Beaumont et al. 2007; Saunders et al. 2010; Atkins et al. 2013). However, further work is still needed to determine the value (monetary or otherwise) of the different benefits we derive from the marine environment to better understand: (1) what it is that we need to measures to be able to monitoring changes in ESs; and (2) the links between ESs and the environment that supports them (Hussain et al. 2013; Url5 VALMER).

1.3. Approach

The purpose of this literature review was to explore and propose a process for implementing an ecosystem approach to fisheries management (EAFM) in Wales. Whilst the focus of the review is on an EAFM, information and lessons learned from guidance on the various related themes (e.g. ecosystem approach, ecosystem based management, ecosystem based fisheries management) were also utilised to meet the review's three key objectives:

1. Explore commonalities and differences between EA(FM) implementation processes, including the strengths and weaknesses (Section 2);
2. Outline a process for implementing an EA(FM) (Section 3); and
3. Reflect on how current projects and initiatives in Wales, such as FMM, could assist in implementing an EAFM in Wales (Section 4).

This review was commissioned as part of the FMM project, and as a result Marine EcoSol have focussed on ensuring the review is relevant and accessible to a broad audience including the fishing industry and other sea users, policy makers, Natural Resources Wales (NRW) staff and Welsh Government (WG). The implementation cycle proposed in this review (Section 3) was presented at the FMM Project Conference (Bangor, December 2013), and feedback from the audience and information from other presentations were incorporated into the report where appropriate. The FMM project has also commissioned a complementary review of lessons learned from global case studies where an EA(FM) has been applied (Woo and Woolmer 2014) which links to this review through the phases of the implementation cycle.

Objective 1: Review of Ecosystem Approach (to Fisheries Management) Implementation Processes (Section 2)

The merits and practicalities of implementing an EAFM in Wales, and to marine management more generally, are currently being explored by the fishing industry, e.g. the Welsh Fishermen's Federation in their "Striking the Balance" report (Woolmer 2012), non-governmental organisations, e.g. the PISCES project work in the Celtic Sea (PISCES 2012), and statutory bodies, e.g. Natural Resources Wales' "Using the Ecosystem Approach – A Framework for Natural Resources Wales" (Spode et al. 2013). The first step here was to review these three frameworks, and explore the strengths and weakness of the implementation processes outlined within them (Section 2.1).

A (time) limited literature search was then undertaken to identify global peer reviewed and grey literature (approximately 25-30 key reports, journals and websites) from the last decade and additional guidance on steps for implementing an EA(FM) (Section 2.2). Whilst the different implementation frameworks reviewed used slightly different terminology, had different numbers of steps, and varying levels of details within steps, there were significant similarities among them which we summarised into six key phases for implementation:

- Phase 1: Understanding the context
- Phase 2: Objective setting
- Phase 3: Explore management options
- Phase 4: Implement preferred management

- Phase 5: Monitor
- Phase 6: Evaluate and adapt

Objective 2: Process for Implementing an Ecosystem Approach to Fisheries Management in Wales (Section 3)

Building on the six implementation phases identified under Objective 1, Marine EcoSol developed an implementation cycle that could be used to inform a process for implementing an EAFM in Wales. The implementation cycle developed is not intended to supersede the implementation steps proposed within the different guidance documents reviewed; instead the six phases of the cycle incorporate appropriate steps from each of the frameworks. Within each phase, key considerations and challenges for those involved in the EAFM process, and tools and approaches that have been developed to assist in achieving progress are discussed (Sections 3.1 to 3.6). A summarising question for each phase was also identified to help with clarity:

- Phase 1: Understanding the context - "*Where are we now?*" (Section 3.1)
- Phase 2: Objective setting - "*Where do we want to be?*" (Section 3.2)
- Phase 3: Explore management options - "*How can we get there?*" (Section 3.3)
- Phase 4: Implement preferred management - "*Do it!*" (Section 3.4)
- Phase 5: Monitor - "*Are things changing?*" (Section 3.5)
- Phase 6: Evaluate and adapt - "*How are we doing (against objectives)?*" (Section 3.6)

Objective 3: Working towards successful implementation of an Ecosystem Approach to Fisheries Management in Wales (Section 4)

The final objective was to consider how current projects and initiatives in Wales, such as FMM could, in combination with a variety of tools and information, contribute towards implementation of an EAFM in Wales (Section 4). This section draws upon information gathered by the Marine EcoSol team from presentations at the FMM Project Conference (Bangor, December 2013), recent policy documents, and discussion with academics and members of the fishing industry in Wales.

2. Overview of Ecosystem Approach Implementation Processes

The concept of an ecosystem approach (EA) has been recognised in a number of international agreements, and derives from the 1992 Convention on Biological Diversity (Url1 CBD) and the subsequent declaration of the 2002 World Summit on Sustainable Development (WSSD) (UN 2002). Ecosystem-based fisheries management (EBFM) has been adopted as a central tenet of the FAO (UN) Code of Conduct for Responsible Fisheries (FAO 1995), and is a stated objective of national and regional fisheries policies (e.g. Europe's Common Fisheries Policy; EC 2009). The EA has also been adopted in a number of cross-sector European policies, including the Integrated Maritime Policy (IMP), the Marine Strategy Framework Directive (MSFD) and the Blue Growth Policy (Url3 JNCC; Url2 EC IMP). At the UK level, the EA has been incorporated into the Marine and Coastal Access Act 2009, and in Wales, underlies the Environment Bill for Wales 2013, and the recently published Wales Marine and Fisheries Strategic Action Plan (WG 2013).

Given these commitments, there is significant interest as to how an EAFM could be implemented in Wales, and what implementation would mean for the people involved (e.g. authorities and sea users), fisheries and the wider marine environment. This section considers the merits and practicalities of implementing an EA to fisheries and wider marine management that are currently being explored by the fishing industry, non-governmental organisations and statutory bodies in Wales (Section 2.1). Through review of global guidance, Section 2.2 builds upon these frameworks and highlights 6 key phases for implementing an EA(FM).

2.1. Implementation Processes involving Welsh Stakeholders

This literature review started with the following recent EA guidance, identified by FMM as being most relevant to the management of fisheries and the wider marine environment in Wales:

- **Striking the Balance: An Ecosystem-Approach for MCZ Management in Wales** (Woolmer 2012);
- **Towards sustainability in the Celtic Sea: A guide to implementing the ecosystem approach through the Marine Strategy Framework Directive** (PISCES 2012); and
- **Using the Ecosystem Approach: A Framework for Natural Resources Wales** (Spode et al. 2013).

All three of the above frameworks have adopted (or adapted) the Convention of Biological Diversity definition of an EA and the associated Malawi Principles (see Box 1.2) in their design. Due to this shared basis there are similarities within the proposed implementation steps and / or the issues to be addressed (Table 2.1). However, they have been developed from different perspectives, for different objectives, and to be implemented at different management scales. The following sub-sections provide a brief overview of each of the three approaches and highlights key similarities and differences amongst them.

Table 2.1 Summary of the ecosystem approach implementation steps in Striking the Balance (Woolmer 2012); Towards sustainability in the Celtic Sea (PISCES 2012); and Using the Ecosystem Approach: A Framework for Natural Resources Wales (Spode et al. 2013).

| Striking the Balance: An Ecosystem-Approach for MCZ management in Wales (Woolmer 2012). | Towards Sustainability in the Celtic Seas: A Guide to implementing the ecosystem approach through the Marine Strategy Framework Directive (MSFD) (PISCES 2012). | Using the Ecosystem Approach: A Framework for Natural Resources Wales (Spode et al. 2013). |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. High level objectives, in line with relevant (inter) national policy drivers are to be developed, to guide the co-management group.</p> | <p>1. Carry out initial assessment of marine waters, determine Good Environmental Status (GES) and define environmental targets and indicators upon which they define GES. To be done at Member State level.</p> | <p>1. Establish Project Team and/or identify key stakeholders. The consortium should include relevant stakeholders, encompass multiple disciplines, and be headed by an appropriate team leader.</p> |
| <p>2. Ecosystem based assessment. An assessment of the ecosystem must be conducted and should include a description of the ecological, social and economic drivers, and their associated risks.</p> | <p>2. Develop and implement monitoring and evaluation programme for continued assessment of GES. To be done at Member State level and should consider transboundary impacts.</p> | <p>2. Understand the activity. The scale and focus of the current activities within the ecosystem should be defined.</p> |
| <p>3. Establish objectives. Based on results from Step 2, site specific management objectives should be developed and agreed by the co-management group.</p> | <p>3. Develop programme of measures to reach or maintain GES.</p> | <p>3. Understand the Place, ecosystems and people: key drivers, issues and opportunities. The scale, key process, diversity, current management practices (if any are present) within the ecosystem, and the interdependence between these factors should be described/understood.</p> |
| <p>4. Develop and implement MCZ management. Locally applicable management measures should be developed by the co-management group to achieve agreed site specific objectives.</p> | <p>4. Implement programme of measures; the programme of measures should be implemented by competent authorities.</p> | <p>4. Understand the ecosystem services relevant to the activity and place. The current, and potential future, ecosystem services should be defined in terms of their condition, beneficiaries, vulnerability to environmental and/or management change, enhanceability and interdependence.</p> |
| <p>5. Collaborative monitoring and feedback to be conducted and outcomes should be fed back into an adaptive management policy, and inform successive management objectives and measures.</p> | <p>5. Evaluation and adaptation. A review and adaptation process is to be conducted on a 6 year cycle, to assess the maintenance or achievement of GES and adapt/enhance process in future iterations within the MSFD.</p> | <p>5. Visioning and objective setting based on the above. Stakeholders should define a collective vision for the ecosystem, with the information/data gathered from Steps 2 to 4, and develop objectives which deliver this shared vision.</p> |

| <p>Striking the Balance: An Ecosystem-Approach for MCZ management in Wales (Woolmer 2012).</p> | <p>Towards Sustainability in the Celtic Seas: A Guide to implementing the ecosystem approach through the Marine Strategy Framework Directive (MSFD) (PISCES 2012).</p> | <p>Using the Ecosystem Approach: A Framework for Natural Resources Wales (Spode et al. 2013).</p> |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | <p>6. Review activity and generate options. Stakeholders should develop a “long” list of feasible management options which addresses conflicts between the collective shared vision (Step 5) and current activities.</p> <p>7. Select preferred option(s). Stakeholders should select the preferred option(s) considering effectiveness, impacts on associated ecosystems, opportunities for restoration and/or enhancement.</p> <p>8. Embed ecosystem approach objectives into the design and development of the preferred option, reflecting objectives in the design and/or timings of proposed activity.</p> <p>9. Detailed appraisal. Prior to implementation, the design of the new activity should be tested against the overall collective vision.</p> <p>10. Implementation of the selected management activity.</p> <p>11. Monitor activity against ecosystem objectives and outcomes, the monitoring protocol should be proportionate.</p> <p>12. Learning and adaptation. Feedback lessons learned to inform current or future activity within the ecosystem.</p> |

2.1.1. Welsh Fishermen's Association (WFA): Striking the Balance, an Ecosystem-Based Approach (EBA) for Marine Conservation Zone management in Wales.

Context

Striking the Balance was written in response to Welsh Government's (WG) proposed Highly Protected Marine Conservation Zones (HPMCZ) model, which the WFA argues *"does not adequately account for, or even acknowledge, the local or wider societal importance of these sites, but rather focuses on a narrow green agenda for no-take zones"* (Woolmer 2012).

EBA Definition

Within Striking the Balance the WFA define an ecosystem-based approach as *"the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognises that humans, with their cultural diversity, are an integral component of many ecosystems"* (Woolmer 2012).

Approach Overview

The WFA have developed an alternative adaptive co-management ecosystem based model for Marine Conservation Zone (MCZ) management in Wales, to that of the proposed Welsh Government's (WG) Highly Protected Marine Conservation Zones (HPMCZ) model. Although written with MCZ management in mind, the suggested management in Striking the Balance could be applied to any small scale or regional fisheries management. The WFA's proposal is based upon the 12 Malawi principles of the Convention on Biological Diversity and includes the following key concepts:

- Decentralisation of governance: management should be decentralised through the establishment of co-management groups composed of locally relevant statutory bodies, sea users and other stakeholders. The purpose of these groups being to develop locally specific management objectives, taking account of high levels objectives dictated by Welsh, UK and EU policy, and implement site-specific management plans for MCZs. It is argued that the resultant stakeholder engagement created by the formation of the local co-management groups will increase a sense of ownership of management and decision-making by the Welsh commercial fishing industry, increase compliance and enforcement with management, and foster greater self-regulation.
- Multiple-use MCZs: MCZs in Wales should be managed as multiple use sites rather than blanket no take zones. The suggestion is that multiple-use MCZs, managed on ecosystem-based principles, can provide win-win-win of environmental, fisheries and socio-economic gains, incorporating small areas of no take zone, to protect sensitive habitats from damage and disturbance, and areas where fishing and other activities are permitted.
- Adaptive management: management should be flexible and able to be able to respond to (natural and human induced) changes in the system, lessons learned and new understanding.
- Knowledge based management: management should be evidence rather than advocacy led and the WFA foresee a central role in research and monitoring to develop appropriate understanding of the marine environment and the ways in which people interact with it.

2.1.2. PISCES: A guide to implementing the Ecosystem Approach (EA) through the Marine Strategy Framework Directive (MSFD).

Context

The Partnership Involving Stakeholders in the Celtic Sea Ecosystem (PISCES) project was led by the World Wildlife Fund (WWF) UK in partnership with WWF-Spain and the Environment Council, and collaboration with SeaWeb and the Coastal and Marine Research Centre. The international and inter-sectoral project aimed to “*demonstrate an ecosystem-based approach to marine management across a number of countries, cultures and sectors*”; and explored the feasibility of implementing an EA within the Celtic Sea, through EU legislative commitments, e.g. the Marine Strategy Framework Directive (MSFD).

EA Definition

Two definitions of the EA were cited within this document: The Convention on Biological Diversity (CBD) and the International Council for the Exploration of the Seas (ICES), which defined an EA as:

1. “A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way” (Url3 CBD).
2. “The comprehensive integrated management of human activities based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity” (Rice et al. 2005; Url4 OSPAR).

Approach Overview

PISCES proposes an ecosystem approach to manage the marine environment at a regional scale, including offshore and coastal areas off Ireland, Wales, England and France. The PISCES project investigated the feasibility of implementing the EA through existing EU legislation, the Marine Strategy Framework (MSFD) which aims to achieve Good Environmental Status (GES) within EU member state marine waters by 2020. GES is broadly defined using the following 11 high level ecological descriptors:

- (1) Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
- (2) Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
- (3) Populations of commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
- (4) All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
- (5) Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.
- (6) Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

- (7) Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
- (8) Concentrations of contaminants are at levels not giving rise to pollution effects.
- (9) Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
- (10) Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
- (11) Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment” (Url1 JNCC).

At the time of publication (2012) the PISCES project reported on the UK and other EU nations progress towards the goals of the MSFD. It stated the UK has completed the initial phase: to conduct an initial assessment of the environmental status of its territorial marine waters, determine GES and environmental indicators. The second stage of the MSFD: develop monitoring programmes, was still in development. Further stages: to develop and implement a programme of measures; to evaluate and adapt implementation stages, which are to be conducted every 6 years, were not yet initiated in the UK. The 11 descriptors of achieving GES within the MSFD fit well within the EA model. However it was highlighted during the PISCES project that the MSFD is not a management tool and to achieve the MSFD goals would require the implementation of tools such as marine spatial planning and marine ecosystem service assessment. These tools will also need to be combined with other EU initiatives, e.g. Blue Growth agenda, to achieve the non-environmental aspects of an EA, to ensure an integrated management approach which incorporates social and economic considerations.

2.1.3. Using the Ecosystem Approach - A framework for Natural Resources Wales.

Context

This framework was produced by the Living Wales Programme (LWP) and provides broad scale guidance to Natural Resources Wales (NRW) staff and Welsh Government (WG) for implementing an EA to any situation or case where the natural environment is affected or managed (Spode et al. 2013).

EA Definition

The LWP EA framework (Spode et al. 2013) cites the CBD definition of an EA “*a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way*”. The framework also describes an EA as “*managing the environment so that its different components are considered together, including its natural systems and the benefits that people get from it, people themselves are part of ecosystems and must be involved in decision making*”.

Approach Overview

The framework’s implementation steps are aimed at all levels of work for staff and teams in NRW and WG. This means the approach is described in terms that will be relevant to a range of terrestrial and marine activities, including projects, programmes, plans and policies, large and small. There are 12 key steps grouped into sections, with the first 9 relating to planning: defining the task or issue, organising the work, scoping understanding and analysing the context, setting out options, and deciding on preferred options. After these initial planning stages it moves onto implementation, monitoring and learning / adaptation. The LWP EA framework differs from the other implementation process reviewed from Wales is that ecosystem service are clearly embedded, ESs relevant to

Wales have been identified and the guidance specifies steps where they should be defined and (where possible) valued. Although described in the text as a linear process, the LWP implementation steps are shown diagrammatically with feedback between steps, and the framework describes the need to regularly go backwards through the steps as more information is available or as things change - i.e. an iterative process.

2.1.4 Comparison of Welsh Ecosystem Approaches

The main defining features of the three frameworks are:

Scale: The three proposed EA for Welsh waters, represent a range of management scales: Striking the Balance focused on MCZs at a local or sub-regional scale; PISCES explored the feasibility of implementing an EA through the MSFD within their project area at a larger cross-sectoral regional (Celtic Sea) scale; whilst the LWP framework was written as general guidance for all NRW and WG activities across both organisations. ***Due to these differences in scale and specificity, the implementation steps and the overall focus of the approaches are slightly different.***

Co-Management: A key component of Striking the Balance is the concept of co-management, which it defines as, “Government and stakeholders cooperating together as equal partners in decision making” (Woolmer 2012). ***Stakeholder participation is a fundamental component of all three approaches; however the level of stakeholder participation is not described in detail in the PISCES or LWP approaches and neither clarifies if or how stakeholders would be involved in decision-making (at local, Wales, regional or European levels).*** Stakeholder participation is nevertheless a fundamental principle of the Malawi principles, and a key strength within all three EA frameworks because it addresses the human component of the ecosystems in question, and the issue of societal choice (Url3 CBD 1992).

Review: Another key strength of the three EA implementation frameworks is the inclusion of a review stage in which information and lessons learned from previous steps, are used to inform successive steps and future iterations of the management cycle. ***A weakness in this regard is the lack of specification of a time duration between review processes i.e. how often should a management review take place?*** Striking the Balance states that a biannual or annual review process should be conducted (Woolmer 2012), whereas within the context of the MSFD under the PISCES project, the review process will be conducted on 6 yearly basis (PISCES 2012). The LWP framework does not specify a timeframe for management review. ***It is important that the review processes is environmentally and economically relevant to the ecosystem, the management implemented and to stakeholders, and that the timeframe of the review cycle is written in to management plans.***

Financing: A weakness of the three proposals is the lack of discussion about the potential economic cost of implementation. ***There is an inherent increase in management costs in the transition to an EA*** (FAO 2005; Garcia & Cochrane 2005; Staples & Funge-Smith 2009), ***and the question of “Who pays?” for the associated costs of increasing local capacity, supporting co-management group activities, broader data and information needs, monitoring, enforcement and/or evaluation processes has not been addressed in any of the Welsh proposals.*** This is particularly relevant given the proposal within Striking the Balance for fishermen to be core members of co-management

groups, and involved in both data collection and enforcement (Woolmer 2012), coupled with the current uncertain economic climate.

A recent consultation document on sustainable management of Wales' natural resources anticipates that the cost implications of implementing (new) management proposals are likely to fall to WG and NRW (WG 2013). However, the expectation is that a more joined-up approach to managing Wales' natural resources will, over the medium to long-term, deliver cost savings (WG 2013), a point supported by other guidance on EA implementation (e.g. Staples & Funge-Smith 2009). Financing an EAFM in Wales is beyond the scope of this report but there are other approaches that could be explored to help meet the increased costs of implementing an EA, for example, additional taxation on the sea users (Garcia & Cochrane 2005; FAO 2005); the WWF's Smart Fishing Initiative's investment model² (Url7 WWF); and Payment for Ecosystem Services_ (Short 2012). Additionally, implementing management, data gathering, enforcement, *etc.* through pre-existing legislation could potentially limit duplication and associated costs (PISCES 2012; ORAP 2013).

2.2. Other current and relevant guidance with steps for implementation of an ecosystem approach (with emphasis on fisheries).

A literature search of key EA terminology generated a significant number of guidance documents and implementation frameworks for EA(FM). However, given limited resources to complete this review, and identification of commonalities, this section focusses on 7 key frameworks and their associated implementation steps that span a decade of development of EA thinking up to the current date. Table 2.2 summarises the implementation steps from the different frameworks and demonstrates that despite differences in language, the numbers of steps, and levels of detail within each step, there are significant commonalities among them which we have used to classify 6 key implementation phases:

- Phase 1: Understanding the context - "Where are we now?"
- Phase 2: Objective setting - "Where do we want to be?"
- Phase 3: Explore management options - "How can we get there?"
- Phase 4: Implement preferred management - "Do it!"
- Phase 5: Monitor - "Are things changing?"
- Phase 6: Evaluate and adapt - "How are we doing (against objectives)?"

The phases are used as the basis of the implementation cycle detailed in Section 3 which draws upon wider EA(FM) literature to provide further detail on considerations required within Phases, and on tools and approaches that have been developed to assist with implementation.

² Through its Smart Fishing Initiative, the WWF is seeking to realize the future economic value of recovered and sustainably managed fish stocks with a *Financial Institution for the Recovery of Marine Ecosystems* (FIRME) which employs an investment model that finances conservation without adversely impacting livelihoods (for further information see <http://wwf.panda.org/?205455/WWF-unveils-new-investment-model-to-recover-marine-ecosystems>).

Table 2.2 Summary of ecosystem approach implementation guidance; colours demonstrate the commonalities among approaches (blue (P1), understanding the context; red (P2), objective setting; purple (P3), exploring management options; green (P4), implement management plan; grey (P5), monitor; and orange (P6), evaluate and adapt).

| Policy Proposals and Operational Guidance for EBM of Marine Capture Fisheries | | Putting into practice the ecosystem approach to fisheries | | Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines | | Integrated ecosystem assessments: developing the scientific basis for EBM of the ocean | | An evaluation of progress in implementing EBM of fisheries in 33 countries. | |
|-------------------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------|
| Ward et al. 2002 | | FAO 2005 (also FAO 2003; FAO 2009) | | Garcia & Cochrane 2005 | | Levin et al. 2009 | | Pitcher et al. 2009 | |
| 1 | Identify stakeholder community (P1). | 1 | High level policy goals (social, economic, environmental) (P1). | 1 | Scoping: Mapping resources, issues, stakeholders, competing uses, and existing rights (P1). | 1 | Scoping: Identify goals of EBM and threats to achieving goals (P1). | 1 | Identify stakeholder community (P1). |
| 2 | Prepare a map of eco regions and habitats (P1). | 2 | Identify broad objectives relevant to fishery (or area) in question (P2). | 2 | Collection of background information and analyses: Ex-ante assessments, strategic analysis, synergies, conflicts (P1). | 2 | Indicator development: Develop ecosystem indicators and targets (P2). | 2 | Prepare a map of eco regions and habitats (P1). |
| 3 | Identify partners and their interests/responsibilities (P1). | 3 | Break these objectives down into smaller priority issues and sub-issues that can be addressed by management measures (P2). | 3 | Setting operational objectives: With indicators and reference points (P2). | 3 | Risk analysis (P1). | 3 | Identify partners and their interests/ responsibilities (P1). |
| 4 | Establish ecosystem values (P1). | 4 | Set operational objectives (P2). | 4 | Formulation of decision rules (P3). | 4 | Ecosystem assessment: Assessment of ecosystem status relative to EBM goals (P1). | 4 | Establish ecosystem values (P1). |
| 5 | Determine major factors influencing ecosystem values (P1). | 5 | Develop indicators and reference points (P2). | 5 | Implementation and enforcement (P4). | 5 | Management strategy evaluation (P3). | 5 | Determine major factors influencing ecosystem values (P1). |
| 6 | Conduct Ecological Risk assessment (P1). | 6 | Develop decision rules on how the management measures are to be applied (P3). | 6 | Monitoring (P5). | 6 | Implementation of management action (P4). | 6 | Conduct ecological risk assessment (P1). |
| 7 | Establish objectives and targets (P2). | 7 | Monitor (P5) and evaluate performance (P6). | 7 | Ex-post assessment and review (P6). | 7 | Monitoring of ecosystem indicators & manage effectiveness (P5). | 7 | Establish objectives and targets (P2). |
| 8 | Establish strategies for achieving targets (P3). | | | | | 8 | Adapt management if necessary (P6). | 8 | Establish strategies for achieving targets (P3). |
| 9 | Design information system, including monitoring (P5). | | | | | | | 9 | Design information system, including monitoring (P5). |
| 10 | Establish research and information needs and priorities (P6). | | | | | | | 10 | Establish research and information needs and priorities (P6). |
| 11 | Design performance assessment and review process (P6). | | | | | | | 11 | Design performance assessment and review processes (P6). |
| 12 | Prepare education and training package for fishers (P6). | | | | | | | 12 | Prepare education and training package for fishers (P6). |

Table 2.2 cont. Summary of ecosystem approach implementation guidance; colours demonstrate the commonalities among approaches (blue (P1), understanding the context; red (P2), objective setting; purple (P3), exploring management options; green (P4), implement management plan; grey (P5), monitor; and orange (P6), evaluate and adapt).

| The many faces of Ecosystem – Based Management: Making the process work today in real places | | Structuring decision-making for ecosystem-based management | | PISCES: Celtic Seas Project | | Welsh Fisherman’s Association: Striking the Balance | | Natural Resources Wales: Ecosystem Approach Framework | |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|--------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Tallis et al. 2010 | | Espinosa-Romero et al. 2011 | | PISCES 2012 | | Woolmer 2012 | | Spode et al. 2013 | |
| 1 | Scoping: Identify goals and threats (P1). | 1 | Definition of objectives, threats to ecosystems and ecosystem management drivers (P1). | 1 | Carry out initial assessment of marine waters, determine Good Environmental Status (GES) (P1) and define environmental targets and indicators (P2). | 1 | High-level objective setting (P1). | 1 | Establish the project team and/or key stakeholders (P1). |
| 2 | Indicators: Choose measures or proxies for goals (P2). | 2 | Development of indicators for ecosystem state (P2) | 2 | Develop (P3) and implement monitoring and evaluation programme (P3). | 2 | Ecosystem-based assessment (P1). | 2 | Understand the activity (P1). |
| 3 | Thresholds: Set target levels or trends (P2). | 3 | Establishment of thresholds for each indicator (P2). | 3 | Develop programmes of measure (P3)s. | 3 | Establish objectives (P2). | 3 | Understand the place, ecosystems and people: Key drivers, issues and opportunities (P1). |
| 4 | Risk Assessment: Link between indicators and threats (P1). | 4 | Risk analyses to evaluate how indicators respond to human and environmental disturbances and the probability that indicators will reach an undesirable state (P1). | 4 | Implement programme of measures (and monitoring) (P5). | 4 | Develop and implement (P4) MCZ management. | 4 | Understand the ecosystem services relevant to the activity and place (P1). |
| 5 | Management Strategy Evaluation: Asses options and choose approach (P3). | 5 | Evaluation of management strategies to predict the effects on the indicators (P3). | 5 | Evaluation and adaptation (P6). | 5 | Collaborative monitoring (P5) and feedback (P6). | 5 | Visioning and objective setting based on the above (P2). |
| 6 | Monitor: Track indicators (P5). | 6 | Monitoring management strategy outcomes (P5). | | | | | 6 | Review activity and generate options (P3). |
| 7 | Evaluation: Assess change (P6). | | | | | | | 7 | Select preferred option(s) (P3). |
| | | | | | | | | 8 | Detailed appraisal (P3). |
| | | | | | | | | 9 | Embed ecosystem approach objectives into the design and development of the preferred option (P3). |
| | | | | | | | | 10 | Implementation (P4). |
| | | | | | | | | 11 | Monitor activity against ecosystem objectives and outcomes (P5). |
| | | | | | | | | 12 | Learning and adaptation (P6). |

2.2.1 WWF: Policy Proposals and Operational Guidance for Ecosystem-Based Management of Marine Capture Fisheries (Ward et al. 2002), also Implementation of Ecosystem-Based Management in marine capture fisheries: case studies from WWF's Marine Ecoregions (Grieve and Short 2007)

The World Wide Fund for Nature (WWF) published a twelve-step approach (Table 2.2) (Ward et al. 2002), which by being targeted at both macro-policy and hypothetical fishery levels is applicable internationally, to any marine capture fishery and much is relevant at any geographic scale. As well as guiding the reader through the implementation steps (Appendix 1), this document describes the people and processes involved, and intended outputs or outcomes from each step. The framework is based on 5 principles:

1. The central focus is maintaining the natural structure and function of ecosystems, including the biodiversity and productivity of natural systems and identified important species.
2. Human use and values of ecosystems are central to establishing objectives for use and management of natural resources.
3. Ecosystems are dynamic; their attributes and boundaries are constantly changing and consequently, the interactions with human uses also are dynamic.
4. Natural resources are best managed within a management system that is based on a shared vision and a set of objectives developed amongst stakeholders.
5. Successful management is adaptive and based on scientific knowledge, continual learning and embedded monitoring processes.

This framework also identifies six key elements that must be addressed for effective EBM:

- (1) Management operates within a policy framework designed to facilitate and enable effective implementation of all the principles of ecosystem based management,
- (2) Recognition of economic, social and cultural interests as factors that may affect resource management objectives, targets, strategies and activities,
- (3) Ecological values are recognised and incorporated into the management system through developing agreed objectives, targets, strategies and activities that reduce the risk of the impacts of resource exploitation,
- (4) Information on utilised species is adequate to ensure that there is a low risk of over-harvesting and population genetic diversity are maintained,
- (5) The resource management system is adequate and appropriate to ensure that EBM can be effective and efficient.
- (6) Environmental externalities that may affect the resource, or that the resource exploitation system may impact, are properly considered within the resource management system.

Whilst this document has wide scope, the detail contained in the *Guidelines for implementing EBM in a hypothetical coastal fishery* (Appendix 1) is relevant for implementation of an EAFM in Wales. Building on Ward et al. (2002), Grieve and Short (2007) argue “for EBM to be effective, the principles and elements of EBM need to be translated into actions and control measures that are applied within a fishery”, and the implementation steps (Table 2.2) and associated detail set out in Ward et al. (2002; Appendix 1) can be used to make the framework operational.

Furthermore, the inclusion of the required outcomes from each step provides a useful, and transparent, checklist against which the performance and progress of EAFM projects can be measured (e.g. Grieve and Short 2007; Pitcher et al. 2009).

2.2.2 FAO: *Putting into practice the Ecosystem Approach to Fisheries (EAF) (FAO 2005)*, see also *The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries (FAO 2003)* and *Ecosystem approach to fisheries and aquaculture: Implementing the FAO Code of Conduct for Responsible Fisheries (Staples & Funge-Smith 2009)*.

In 2003, the FAO produced Technical Guidelines to supplement the FAO Code of Conduct for Responsible Fisheries (1995) based on the Ecosystem Approach to Fisheries (EAF) (FAO 2003), subsequently abridged into non-technical guidance entitled *Putting into practice the Ecosystem Approach to Fisheries* (FAO 2005). The purpose of these documents was to make an EAF operational by providing guidance on how to translate the economic, social and ecological policy goals and aspirations of sustainable development into operational objectives and actions (Staples & Funge-Smith 2009). The guidance is aimed at an international scale and is therefore relevant to Welsh fisheries. However, it lacks specifics that could be applied to an EAF initiative in Wales.

The Technical Guidelines are based on seven implementation steps (Table 2.2) and include a process for developing a management plan for an EAF for a fishery (Appendix 2), defined as a formal or informal arrangement between stakeholders and the fisheries management authority that results from the process of implementing the EAF. Broadly speaking, the objective of the management plan is to ensure that the goals and needs of all legitimate stakeholders are addressed in a transparent manner, and that major interactions between fisheries and the environment are taken into account.

The guidance also highlights potential threats to successfully implementing an EAF, including:

- Managing expectations – a key impediment to EAF is the mismatch between the expectations of stakeholders and the resources available for fisheries management
- Difficulty in reconciling the competing objectives of multiple stakeholders or sectors
- Insufficient or ineffective stakeholder participation
- Insufficient knowledge of fishing and ecosystem interactions
- Inadequate capacity within management agencies and stakeholder groups to deal with the additional demands of EAF
- Insufficient education and awareness at all levels of EAF
- Difficulties in resolving issues related to equity
- The costs and other problems involved in aligning ecosystem boundaries with the existing jurisdictions of management authorities
- Controlling illegal behaviour by some stakeholders
- Finding means of adequately compensating those living in poverty and dependant on affected fisheries for any short – and medium – term negative impacts on their fishing activities brought about by the implementation of EAF.

A key issue that the FAO (2005) and Garcia & Cochrane (2005) (see Section 2.2.3 below) mention, that few other publications consider in detail, is the potential higher financial cost of moving from existing forms of management to an EAFM, in the short-term at least. An EAF requires consideration of social, economic and ecological aspects of the ecosystem, and as such has requires a far greater breadth of information than traditional fisheries management systems. Such information needs to be acquired, analysed and reported/disseminated; an EAF requires additional planning, more consultative decision-making processes, greater scope to monitoring, surveillance and enforcement/control (FAO 2005). It is beyond the scope of this review to consider how an EAFM in Wales could be financed but the FAO (2005) argues that increased costs could, in part, be paid by the fishing industry itself, for example through additional levies/taxes (see also discussion under *Financing* in Section 2.1.4).

2.2.3 Garcia & Cochrane: Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines (Garcia and Cochrane 2005).

Whilst there has been significant progress in both the science and policy aspects associated with implementation of an EAF in the last decade (e.g. see the Packard Foundation EBM Science Programme³; Bloomfield et al. 2011), Garcia & Cochrane's (2005) review identified some key points that are still valid and useful for consideration of an EAFM in Wales. First they highlight that one of the main tasks for implementing an EAF is to translate generic and conceptual EAF frameworks into something that is operational. As with conventional fisheries management, this requires: a *policy*, a *strategy*, and an *operational management plan* (Garcia & Cochrane 2005). Broadly speaking, the policy should spell out commitments and provide a backdrop against which EAF can be implemented. The strategy turns conceptual goals into operational objectives, prioritises them and defines the time frames within which they should be attained. The management plan provides the details on the resources available, the stakeholders involved, the management measures for achieving the operational objectives specific to the various fisheries, and the enforcement mechanisms.

Second, Garcia & Cochrane (2005) state the need for interconnected actions, strategies and plans at several scales to effectively implement an EAF, highlighting that actions and plans must nest within each other at regional, national, sectoral and individual fishery scales. This assertion echoes that of the FAO (2005) which called for mechanisms to ensure that management decisions and actions are consistent and coordinated at all levels, and joined-up decision making between fisheries and other sectors that operate in the same ecosystem. They also provide details on the expected outcomes of each step of the implementation process, and in doing so provide a mechanism for feedback and adaptation in light of new information and understanding. A final key point is the additional data requirements of an EAF, "*the increase of the scope and sophistication of science is proportional to the ecosystem complexity*"; both are known to increase uncertainty. Garcia and Cochrane (2005) suggest that tools including risk assessment can be used to assist in determining and prioritising levels of acceptable uncertainty, in light of limited resources for collecting further data.

³ <http://www.packard.org/what-we-fund.conservation-and-science/science/ecosystem-based-management-initiative>

2.2.4 Integrated Ecosystem Assessments (IEA).

- Levin et al. 2009. Integrated Ecosystem Assessments (IEA): developing the scientific basis for ecosystem-based management of the ocean.
- Tallis et al. 2010. The many faces of Ecosystem – Based management: Making the process work today in real places.
- Espinosa-Romero et al. 2011. Structuring decision-making for ecosystem-based management.

Several EA implementation guides within this review are based upon Integrated Ecosystem Assessment (IEA), a decision-making aid developed by the US National Oceanic and Atmospheric Administration (NOAA). IEA is claimed to be the most useful decision-making framework for marine management that integrates science to assist decision makers (Espinosa-Romero et al. 2011). Levin et al. (2009) describe a step by step process for conducting an IEA:

“An IEA begins with a scoping process to identify key management objectives and constraints, identifies appropriate indicators and management thresholds, determines the risk that indicators will fall below management targets, and combines risk assessments of individual indicators into a determination of overall ecosystem status. The potential of different management strategies to alter ecosystem status is evaluated, and then management actions are implemented and their effectiveness monitored. The cycle is repeated in an adaptive manner.”

Tallis et al. (2010) takes the reader through the process of conducting an IEA through two real world scenarios: Raja Ampat (Philippines), an example with poor data quality and weak governance; and Puget Sound (USA), a data rich example with strong governance. During each of the implementation steps Tallis et al. (2010) explains the appropriate actions in reference to both the data rich and data poor case studies. In scenarios where data is readily available and governance is strong, an emphasis is placed upon the use of statistical and modelling techniques, particularly to determine indicators and acceptable thresholds, and also when conducting risk analysis and monitoring. Where data is lacking, of poor quality, or governance is weak, Tallis et al. (2010) suggest data gathering through stakeholder engagement is more appropriate.

Espinosa-Romero et al. (2011) also use a case study to describe Systematic Decision-Making (SDM), a tool within the IEA framework which aims to “*help define operational objectives that reflect the values of the constituents and derive indicators based on those objectives so as to facilitate the process of decision-making within an EBM context*” (Espinosa-Romero et al. 2011). To successfully implement EBM Levin et al. (2009), Tallis et al. (2010) and Espinosa-Romero et al. (2011) all emphasise sufficient time and effort must be spent on setting operational objectives and that stakeholders must move past contentious issues to ensure objectives are collectively supported. Additionally the importance of defining adequate and relevant indicators and thresholds is highlighted by all three authors, as without clear standards for acceptable levels of indicators, it is impossible to evaluate management success (Tallis et al. 2010).

3. A Process for Implementing an Ecosystem Approach to Fisheries Management (EAFM)

Having reviewed the relevant literature, Marine EcoSol summarised the phases of the implementation process into the cycle below (Figure 3.1); details of each phase are provided in sections 3.1. to 3.6. It should be noted “*the Ecosystem Approach (EA) is not a rigid methodology, but a way of thinking that should help us develop and implement our plans, projects and assessments in a more integrated and joined up way*” (Spode et al. 2013). The phases described are not intended to supersede the steps outlined in the different guidance documents reviewed; instead each of the six phases incorporates one or more steps from the reviewed implementation processes (see Table 2.2). Almost all of the EA(FM) frameworks reviewed state that implementation should:

- be driven by High Level Policy Objectives and wider societal objectives for the marine environment (ecological, social and economic);
- be adaptive and operate based on the best available evidence; and
- involve stakeholder participation.

The frameworks, and the wider EA(FM) literature, also provide guidance on the core principles for good decision making, and these are also discussed below to set the scene for the phases of the implementation process in the subsequent sub-sections.

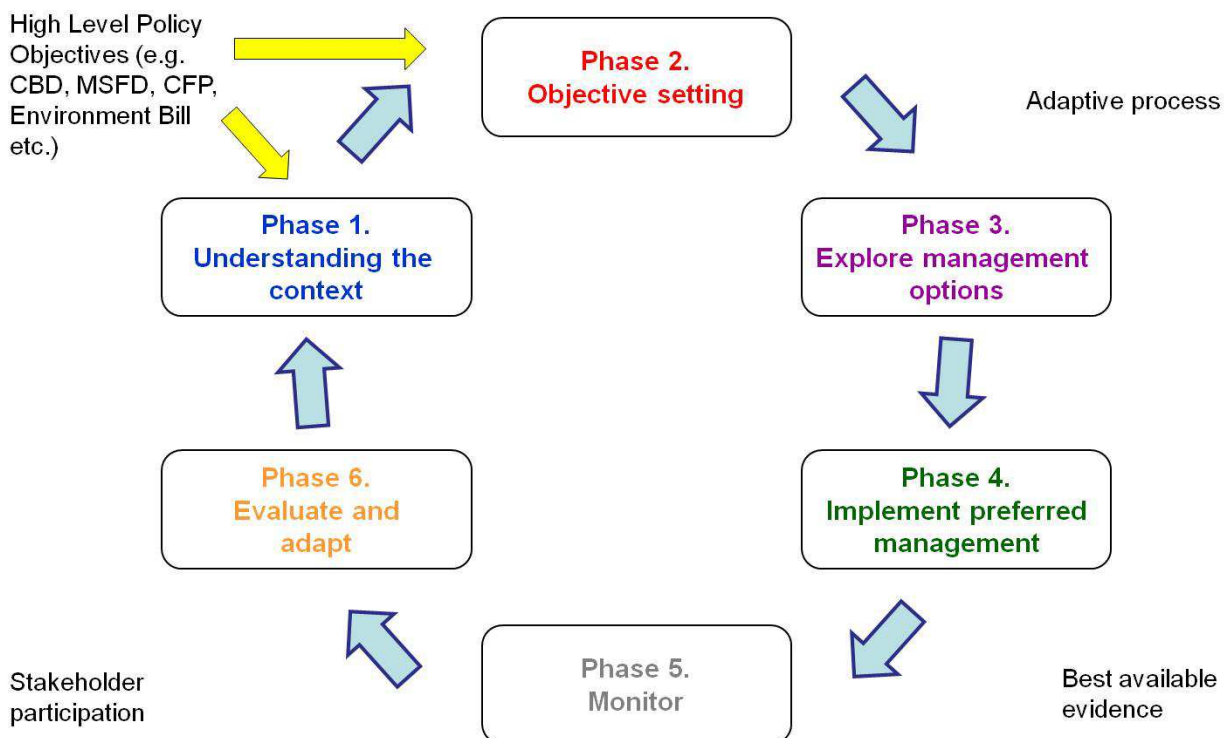


Figure 3.1 Key phases in the implementation process for an ecosystem approach to fisheries management (EAFM); summarised following literature review.

Adaptive management

The implementation process can be viewed as a cycle, and although the arrows in Figure 3.1 are unidirectional, a key component in an EA is that there is feedback among phases. It is important to note that there are few situations where an EA project or process would start with a blank page in Phase 1 given that management is most likely to be building on, or responding, to existing management and / or issues. Whilst the following sections (3.1 to 3.6) focus on individual phases of the cycle, there is likely to be some overlap of actions across multiple phases. Furthermore, it may not be possible nor appropriate to complete all actions within a particular phase before progressing to the next phase.

The management framework must recognise that all components of the system are dynamic, and constantly changing, and therefore be flexible to be able to respond to environmental changes (e.g. climate change), and new information and understanding (Frid et al. 2006; Grieve & Short 2007 ; Bloomfield et al. 2011b; Spode et al. 2013; Woolmer 2012). Fundamentally, management must be implemented based on clear (ecological, social and economic) objectives, with performance assessed against those objectives at appropriate timeframes, acknowledging that different objectives may require different timeframes to be realised. It may not be possible to achieve all objectives within a single cycle, or even at all, but monitoring and evaluation must be able to report on progress in support of all objectives, and to identify where action is required. Objectives should also be periodically reviewed as part of the EA process to ensure their continued (ecological, social and economic) relevance.

Best available evidence

Understanding of the links between ecological, social and economic systems is crucial to ensuring that management decisions are appropriately informed (see also reference to Social Ecological Systems in Section 1.2). This has implications for the knowledge base required to support management advice given that much of this information is “new” to traditional fisheries (and wider marine management) approaches. It is clear that it will not be possible to meet all potential additional data requirements using the data that are currently collected (Garcia & Cochrane 2005; Frid et al. 2006; Bloomfield et al. 2011)

The Welsh Fishermen’s Association (Woolmer 2012) state that “*flexible and adaptive management will only be possible with a sound understanding of the marine environment and the ways in which we interact with it*”. This assertion is supported by others (Levin et al. 2009; Tallis et al. 2010; Espinosa-Romero et al. 2011). However, whilst there is a desire for more data and evidence-led management to avoid unnecessary precautionary action (Woolmer 2012), the inherent complexity of marine ecosystems, and our limited knowledge and understanding of them and the ways in which fisheries affect them, means that (some) management decisions will continue to be made in a climate of uncertainty (Grieve and Short 2007). In such situations, the FAO Code of Conduct dictates that a precautionary approach should be applied (FAO 1995).

It has been suggested that the data requirements “wish list” has the potential to become prohibitive for EAFM, and that there is a need to make sense and use of the data we already have (Glazier 2011; Van Hoof et al. 2011). Management advice should be formulated based on the best available evidence, using multiple lines of investigation, consistent with the FAO Code of Conduct for Responsible Fisheries (Grieve and Short 2007; Bloomfield et al. 2011). Qualitative assessments and expert judgement from outside of the traditional scientific fisheries advice domain (e.g. from industry, environmental and social scientists, and economists) are needed to supplement analytical modelling, particularly with respect to social and economic objectives, if an EA is to be made operational. Van Hoof et al. (2011) also pointed out that there is rarely no knowledge on a particular issue but for those things that really are unknown we need to understand how “not knowing” could affect predictions of management outcomes (Phase 3; Figure 3.1).

Bloomfield & et al. (in prep) summarise that an effective an advice framework must be: (1) able to incorporate data on the status of ecological, economic and social indicators to report against the established objectives; (2) sufficiently flexible to work with the best available evidence (quantitative, qualitative, expert judgement) rather than placing demands for further research; and (3) able to convey the available information in a clear, structured and transparent manner to inform decision making.

Stakeholder participation

There is consensus in the literature that people are both part of the ecosystem and must also be part of the management process of an EA (Ward et al. 2002; Bloomfield et al. 2011b; Woolmer 2012; Spode et al. 2013; and others). Meaningful stakeholder participation is expected to increase credibility of management objectives, foster stakeholder support for the resultant management, and thus improve the likelihood of management success (Tallis et al. 2010; Bloomfield et al. 2011b; Espinosa-Romero et al. 2011; PISCES 2012). Stakeholder involvement can also bring new (non-traditional) data and understanding to the table to aid decision-making. The challenge is building an appropriate project team to deal with the issues; the key questions being, “*Who are the stakeholders?*” and “*What is their role?*”

The term “stakeholder” has commonly been used to refer to sea users, for example fishermen, recreational users, and others with an interest in the marine environment e.g. environmental non-governmental organisations (NGOs) (e.g. Woolmer 2012). It is important to ensure that all those who have an interest (financial or otherwise) in the area being managed are kept abreast of developments and that there is an appropriate level of involvement in the actual EA design and implementation process.

The role of stakeholders depends on the governance structure in which management is developed and there is a call for more co-management based approaches (FAO 2006; PISCES 2012; Woolmer 2012). Woolmer (2012) describes the co-management continuum, with differing levels of responsibility and authority for the state and stakeholders, from “instructive”, in which a mechanisms exist for dialogue with users but are predominantly used as a conduit for government to inform stakeholders of decisions they plan to make, through to “informative”, in which decision making authority has been delegated to stakeholders who are then responsible for informing governments of management decisions (Figure 3.2).



Figure 3.2 The co-management scale (modified from Woolmer 2012).

The reality is that fisheries and marine management in developed nations, such as the UK, tends to sit at the state-controlled end of the governance continuum (Figure 3.2). With stakeholder participation, at best, in the form of consultation, and decisions ultimately being made and enforced by governments or by authorities acting on their behalf (FAO 2005; PISCES 2012; Ward et al. 2002). For example, in existing management of fisheries (pre 2013 Reform of the Common Fisheries Policy) beyond territorial limits in Europe, advice has been sought from stakeholders through Regional Advisory Councils. However there has been no legal requirement for advice to be taken on board by the authorities (Member States (MS) and/or the Commission), with decision making and setting of targets remaining the sole competency of the EU, and policy implemented at the MS level (Van Hoof et al. 2011).

There is recent emphasis on a more co-operative (true) co-management approach in which stakeholders are part of the decision-making team, and work collaboratively with “traditional” managers and decision-makers, scientists, policy makers, etc. at appropriate geographical scales (Bloomfield et al. 2011b, Woolmer 2012). In doing so, all stakeholders would be fully informed of developments of the EA and become partners in its implementation, contributing to the potential for success. Recent communication from Welsh Government indicates that they are supportive of trialling a regional co-management initiative, which is being championed by the Welsh Fishermen’s Association on the Llŷn Peninsula (WG 2013). Development of this, and similar, partnerships should draw upon lessons learned from existing co-management structures (see Woo and Woolmer 2014 for examples relevant to implementation of an EAFM in Wales).

Key considerations for good-decision making

Informed decision-making for EAFM is reliant on the ability to predict the likely outcomes of potential management actions in relation to multiple, and potentially conflicting, objectives (Watters et al. 2013). Decisions will be required in all phases of the implementation cycle (Fig. 3.1), and a selection of relevant tools and approaches that have been developed to assist with specific implementation steps are detailed in the appropriate phases. The literature identifies a number of key considerations for decision-making:

- Decision-making in EA(FM) should be informed by science (based on the best available evidence, e.g. empirical, modelled, expert judgement, traditional knowledge etc.) (FAO 2005; Bloomfield et al. 2011b; Glazier 2011; ORAP 2013; Watters et al. 2013) but is not an exclusive science-based process:

“Human values, articulated and pursued within appropriate governance processes, are at the heart of why EBM is important and they define what EBM should achieve. Because management is the process of making decisions, the implementation of EBM requires a participatory and systematic framework to identify the values of the constituents with respect to EBM and to make decisions that best satisfy those values” (Espinosa-Romero et al. 2011).

- Decision-making in EA(FM) should utilise approaches that enable simultaneous consideration of the potential impacts of different management options against ecological, social and economic objectives in a clear and transparent way to enable decision-makers to consider trade-offs among objectives in support of human use values (Bloomfield et al. 2011; Espinosa-Romero et al. 2011; Glazier 2011; Watters et al. 2013).

“Due to the nature of the trade-offs, it may not be possible to meet all objectives or satisfy all stakeholder groups simultaneously, particularly given the short-term incompatibility of environmental, social and economic objectivesResolution of the trade-offs required to deliver the overarching objectives is not a technical or scientific decision, however application of a decision support framework..... coupled with agreed (and formalised) guidance on the priority to be given to objectives when trade-offs have to be made, will aid managers [decision-makers] in making appropriate decisions on the basis of the best available information” (Bloomfield et al. 2011b).

- Decision-making in EA(FM) should be decentralised to the lowest possible level and involve all stakeholders in knowledge sharing, decision-making and management (FAO 2005; Bloomfield et al. 2011; Url8 JNCC).

“Implementation of EBM requires a participatory and systematic framework to identify the values of the constituents.....This framework would help managers anticipate and address the concerns of stakeholders.... In addition, if stakeholders see their values reflected they are more likely to trust the process and/or support its implementation” (Espinosa-Romero et al. 2011).

“Implementation of appropriate governance mechanisms, at appropriate geographical scales, that facilitate true stakeholder engagement in the development of fisheries policy and management. This includes involvement of stakeholders in both the definition of objectives (ecological, social and economic) and appropriate (region specific) indicators and in the development and evaluation of resultant management. Closer integration among stakeholders, fisheries scientists, ecologists, social scientists and economists will help to develop more effective management advice, generate credibility in the management process and foster stakeholder support” (Bloomfield et al. 2011).

3.1. Phase 1: Understand the context and issue(s) to be addressed

Understand the activity, the current state of the environment, and the stakeholders who will be affected:

“Where are we now?”

Whilst there might be the desire to rapidly progress to implementation of management to achieve an EA, it is crucial that the first phase of an EA should include an initial assessment to define the scope and boundaries of the project or initiative, and the past, present and future issue(s), activities and drivers within the ecosystem (Tallis et al. 2010; Woolmer 2012; Spode et al. 2013). The reality is that the decision-making process is rarely (if ever) starting with a blank page, and is more likely to be building upon existing management and governance frameworks. Therefore this phase should not be overlooked as it is crucial to: (1) form a solid foundation for action under subsequent phases; and (2) allow expectations be managed of what an EA can achieve, and under what timeframes. Table 3.1. summarises the steps relevant to this phase from the key implementation guidelines reviewed. The key components of this phase should:

- Clarify the activity or issue to be addressed, and the relevant geographical scale;
- Identify the stakeholder community: those to which the issue is relevant (both directly and indirectly);
- Clarify the roles and responsibilities of stakeholders in the process, and the governance structure supporting the process;
- Agree the overarching scope and direction of the project, based on high level (social, economic and environmental) objectives; and
- Assess the present state of the ecosystem (social, economic and environmental), including any risks to the ecosystem state, based upon the best available evidence.

Table 3.1 Steps relevant to Phase 1 “Where are we now?” from the key implementation guidelines reviewed (adapted from Table 2.2).

| Key implementation guides | Relevant steps (and number) |
|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ecosystem Based Management of Marine Capture Fisheries (WWF; Ward et al. 2002). | <ol style="list-style-type: none"> 1. Identify stakeholder community. 2. Prepare a map of eco regions and habitats. 3. Identify partners and their interests/responsibilities. 4. Establish ecosystem values. 5. Determine major factors influencing ecosystem values. 6. Conduct Ecological Risk assessment. |
| Putting into practice the ecosystem approach to fisheries (FAO; FAO 2005). | <ol style="list-style-type: none"> 1. High level policy goals (social, economic, environmental). |
| Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines (Garcia & Cochrane 2005). | <ol style="list-style-type: none"> 1. Scoping: Mapping resources, issues, stakeholders, competing uses, and existing rights. 2. Collection of background information and analyses: Ex-ante assessments, strategic analysis, synergies, conflicts. |
| Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the | <ol style="list-style-type: none"> 1. Scoping: Identify goals of EBM and threats to achieving goals. 3. Risk analysis. 4. Ecosystem assessment: Assessment of ecosystem status relative to EBM goals. |

| Key implementation guides | Relevant steps (and number) |
|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ocean (Levin et al. 2009). | |
| An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries (Pitcher et al. 2009). | <ol style="list-style-type: none"> 1. Identify stakeholder community. 2. Prepare a map of eco regions and habitats. 3. Identify partners and their interests/responsibilities. 4. Establish ecosystem values. 5. Determine major factors influencing ecosystem values. 6. Conduct Ecological Risk assessment. |
| The many faces of Ecosystem – Based management: Making the process work today in real places (Tallis et al. 2010). | <ol style="list-style-type: none"> 1. Scoping: Identify goals and threats. 4. Risk Assessment: Link between indicators and threats. |
| Structuring decision-making for ecosystem-based management (Espinosa-Romero et al. 2011). | <ol style="list-style-type: none"> 1. Definition of objectives, threats to ecosystems and ecosystem management drivers. 4. Risk analyses to evaluate how indicators respond to human and environmental disturbances and the probability that indicators will reach an undesirable state. |
| PISCES: Celtic Seas Project (PISCES 2012). | <ol style="list-style-type: none"> 1. Carry out initial assessment of marine waters, determine Good Environmental Status (GES) and define environmental targets and indicators. |
| Welsh Fishermen's Association: Striking the Balance (Woolmer 2012). | <ol style="list-style-type: none"> 1. High-level objective setting. 2. Ecosystem-based assessment. |
| Natural Resources Wales: Ecosystem Approach Framework (Spode et al. 2013). | <ol style="list-style-type: none"> 1. Establish the project team and/or key stakeholders. 2. Understand the activity. 3. Understand the place, ecosystems and people: Key drivers, issues and opportunities. 4. Understand the ecosystem services relevant to the activity and place. |

The focus of the process needs to be clearly defined. For example, the focus may be application of an EA with respect to fisheries management (i.e. EAFM or EBFM; e.g. at local scale or through the EU's Common Fisheries Policy) or it may be an EA to management of multiple sectors (e.g. through the EU's *Integrated Maritime Policy 2007*). Clearly the focus of the project will have an effect on the stakeholders involved, but even where the focus is on fisheries, there should be acknowledgement of the potential effects of, and on, non-fisheries stakeholders that utilise the same space or resources. Information on the existing activities within the area of interest, and how they interact with one another and the marine environment is therefore needed, as well as consideration of potential indirect effects on wider stakeholder groups (e.g. the general public may have an interest given the potential for changes in ecosystem service provision that may affect them or future generations).

There are likely to be projects or initiatives running at various geographic scales and where there is overlap, or close proximity, it is important to ensure that they complement one another and that their objectives are broadly aligned (Garcia & Cochrane 2005; PISCES 2012). This doesn't mean that the objectives across all scales (or projects) must be identical, but care must be taken to ensure that achievement of objectives at one scale, or for a particular project, does not compromise objectives at another scale, or within another project. Therefore excellent inter-project or inter-initiative communication is required.

There also needs to be clear definition of the area of interest to help identify the relevant stakeholder communities and their role in the EA process (Spode et al.

2013), and a more effective governance model that enables greater interaction amongst stakeholders, (traditional) managers / authorities and scientists to develop better evidence, and more effective and well supported management (PISCES 2012) (see also the introduction to Section 3). Furthermore, care needs to be taken to ensure that the expectations of all parties involved are effectively managed, and that there is sufficient time and support to enable those involved to overcome barriers which limit transparency of the management process (e.g. issues to do with language) and thus trust amongst different groups (Ward et al. 2002; Spode et al. 2013). To date, the formal role of stakeholders in management process and decision-making in the UK has tended to be limited to the consultation end of the governance spectrum (see Figure 3.2) (PISCES 2012). On occasion this has led to conflict between stakeholders and managers (e.g. the controversy over the HPMCZs in Wales) and the fishing industry have called for a true co-management approach with greater involvement and responsibilities for sea users in the management process (Woolmer 2012).

Within this phase a review of existing policies and high level objectives should be undertaken to ensure that the project's scope and aims broadly fit within existing legislative commitments (FAO 2005; Garcia & Cochrane 2005), or at the very least do not jeopardise such commitments.

Phase 1 should also include an assessment of the current state of the ecosystem – taking account of ecological, social and economic aspects, and based upon the best available evidence. Additional surveys can be economically and temporally costly (FAO 2005; Garcia et al. 2003) and existing legislative commitments can be used as a tactic to reduce costs and effort duplication (e.g. Knights et al. 2011; see Box 3.1). For example, the Marine Strategy Framework Directive (MSFD) aims to achieve “Good Environmental Status” (GES) in European territorial waters by 2020 and the PISCES project suggests that regional data from the initial and monitoring phase of the MSFD could be used to supplement the initial phase of an EA (PISCES 2012). This assessment should identify existing data gaps and priorities for management.

Box 3.1 Examples of approaches that have been developed to undertake initial assessments of state of the ecosystem to help identify management priorities.

(1) An environmental assessment of risk in achieving good environmental status to support regional prioritisation of management in Europe.

Breen and colleagues on the ODEMM Project (*Options for Developing Ecosystem-based Marine Management*, www.liv.ac.uk/ODEMM) developed an approach to help to identify and prioritise issues for management based on standardised methods to assess current levels of departure from Good Environmental Status (GES) in Europe's regional seas, in the context of the Marine Strategy Framework Directive (MSFD).

The ODEMM team utilised existing information describing the status of ecosystem components of a regional sea (e.g. from OSPAR assessments) and developed a risk assessment framework to score departure from GES for 10 out of the 11 GES descriptors, based on proposed definitions of 'good' status, and current knowledge of environmental status in each of EU's four regional seas (North-East Atlantic,

Mediterranean Sea, Baltic Sea and Black Sea). Departure from GES definitions is described as ‘high’, ‘moderate’ or ‘low’ and thus the approach allows for prioritisation of environmental issues and management. The authors propose that the approach could also be modified to evaluate other high-level social, economic or environmental objectives.

Further reading: Breen et al. 2012; Knights et al. 2011.

(2) A pressure-based approach to assess effects of human effects on the marine environment.

Pressure assessment approaches (e.g. Robinson et al. 2008) have been used in several assessments of the state of the marine environment (e.g. the OSPAR Quality Status Report 2010 and Charting Progress 2) (DEFRA 2010). Building on these, the ODEMM project developed a pressure assessment approach to evaluate the mechanisms through which a human activity affects the ecosystem for MSFD descriptors that explicitly recognise the relationship between pressure and the status of ecological characteristics. For example, the objective of GES Descriptor 6: Seafloor integrity is “*that human pressures do not hinder the ecological characteristics to retain their natural diversity, productivity and dynamic ecological processes*”. The approach uses several steps, each reached via expert judgement, to evaluate the effect(s) of human activities on ecological characteristics. Under this framework, increased pressure is expected to result in increased damage to the marine environment, its characteristic species and habitats.

The impact of the pressures associated with activities undertaken by different marine sectors is evaluated using a combination of expert judgment and published literature based on five criteria, namely: (1) overlap between the pressure and ecological characteristic (extent), (2) frequency of occurrence of the pressure, (3) degree of impact of the pressure on the ecological characteristic, (4) ecological characteristic resilience (recovery time), and (5) pressure persistence beyond activity cessation. The interaction of each pressure combination is ranked using predefined categories, each indicating a different level of threat depending on the ecological characteristic being evaluated. Whilst the approach was developed in the context of the MSFD, it does not attempt to directly infer the status of the GES Descriptors being evaluated, instead providing relevant information on pressures and/or impacts on the ecological characteristics to help prioritise management.

Further reading: Robinson et al. 2008; Knights et al. 2011; ODEMM guidance document for the Pressure Assessment⁴; Knights et al. 2013.

(3) Assessing Marine and Coastal Ecosystem Services

There is increasing interest in incorporating the concept of ecosystem goods and services to meet the requirements of an EA(FM) (Beaumont et al. 2007; Url5 VALMER; Spode et al. 2013). Ecosystem services (ESs) are the benefits people derive from the environment, broadly defined as the direct and indirect contributions of ecosystems to human well-being (De Groot et al. 2010). In the last decade, a number of frameworks have been developed for classifying (e.g. Millennium

⁴ www.liv.ac.uk/odemmm/outputs/guidancedocuments

Ecosystem Assessment 2003) and methodologies for assessing ecosystem services (ESs) (e.g. see Url6 TEEB and Linqete et al. 2013 for review). The most comprehensive assessment being the Millennium Ecosystem Assessment which was carried out between 2001 and 2005 with the intention of: (1) assessing the consequences of ecosystem change for human well-being; and (2) establishing the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being (Millennium Ecosystem Assessment 2005).

Whilst the majority of approaches have focussed on terrestrial systems, there is a growing body of research for classifying and assessing marine ecosystem services (MESs). The UK is a forerunner in the development of MES assessment (e.g. Beaumont et al. 2007; Saunders et al. 2010; Atkins et al. 2013). International approaches to MESs assessments include work completed in support of implementation of the MSFD (e.g. Bohnke-Henricks et al. 2013) and the Marine InVEST tool (Integrated Valuation of Ecosystem Services and Trade-offs), developed through the Natural Capital Project, to *“map and model ecosystem service flows and their changes under alternative management scenarios to elucidate the true costs and benefits of natural resource management options. the are also gaining significant support”*. However, further work is still needed to determine the value (monetary or otherwise) of the different benefits we derive from the marine environment to better understand: (1) what it is that we need to measures to be able to monitoring changes in ESs; and (2) the links between ESs and the environment that supports them (Hussain et al. 2013; Url5 VALMER).

Further reading: Millennium Ecosystem Assessment 2005; Beaumont et al. 2007; Saunders et al. 2010; Atkins et al. 2013; Linqete et al. 2013; Bohnke-Hendricks et al. 2013; Hussain et al. 2013; Marine InVEST, <http://www.ebmtools.org/?q=marine-invest.html-0>

3.2. Phase 2: Objective setting

Agreeing a collective vision, setting operational objectives and defining thresholds:

“Where do we want to be?”

Phase 2 involves using the information from Phase 1, including the project’s scope and aims, the present state of the ecosystem and the high level policy objectives, to agree upon a collective vision for where we want to be in the future, i.e. the desired ecosystem state (including ecological, social and economic elements).

The different groups involved in this process are likely to have differing and potentially conflicting objectives, views and ideas for how and why the marine environment should be managed. It is therefore imperative that enough time and resources are spent on this important phase to ensure stakeholders move past contentious issues and agree upon a collective vision and support the subsequent set of operational objectives (Tallis et al. 2010). An operational objective being a short-term clear, and measurable, goal whose attainment moves an organisation towards achieving strategic or longer-term aims (Url9 Wikipedia). Relevant targets, indicators and / or thresholds should then be identified for each operational objective (Figure 3.3), against which: the current ecosystem state; the potential management effects (Phase 3); and changes in the ecosystem state (i.e. the ecological, social and economic components) as a result of management and/or uncontrollable factors such as climate change (Phase 5) can be measured. Ultimately this information will be used to evaluate progress against the collective vision (Phase 6).

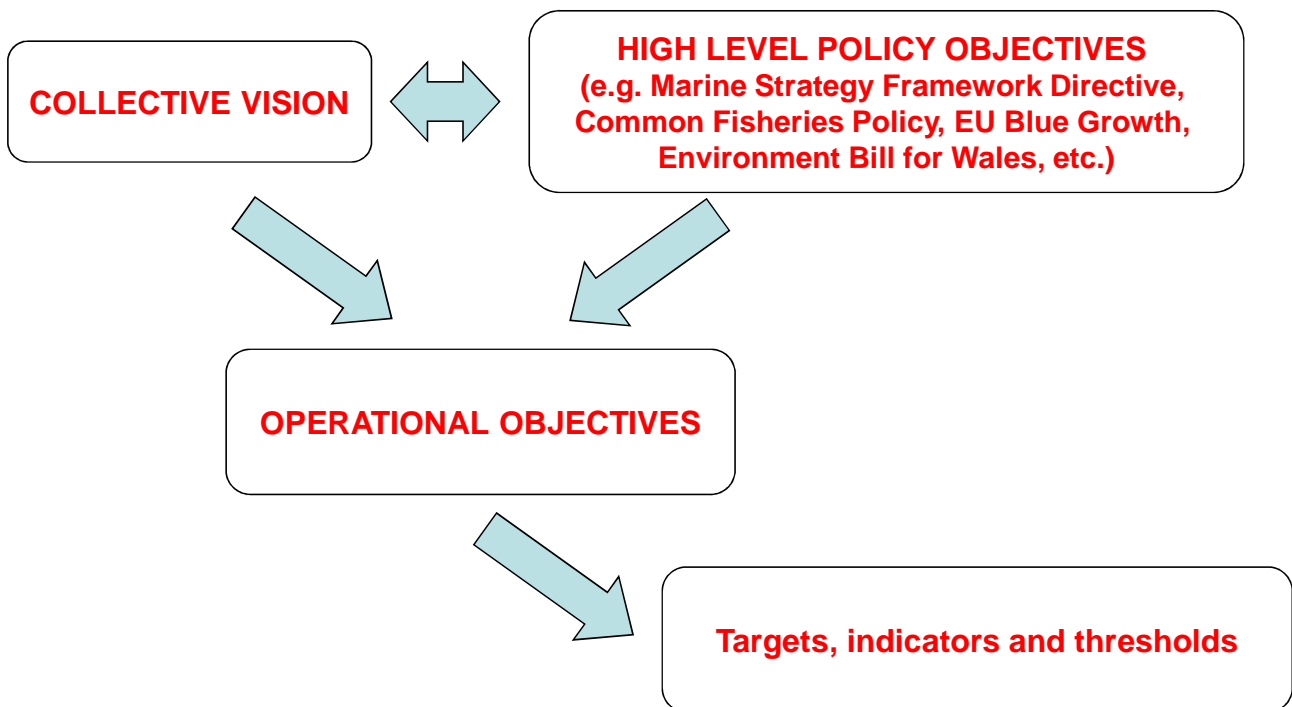


Figure 3.3 Translating the collective vision and high level policy objectives into operational objectives with targets, indicators and thresholds.

Table 3.2 Steps relevant to Phase 2 “Where do we want to be?” from the key implementation guidelines reviewed (adapted from Table 2.2).

| Key implementation guides | Relevant steps (and number) |
|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ecosystem Based Management of Marine Capture Fisheries (WWF; Ward et al. 2002). | 7. Establish objectives and targets. |
| Putting into practice the ecosystem approach to fisheries (FAO; FAO 2005). | 2. Identify broad objectives relevant to fishery (or area) in question. 3. Break these objectives down into smaller priority issues and sub-issues that can be addressed by management measures. 4. Set operational objectives. 5. Develop indicators and reference points. |
| Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines (Garcia & Cochrane 2005). | 3. Setting operational objectives: With indicators and reference points. |
| Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the ocean (Levin et al. 2009). | 2. Indicator development: Develop ecosystem indicators and targets. |
| An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries (Pitcher et al. 2009). | 2. Establish objectives and targets. |
| The many faces of Ecosystem – Based management: Making the process work today in real places (Tallis et al. 2010). | 2. Indicators: Choose measures or proxies for goals. 3. Thresholds: Set target levels or trends. |
| Structuring decision-making for ecosystem-based management (Espinosa-Romero et al. 2011). | 2. Development of indicators for ecosystem state. 3. Establishment of thresholds for each indicator. |
| PISCES: Celtic Seas Project (PISCES 2012). | 1. Carry out initial assessment of marine waters, determine Good Environmental Status (GES) and define environmental targets and indicators. |
| Welsh Fishermen’s Association: Striking the Balance (Woolmer 2012). | 3. Establish objectives. |
| Natural Resources Wales: Ecosystem Approach Framework (Spode et al. 2013). | 5. Visioning and objective setting based on steps 1 - 4. |

It is important that this stage has a clear, transparent and systematic process that allows all parties to propose and discuss individual and personal objectives, whilst ensuring that the overall set of objectives reflect collective values (Espinosa-Romero et al. 2011). Espinosa-Romero et al. (2011) utilise Structured Decision-Making (SDM) to this aim to provide clear advice on how to break-down and define the collective vision into operational objectives, indicators and thresholds (Box 3.2 and Appendix 3) which can be used to explore alternative desired ecosystem state. Tallis et al. (2010) also advocate the use of indicators and thresholds to measure progress against objectives, and demonstrate how this approach can be applied in both an idealistic data rich (i.e. long-term quantified datasets available for many of the attributes of the

objectives and ecosystem variables) and more realistic data-poor (i.e. no quantified data available) scenarios (see Box 3.2).

Given limitations on time and resources, Espinosa-Romero et al. (2011) highlight the need to limit the list of operational objectives, indicators and thresholds to be taken forward through the EA process to the key elements of the ecosystem (that are able to be monitored). They also advocate that the SDM process (or other decision-making process) is facilitated by someone with experience of the process to ensure that it is both time efficient and effective. Using a case study from Canada, they demonstrate how a list of original stakeholder generated objectives was significantly reduced after review by a SDM expert and following translation to operational objectives, principally through the removal of duplicates and identification of intrinsic links among objectives (see Appendix 3 for further details).

Box 3.2 Examples of tools and approaches for developing operational objectives and identifying appropriate indicators, targets and thresholds.

(1) Structured decision-making for ecosystem-based management

Having identified the limitations of Integrated Ecosystem Assessments (IEAs) as a decision-making framework for marine management, Espinosa-Romero et al. (2011) describe Structured Decision-Making (SDM). SDM is a transparent and systematic process that can be used for collectively agreeing a collective vision, setting fundamental (operational) objectives, and defining indicators and thresholds (Phase 2) to guide decision-making in support of EAFM. SDM can also be used to explore alternative ecosystem states and management measures that could be implemented to achieve objectives (Phase 3 – see Box 3.3).

Clemen and Reily (2001) developed a test ('why each objective is important') to differentiate between fundamental objectives and means objectives; means objectives are important because they contribute to the achievement of other objectives, whereas fundamental objectives are important in their own right as they represents the underlying values of the stakeholder group. The importance in differentiating between the two for decision-making is summarised by Espinosa-Romero et al. (2011), "*When means objectives are mistaken for end objectives, the risks are that management may achieve means objectives in a manner that fails to achieve the end objectives. Fundamental objectives should be non-redundant to be clear and concrete; measurable to facilitate the evaluation of alternatives and the achievement of objectives; and meaningful to those who are going to use them to ensure their applicability for decision-making and the engagement of stakeholders*".

By describing fundamental objectives in terms of their attributes, it is easier to identify relevant indicators or performance measures that can be used to monitoring objectives, thereby making them operational. The next step is to then to establish relevant and acceptable thresholds for each indicator which can be used to management action (Espinosa-Romero et al. 2011).

Further reading: Espinosa-Romero et al. 2011; see also Appendix 3 for application of the SDM process for translating stakeholder identified objectives into operational objectives using the West Coast of Vancouver Island (WCVI) case study.

(2) Selecting operational objectives and ecosystem indicators.

Tallis et al. (2010), Levin et al. 2009 & Planganyi (2007) suggest the use of ecosystem modelling software, such as EcoSim with EcoPath (Ecopath 2013) to help stakeholders to select suitable operational objectives and ecosystem indicators based on key ecosystem processes. The use of such software packages however requires quantified data sets which are generally rare, or have significant gaps which limits their ability to reflect the system on which they are intended to report. Tallis et al. (2010) advocates the development of qualitative / conceptual models, or a combination of both quantitative and qualitative data sources to address these limitations.

Qualitative models can be developed either through stakeholder engagement processes, or literature reviews of similar ecosystems globally (Tallis et al. 2010). For example, a qualitative conceptual model could be developed by establishing a cross sectoral stakeholder forum and utilising informal data sources, e.g. polygons indicating areas of fishing activity, biodiversity hotspots or the distribution of habitats/species (Tallis et al. 2010). The FishMap Môn project is a good example of the development of such as model, which has generated maps of the distribution and intensity of commercial and recreational fishing activity from interviews with fishermen, and combined this with existing survey-based and modelled data on the distribution of (sensitive) marine habitats within the project area (Aron et al. 2014).

Further reading: Planganyi 2007; Levin et al. 2009; Tallis et al. 2010; Espinosa-Romero et al. 2011; Ecopath 2013; Aron et al. 2014.

3.3. Phase 3: Explore management options and develop management plan

Evaluate impacts of management, agree preferred option and write management plan:

“How can we get there?”

The aim of Phase 3 is to explore options and actions which allow us to move from Phase 1, where we are now (i.e. the current ecological, social and economic state); to Phase 2, where we want to be (i.e. the desired ecological, social and economic state). The desired ecosystem state, defined in Phase 2 by a set of objectives, indicators and thresholds, and all Phase 3 management options, must encompass ecological, social and economic elements of the ecosystem. Once Phase 3 actions and management measures are agreed by the stakeholder group, these should be documented within a structured management plan, which then forms the road map for all subsequent phases. This phase is therefore concerned with choosing the best course of action which partly or wholly achieves as many of the project’s objectives as possible. Table 3.3. summarises the steps relevant to this phase from the key implementation guidelines reviewed. Key considerations to assist in the selection of preferred management option(s) for the management plan are shown in Figure 3.4.

Table 3.3 Steps relevant to Phase 3 “How can we get there?” from the key implementation guidelines reviewed (adapted from Table 2.2).

| Key implementation guides | Relevant steps (and number) |
|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Ecosystem Based Management of Marine Capture Fisheries (WWF; Ward et al. 2002). | 8. Establish strategies for achieving targets. |
| Putting into practice the ecosystem approach to fisheries (FAO; FAO 2005). | 6. Develop decision rules on how the management measures are to be applied. |
| Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines (Garcia & Cochrane 2005). | 4. Formulation of decision rules. |
| Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the ocean (Levin et al. 2009). | 5. Management strategy evaluation. |
| An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries (Pitcher et al. 2009). | 8. Establish strategies for achieving targets. |
| The many faces of Ecosystem – Based management: Making the process work today in real places (Tallis et al. 2010). | 5. Management Strategy Evaluation: Asses options and choose approach. |
| Structuring decision-making for ecosystem-based management (Espinosa-Romero et al. 2011). | 5. Evaluation of management strategies to predict the effects on the indicators. |

| Key implementation guides | Relevant steps (and number) |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PISCES: Celtic Seas Project (PISCES 2012). | 2. Develop and implement monitoring and evaluation programme. 3. Develop programmes of measures. |
| Welsh Fishermen's Association: Striking the Balance (Woolmer 2012). | 4. Develop and implement MCZ management. |
| Natural Resources Wales: Ecosystem Approach Framework (Spode et al. 2013). | 6. Review activity and generate options. 7. Select preferred option(s). 8. Detailed appraisal. 9. Embed ecosystem approach objectives into the design and development of the preferred option. |

Performance against objectives

- Best available evidence
- Confidence in predictions

Costs and benefits

- Consequences and for whom?
- Who is paying for what and how?
- Are there wider benefits e.g. ecosystem services?

Likelihood of success

- Appropriate governance structures
- Stakeholder support for management
- Evidence of previous success

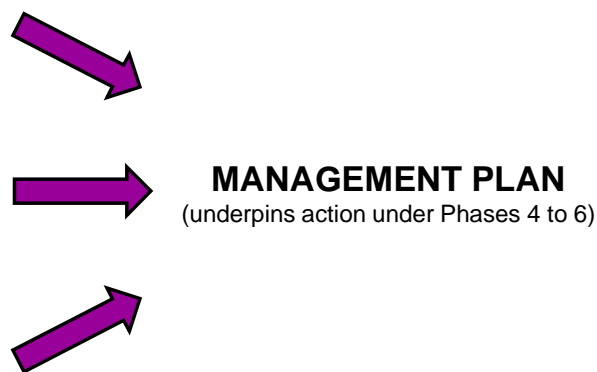


Figure 3.4 Key considerations in the development of a management plan as the output from Phase 3 (see Table 3.1.1. for guidance on key components of an Ecosystem Approach to Fisheries Management Plan).

The key to this phase is to examine the consequences of different management options that could be used to work towards objectives in a structured and transparent manner (see Box. 3.3). For each management option considered, the process should, for example, consider: what progress would be made towards each objective individually and also towards the set of objectives as a whole (ecological, social and economic); what activities would be affected, in which way and to what extent; what are the likely costs e.g. in terms of monitoring and enforcement and benefits (e.g. in terms of ecosystem service provision) and to whom?

Closer integration amongst stakeholders, fisheries scientists, ecologists, social scientists and economists is likely to enable more effective management advice, generate credibility in the management process and foster stakeholder support for resultant management measures (Bloomfield et al. 2011). Furthermore, this will enable access to new and non-traditional data sources.

Ultimately management decisions will be made on the basis of overarching objectives. Trade-offs will be required among objectives and, due to the nature of the trade-offs, it may not be possible to satisfy all stakeholder groups simultaneously. Resolution of these trade-offs is not a technical scientific decision, however development of decision support frameworks and decision support tools can help to ensure that appropriate decisions are made on the basis of the best available information (Bloomfield et al. 2011b; see Box 3.3).

The main output of this phase is a management plan which will consist of one or more management tools; the management tools that go forward should be supported by all involved in the process. Such support is more likely to be given if the people and groups also helped evaluate and choose the best management options to achieve the greatest number of objectives as defined in Phase 2. Furthermore these people and groups will have witnessed how the choice of management options was based upon predictions and modelled outcomes using the best available information available at the time. Noting that people have different priorities and perceptions regarding objectives and management options, there will need to be compromise and consensus building to achieve collective support.

The FAO (2005) provide a step by step guide to developing an EA management plan which is shown in Appendix 2, and highlight the key components of a management plan (Table 3.3.1). A number of tools and approaches, described in the reviewed guidelines, that could be used to help with this phase, are detailed in Box 3.3 and Appendix 2.

Table 3.3.1 Key components of an Ecosystem Approach to Fisheries Management Plan (FAO 2005).

| | |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Background | (1) social and institutional aspects (e.g. area of operation of the fishery, jurisdiction and ecosystem "boundaries"; stakeholders and their interests; other uses/users of the ecosystem); (2) descriptions of fishing activity, resources and the ecosystem (e.g. target species and by-product; fleet types or fishing categories); and (3) ecological issues and challenges (e.g. critical environments, particularly sensitive areas; biodiversity concerns). |
| Objectives | Objectives, reference points and performance measures for the fishery: environmental, social and economic. |
| Management measures | Agreed measures for the regulation of fishing to work towards objectives within agreed time frame |
| Decision rules | Pre-agreed rules for applying management measures: |
| Evaluation of management | Against agreed indicators and performance measures – environmental, social and economic assessment based on the most recent (best available) data. |
| Monitoring, control and surveillance | Based on agreed arrangements |
| Communication | Based on agreed strategy and details of planned education and training of stakeholders |
| Review | Date and nature of next review of management performance |

Box 3.3 Examples of tools and approaches for exploring and evaluating management options, choosing preferred management tools and creating a management plan.

(1) Potential changes in Ecosystem Services

The Marine Strategy Framework Directive (MSFD) requires member states to implement an ecosystem approach to marine management. Implementing this approach involves consideration of changes in Ecosystem Service (ES) benefits related to this management. ESs can be defined as the direct and indirect contributions of (marine and coastal) ecosystems to human well-being. The ODEMM project developed an ES typology as a framework to explore what marine and coastal ecosystems provide for people (Böhnke-Henrichs et al. 2013). The objective of the framework is to provide a structure that is economically usable, conceptually clear, and that supports the consideration of how ESs can be affected by management interventions. The project also developed an approach to explore potential changes in ES provision under different management options. This approach is dependent on identification of links between ecological components (e.g. fish, shellfish, seaweed) and ES provision (e.g. seafood), and information on potential changes in the state of ecological components under different management options.

Other approaches for assessment of (M)ESs that could be used in support of an EAFM are also being developed, and include the Marine InVEST (Integrated Valuation of Environmental Services and Trade-offs) tool which utilises models to map and value the goods and services humans derives from nature, and enable decision-makers to assess quantified trade-offs associated with alternative management options. The tool can also be used to identify areas where investment in natural capital can enhance human development and conservation.

Further reading: Böhnke-Henrichs et al. 2013; www.liv.ac.uk/odemmm; Natural Capital Project website, <http://www.naturalcapitalproject.org/InVEST.html>.

(2) Management strategy evaluation matrix

Making the European Fisheries Ecosystem Plan Operational (MEFEPO) project developed a structure for Fisheries Ecosystem Plans (FEP) for Europe's regional seas to integrate the Marine Strategy Framework Directive (MSFD) objectives within a reformed Common Fisheries Policy (CFP) in the context of sustainable Ecosystem Based Fisheries Management (EBFM). Central to the development of the FEP was a Management Strategy Evaluation Matrix (MSEM), a decision support tool that allows simultaneous consideration of the potential impacts of different combinations of management measures on the ecological, social and economic status of the system based on the best available evidence (modelled, empirical and expert judgment).

'Descriptors' for the ecological, social and economic status of the fisheries were developed (comparable to the indicators of operational objectives described in Phase 2) and utilised within the matrix. Ecological descriptors were drawn directly from the MSFD and were selected at a MEFEPO stakeholder workshop as those most impacted by fishing activities (biodiversity, commercial fish, food-webs and seafloor integrity). Social and economic descriptors were defined to monitor the main aspects of fishing contributing to the economic and social wellbeing of society, in particular

coastal communities. Economic descriptors focussed on fishers' ability to maximise economic efficiency of fishing operations (efficiency) and minimising fluctuations in harvesting possibilities over time (stability). Social descriptors monitored employment opportunities within the catching sector (community viability) and securing catch potential for human consumption (food security).

The potential performance of a limited suite of management strategies can then be evaluated against these descriptors and potential effects of the different management strategies can then be presented in the MSEM in a transparent and structured approach that forces explicit consideration of the trades-off among objectives results (see example in Figure 3.5).

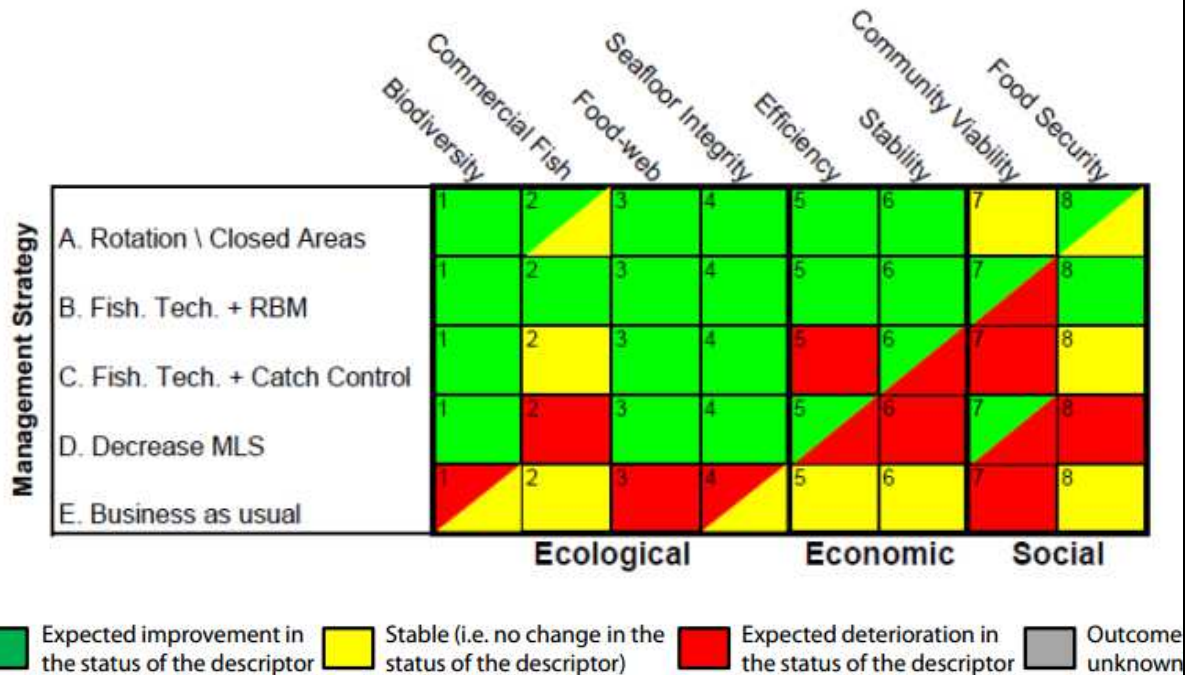


Figure 3.5 Example MSEM showing expected medium-term (5-10 year) outcomes from the four scallop management strategies for the scallop fisheries in North Western Waters. This example evaluation was produced in consultation with an expert (external to MEFEP0) and supported by relevant literature (modified from Bloomfield et al. 2011b).

Further reading: Bloomfield et al. 2011b; www.liv.ac.uk/MEFEPO; see also Fulton et al. 2014, for insights from ecosystem-level management strategy evaluation in support of EBFM.

(3) FishMap Môn Web-based Guidance Tool

The FishMap Môn (FMM) Web-based Guidance Tool has been developed to allow stakeholders to view fishing (commercial and recreational) activity maps and relevant marine data layers in combination with seabed habitats and their sensitivity (Url10 FMM). In its current format, the tool enables users to select an area of interest (from the project area around Anglesey) and, using the 'scenario builder', assess the impact of hypothetical additional fishing activity upon that area of interest. There is the potential for this tool to be modified for use as a decision-support tool by enabling effects of different management options (e.g. removal of effort from a particular

sector, or part of a sector) to be explored (see also Section 4.1). Furthermore, the information within the tool could be expanded to include other sectors and other ecosystem components.

Further reading: The FishMap Mon Project Report (Aron et al. 2014); http://naturalresourceswales.gov.uk/out-and-about/maps/fishMapmon/fishmap-mon-guidance-tool/?lang=en#.Ux-gvPI_u0I

(4) Exploring alternative ecosystems states through Structured Decision Making

Structure Decision Making (SDM), as outlined by Espinosa-Romero et al. (2011), can be used to explore alternative ecosystem states and assessing performance against selected indicators and their associated fundamental objectives. Gregory et al. (2001) note that the process of identifying fundamental objectives and associated attributes in Phase 2 (see Box 3.2) often leads stakeholders to develop more innovative management approaches that are better able to meet a greater proportion (if not all) of the objectives or the objectives that are perceived to be most important.

Espinosa et al. (2011) highlight that “*Choosing between alternatives involves trade-offs. A key strength of SDM is that such trade-offs are made explicit and stakeholders are able to understand what trade-offs each alternative entails*”, as such this approach enables decision-making in a clear and transparent manner which is ultimately likely to lead to greater support for the resultant management.

Further reading: see Espinosa-Romero et al. 2011 (and Appendix 3) for further details on the application of the SDM process to a EBM initiative on the west coast of Vancouver Island, Canada.

3.4. Phase 4: Implement preferred management

Implement management based on the management plan:

“Do it!”

Whilst there is considerable literature on what should be considered in the early steps of an EA process (Phases 1 to 3), there is less discussion on the latter stages of the process, and Pitcher et al. (2009) and others (e.g. Frid et al. 2005; Jennings & Rice 2011) have reported little progress in actual implementation of an EAFM. Several EA guidance documents do not identify “implementation of management” as a step in itself (e.g. Ward et al. 2002; Tallis et al. 2010; Espinosa-Romero et al. 2011), rather viewing the whole process as implementation of an EA (Table 3.4).

Table 3.4 Steps relevant to Phase 4 “Do it!” from the key implementation guidelines reviewed (adapted from Table 2.2).

| Key implementation guides | Relevant steps (and number) |
|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Ecosystem Based Management of Marine Capture Fisheries (WWF; Ward et al. 2002). | Not included as a step in this guidance document, although it is described elsewhere in the text. |
| Putting into practice the ecosystem approach to fisheries (FAO; FAO 2005). | Not included as a step in this guidance document, although it is described elsewhere in the text. |
| Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines (Garcia & Cochrane 2005). | 5. Implementation and enforcement. |
| Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the ocean (Levin et al. 2009). | 6. Implementation of management action. |
| An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries (Pitcher et al. 2009). | Not included as a step in this guidance document, although it is described elsewhere in the text. |
| The many faces of Ecosystem – Based management: Making the process work today in real places (Tallis et al. 2010). | Not included as a step in this guidance document, although it is described elsewhere in the text. |
| Structuring decision-making for ecosystem-based management (Espinosa-Romero et al. 2011). | Not included as a step in this guidance document, although it is described elsewhere in the text. |
| PISCES: Celtic Seas Project (PISCES 2012). | 4. Implement programme of measures (and monitoring). |
| Welsh Fishermen’s Association: Striking the Balance (Woolmer 2012). | 4. Develop and implement MCZ management. |
| Natural Resources Wales: Ecosystem Approach Framework (Spode et al. 2013). | 10. Implementation. |

However, it is the authors' view that given that action is likely to be required by several parties, implementation of the management plan warranted consideration separately, albeit that decisions on what action is required and by whom will have been considered and decided in the development of the management plan in Phase 3.

A key point for consideration is how the roles and responsibilities of the different groups change under the management plan. For example, governments and management organisations may need to make changes to how they operate, by devolving powers to a co-management team, or better coordinating activities with stakeholder groups. Sea users may have been allocated additional roles under the management plan and there needs to be clear guidance on the expectations and funding of these roles. For example, in *Striking the Balance* (Woolmer 2012), the suggestion is that fishers and other sea-users should be involved in enforcement of implemented management measures (Marine Conservation Zones, MCZs). However, there is little detail on how policing should or could be undertaken. Depending on the nature of policing activities there may be financial and time implications for fishermen. If policing of an MCZ was a scheduled activity, would fishermen be required to go to sea at their personal expense, or would they be subsidised or paid to be at sea? Would they be able to fish whilst at sea policing? What powers would they have when rule-breaking was observed and to whom would rule breaking be reported? If we consider self-enforcement of management measures alongside potential roles for sea-users in monitoring effects of management measures (see Phase 5), then the resource requirements (time and financial) may be considerable.

A final point is that information about the management plan and what has been agreed (and by whom) needs to be well communicated to all who could be affected, and that communication is maintained to ensure that the management plan has continued support and relevance.

3.5. Phase 5: Monitor

Monitoring indicators against targets and thresholds, as per management plan:
“How are things changing?”

As with Phase 4 (Implementation), the details of this step should have been explored, agreed and incorporated into the management plan in Phase 3. All of the guidance documents reviewed state that monitoring methods should have been identified (or developed) that are appropriate to measure against targets, indicators or thresholds for the ecological, social and economic objectives agreed in Phase 2 (Table 3.5).

Table 3.5 Steps relevant to Phase 5 “*How are things changing?*” from the key implementation guidelines reviewed (adapted from Table 2.2).

| Key implementation guides | Relevant steps (and number) |
|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Ecosystem Based Management of Marine Capture Fisheries (WWF; Ward et al. 2002). | 9. Design information system, including monitoring. |
| Putting into practice the ecosystem approach to fisheries (FAO; FAO 2005). | 7. Monitor and evaluate performance. |
| Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines (Garcia & Cochrane 2005). | 6. Monitoring. |
| Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the ocean (Levin et al. 2009). | 7. Monitoring of ecosystem indicators & manage effectiveness. |
| An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries (Pitcher et al. 2009). | 9. Design information system, including monitoring. |
| The many faces of Ecosystem – Based management: Making the process work today in real places (Tallis et al. 2010). | 6. Monitor: Track indicators. |
| Structuring decision-making for ecosystem-based management (Espinosa-Romero et al. 2011). | 6. Monitoring management strategy outcomes. |
| PISCES: Celtic Seas Project (PISCES 2012). | 2. Develop and implement monitoring and evaluation programme. 4. Implement programme of measures (and monitoring). |
| Welsh Fishermen’s Association: Striking the Balance (Woolmer 2012). | 5. Collaborative monitoring and feedback. |
| Natural Resources Wales: Ecosystem Approach Framework (Spode et al. 2013). | 11. Monitor activity against ecosystem objectives and outcomes. |

Much of this information is likely to be new compared to traditional monitoring of the marine environment and fisheries, and requires new skill sets, data sources and providers and the monitoring process should seek to utilise the best available evidence, quantitative or qualitative (FAO 2005; Garcia & Cochrane 2005; Bloomfield et al. 2011b).

Key questions for this step include:

- Who is undertaking the monitoring and how is it financed – is it sea users, management authorities, other interest groups or a combination of these groups?
- Is monitoring by different groups complimentary and how good is the evidence?
- Who is responsible for bringing this information together? Who will hold the data? Who will analyse the data and who will pay for this?
- What are the appropriate timeframes for monitoring?
- What are the other potential uses of the data?

The responsibility of who conducts the monitoring programme will be affected by the management scale and how the management plan has been created. For example, in *Striking the Balance* (Woolmer 2012), the suggestion is that stakeholders (specifically Welsh fishermen) would adopt a central role in monitoring of Marine Conservation Zones (MCZs), becoming “*stewards of Welsh MCZs*”. In other implementation frameworks (e.g. Spode et al. 2013; PISCES 2012), responsibility for undertaking monitoring is not specified although a more collaborative approach to monitoring, as with all stages of the EA process, is seen as a mechanism to foster greater management transparency and thus management support (Bloomfield et al. 2011b).

Monitoring can be expensive and labour intensive and can benefit from specialised expertise and/or training of sea users⁵. Collaborative monitoring initiatives can reduce the personnel and economic costs of monitoring through the provision of pre-existing knowledge from experienced sea users, direct contributions to sampling or provisions of aiding services e.g. leasing fishing vessels (Garcia & Cochrane 2005; PISCES 2012). Depending on the objectives (targets and indicators) identified for an EA, it may also be possible to reduce the resource requirements for monitoring of measures implemented under an EA through coordination with existing monitoring programmes (Garcia and Cochrane 2005; PISCES 2012) or those historically conducted within the area of interest (such as those that being implemented through the MSFD or for NATURA 2000 sites). Monitoring programmes should at least complement those already in place within the area of interest.

⁵ A number of sea-user based data initiatives are being trialled globally, for example inshore fishermen in NZ are involved in project with Trident Systems who aim to “*provide high quality fisheries research services in support of effective and efficient management of New Zealand fisheries, with the active involvement of the seafood industry and for the collective benefit of quota owner*” (see <https://www.tridentystems.co.nz/> for further details. In Wales, fishermen are already involved in collecting ecological data as part of the *Sustainable Use of Fisheries Resources in Welsh Waters* project, coordinated by the Bangor University (see Section 4.2 for further details).

Where possible monitoring protocols should adhere to a scientifically robust methodology which allows temporal and/or spatial indicator interactions to be formally assessed and related to management measures (PISCES 2012). The scope and intensity of monitoring needs to be temporally and spatially relevant. Thus, whilst review periods may be set by relevant policies (e.g. the MSFD requires review on a 6 yearly basis) the appropriate frequency of data collection will vary based on the nature of the indicator, target or threshold being monitored, and its inherent variability.

Most commonly the monitoring processes discussed are related to information on ecological state of the marine environment, and there is less information on monitoring of social and economic components of the ecosystem. Monitoring of these parameters is likely to require a higher degree of participation from stakeholders (PISCES 2012) and may require greater input of qualitative data or expert judgement to evaluate management effects (see also Box 3.3).

3.6. Phase 6: Evaluate and adapt

Based on results of monitoring, and as detailed in the management plan, evaluate progress to achieving objectives, and adapt management if necessary:

“How are we doing (against objectives)?”

The focus of this phase is on establishing how well management is performing against the agreed objectives (Phase 2), what we have learned and whether further action required to achieve the common vision (Figure 3.6).

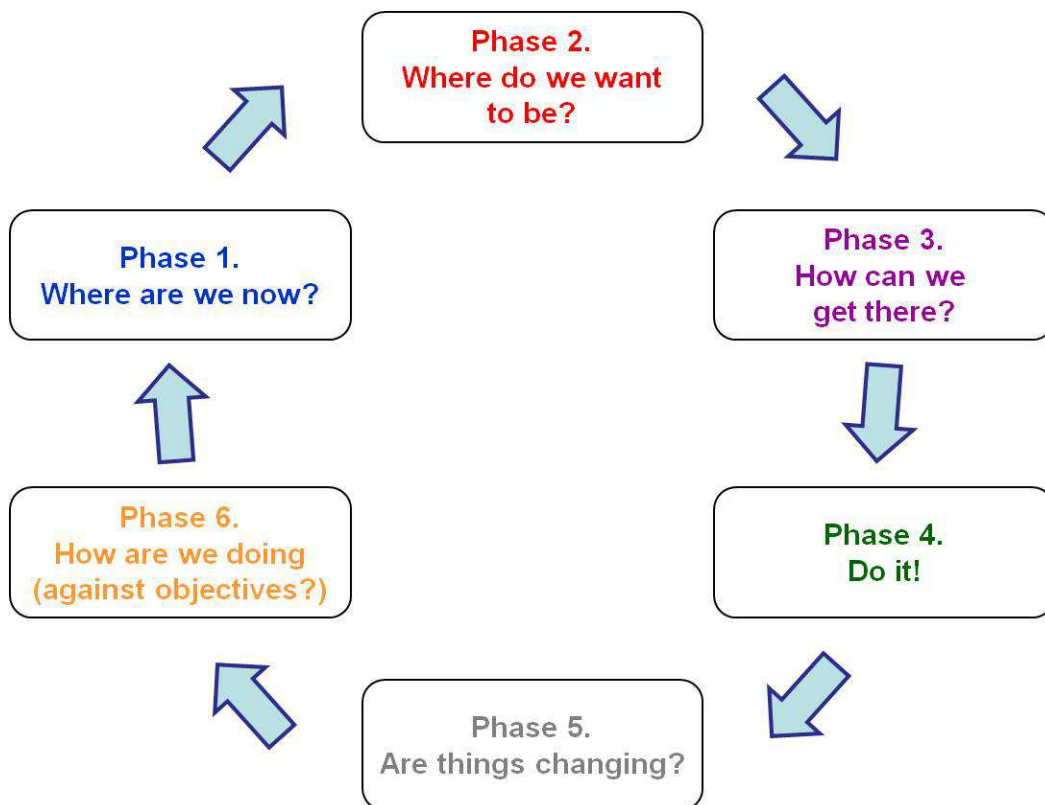


Figure 3.6 Key questions in the implementation cycle of an Ecosystem Approach.

The EA is an iterative process, requiring review and evaluation of management against agreed objectives (Phase 2) (Ward et al. 2002, Garcia & Cochrane 2005, FAO 2005, PISCES 2012, Woolmer 2012, Spode et al. 2013). During the evaluation process important factors such as the effectiveness of management measures need to be considered, and lessons learned from their implementation fed back and documented to update the management plan and practice adaptively.

As with all previous Phases, it is important that a review process is conducted in an open and transparent manner with full participation of stakeholders (PISCES 2012); as such data and associated analyses must be made accessible to a wide audience so that information, which may be complex, can be adequately disseminated (Tallis et al. 2010; Bloomfield et al. 2011b). To achieve full and open understanding of the

monitoring outputs, stakeholders may require additional technical training or support (PISCES 2012).

Table 3.6 Steps relevant to Phase 6 “How are we doing (against objectives)?” from the key implementation guidelines reviewed (adapted from Table 2.2).

| Key implementation guides | Relevant steps (and number) |
|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ecosystem Based Management of Marine Capture Fisheries (WWF; Ward et al. 2002). | 10. Establish research and information needs and priorities. 11. Design performance assessment and review process. 12. Prepare education and training package for fishers. |
| Putting into practice the ecosystem approach to fisheries (FAO; FAO 2005). | 7. Monitor and evaluate performance. |
| Ecosystem Approach to Fisheries (EAF): a review of implementation guidelines (Garcia & Cochrane 2005). | 7. Ex-post assessment and review. |
| Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the ocean (Levin et al. 2009). | 8. Adapt management if necessary. |
| An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries (Pitcher et al. 2009). | 10. Establish research and information needs and priorities. 11. Design performance assessment and review process. 12. Prepare education and training package for fishers. |
| The many faces of Ecosystem – Based management: Making the process work today in real places (Tallis et al. 2010). | 7. Evaluation: Assess change. |
| Structuring decision-making for ecosystem-based management (Espinosa-Romero et al. 2011). | Not included as a step in this guidance document, although it is described elsewhere in the text. |
| PISCES: Celtic Seas Project (PISCES 2012). | 5. Evaluation and adaptation. |
| Welsh Fishermen’s Association: Striking the Balance (Woolmer 2012). | 5. Collaborative monitoring and feedback. |
| Natural Resources Wales: Ecosystem Approach Framework (Spode et al. 2013). | 12. Learning and adaptation. |

The frequency of review should have been established in developing the management plan (Phase 3) and it is important to note that some objectives may take longer to achieve than others. Therefore not all objectives will be achieved in one management cycle, or at all. However this step can establish whether indicators are moving in the right direction (e.g. towards targets) and help to prioritise further action. Where objectives have been met within a cycle, this is clearly good progress but it doesn’t mean that the EA has reached an end point. The world we live in is constantly changing and new policies, objectives, management tools and understanding are likely to come on line, therefore the review process should also

consider the continued relevance of where we want to be (Phase 2) and what we can do to get there (Phase 3).

If objectives are not being achieved within their expected timeframes, it is important to establish why and what action could be taken. It could be that indicators or targets were not appropriate for the objectives, or that rule breaking has occurred, or simply that there was not sufficient understanding of the system.

In order to fully assess the effectiveness of management measures, ecologically and socially relevant time periods between reviews are required to allow a measurable response from the ecosystem (Ward et al. 2002). The MSFD requires that Marine Strategies (aimed at achieving GES) be kept up-to-date and reviewed every 6 years (Url11 EC). In contrast Woolmer (2012) proposed constant revisions of Welsh MCZ management plans, based on an annual or biannual review process. FAO (2005) guidance states that both a short and long term review process should be conducted: short term reviews, conducted annually, to account for minor corrections to management policies; and a long term review, conducted every 3-5 years, to comprehensively review the management plan and refine operational objectives if necessary (FAO 2005). As with monitoring (Phase 5), in order to limit economic costs and duplication of survey and/or management effort it would be advantageous to synchronize efforts and conduct long term review processes in line with existing legislation (FAO 2005, Garcia et al. 2003).

A final facet of the evaluation process is to review the perceptions of the stakeholders on the success or failure of management measures (PISCES 2012), and relate this to monitoring outcomes. This process may help to foster greater trust between stakeholders and governance, and allow management measures (and associated enforcement and monitoring) to be refined so they are more in line with the collective stakeholder vision identified in Phase 2 (PISCES 2012).

4. Working towards successful implementation of an Ecosystem Approach to Fisheries Management in Wales

There are a number of key drivers for an ecosystem approach to fisheries management (EAFM) in Welsh waters, and to management of the marine environment more generally, at international, European and UK levels, and recent policies from the Welsh Government have the EA principles at their core (Table 1). Given these commitments, there is significant interest as to how an EAFM could be implemented in Wales, and what implementation would mean for both the people involved (including governments, authorities and sea users) and the marine environment.

The objective of this final section of this review is to reflect on how a selection of current projects and initiatives in Wales, including the FMM project, could contribute to successful implementation of an EAFM. This section draws upon information gathered by the Marine EcoSol team from presentations at the FMM Project Conference (Bangor, December 2013), recent policy documents, and discussion with academics and members of the fishing industry in Wales. The selected projects and initiatives are briefly described, and we consider: (1) where these projects and initiatives can currently contribute lessons learned and / or information in the context of the phases of the EAFM cycle (Section 3); and (2) where approaches and or lessons learned within these projects and initiatives could be further developed to assist in implementation of an EAFM in Wales.

4.1 FishMap Môn Project (FMM)



The FMM project is a partnership between Natural Resources Wales (formally the Countryside Council for Wales) and the North Wales Fishermen's Association, Bangor Mussel producers Ltd and the Welsh Federation of Sea Anglers.

The FMM project has worked towards a clearly defined focus of:

- Developing approaches to mapping the distribution and intensity of commercial and recreational fishing activity;
- Developing a Guidance Tool to allowing stakeholders to view fishing activity data or hypothetical fishing scenarios in combination with seabed habitats and their sensitivity; and
- Stakeholder engagement and collaborative working with the fishing industry.

A key relevant lesson from the FMM project relates to stakeholder participation, given the effective working relationships that have been developed between Natural Resources Wales project team (previously under the Countryside Council for Wales) and the partners from the fishing industry. Partners involved in the FMM project who attended the FMM Project Conference (10th December 2013) expressed significant support for the achievements of the project and the NRW-based project team. There was discussion on the fact that changes in personnel (within the NRW-project team

or partners) can affect project progress. Selection of appropriate stakeholder groups and representatives remains a challenge, particularly given that under an EA there are likely to be more projects and initiatives which require stakeholder involvement, and that application of an EA to the Welsh Marine Environment is likely to involve significant sectors and wider interest groups. Aanesen et al. (in press) highlighted that effects of stakeholder involvement on fisheries management (decisions) may be as much about who is representing the different interest groups as to which groups are present. There are also challenges in maintaining effective stakeholder involvement and not overburdening stakeholders with duplicative activities at different scales or with different foci.

The work completed by the FMM project can also contribute lesson learned to Phase 1 of an EA given: the clear spatial definition of the project area of interest; collection of baseline information on the extent and intensity of recreational and commercial fishing activities; and linking of this information on fishing activities with habitat sensitivity.

4.1.1 Potential development for implementing an EA

Future projects could specifically build on the foundations of and lessons from the FMM project to enhance actions in Phase 1 and develop their application in Phase 2 and 3 of the EA implementation cycle (Figure 4.1). Within Phase 1, a project could build upon the partners already established to ensure that stakeholders who are, or have the potential to be affected by fishing activities (or the management thereof) are also represented. Furthermore, the project has developed a Guidance Tool⁶ which could be expanded to include: (1) additional ecological components of the ecosystem (e.g. fish, marine mammals, etc. building on the Ecological Characteristics defined in the MSFD) and incorporate information on their sensitivity to fishing activities, in addition to the information on seabed habitats; and (2) spatially resolved social-economic information on fishing activities. The Guidance Tool could then be further developed to enable it to be used as a decision support tool, by enabling users to explore the potential costs and benefits of a range of management options, for example effects of reducing fishing effort over particular areas.

Within Phase 2, a project could utilise the enhanced stakeholder group and work to develop a collective vision for the marine environment. For example, information on the sensitivity of habitats, and the current spatial extents and intensities of fishing activities (commercial and recreational) could be combined with data on the state of those seabed habitats and used to identify appropriate thresholds for fishing intensities (assuming that the project were granted permission by the data providers for the data to be used for this purpose).

⁶ The FMM project has developed an interactive and accessible (web-based) tool that allows stakeholders and other interested parties to view fishing activity maps and relevant marine data layers from the project area, in combination with seabed habitats and their sensitivity. It also allows users to select an area of interest and, using the innovative 'scenario builder', assess the impact of hypothetical fishing activity upon an area of interest (<http://fishmapmon.naturalresourceswales.gov.uk/?locale=en>)

4.2 Sustainable Use of Fisheries Resources in Welsh Waters Project



The Sustainable Use of Fisheries Resources in Welsh Waters project is co-ordinated by Bangor University. The aim of the project is develop “a programme of scientific evidence gathering through collaboration between academics, industry and government funded bodies and policy makers and managers which will inform management decisions to work towards a truly sustainable future for Welsh fisheries” (Url12 Bangor SOS).

The five key areas of work for the project are:

- Gathering of fishermen's knowledge through interviews and questionnaires;
- Habitat mapping;
- Distribution and abundance of different target species;
- Connectivity of populations;
- Management and policy.

As with the FMM Project, the *Sustainable Use of Fisheries Resources* project is helping to build closer working relationships between the fishing industry, the Welsh Government, Natural Resources Wales, CEFAS and scientists. This will enhance stakeholder participation in the management of marine fisheries resources in Wales, and bring new information and understanding to decision-making.

The majority of the project progress to date is relevant to Phase 1 of the implementation cycle (Figure 4.1). Historically there has been a lack of data to inform the management of Welsh marine resources (Url12 Bangor SOS). The scientific approaches developed, and currently being implemented by Bangor University, are providing baseline information on specific stocks and habitats, and interviews and questionnaires are collecting both ecological and social-economic information from fishermen.

4.2.1 Potential development for implementing an EA

The *Sustainable Use of Fisheries Resources* project has the potential to further contribute to Phase 1 through improving understanding of the marine environment. The continued involvement of fishermen in data collection, and in utilising fishermen's knowledge, will also enhance the breadth of information that can be used as a foundation for later Phases of the implementation cycle (Figure 4.1). Data from stock assessments can be used to assess the current state of specific ecological components of the marine environment under Phase 1, and longer-term data collection will enable appropriate targets and thresholds to be identified for these components under Phase 2.

Relevant to Phase 3, is the future intention of the *Sustainable Use of Fisheries Resources* project to assess potential effects of different management options, proposed by the fishing industry and / or the wider collaborative working group), on the state of the relevant ecological components on which they have baseline data. The results of this assessment would then be fed back to the fishermen to enable discussion on preferred management options (Kaiser, *pers. comm.*, January 2014).

Furthermore, there is potential that the survey techniques currently being developed for collecting stock assessment data could be used to monitor effects of management under Phase 5. The continued involvement of fishermen in the monitoring would support proposals by the WFA in *Striking the Balance* (“*marine stewards*”, Woolmer 2012), increase transparency of monitoring and reporting processes and thus is likely to build trust and enhance the potential success of an EA.

4.3 The Welsh Government’s commitment to explore co-management approaches



The *Wales Marine and Fisheries Strategic Action Plan 2013* is intended to be delivered in partnership with stakeholders (WG 2013). Key demonstration of this commitment came from the Minister for Natural Resources and Food in June 2013, who “*signalled his intention to develop a co-management approach with the fishing industry as set out in the WFA’s document “Striking the Balance”.*”

Inshore Fisheries Groups (IFGs) have already been established in Wales with the intention of improving management of local fisheries through partnership between Welsh Government and fishermen. They have recently been reviewed and now operate more effectively with a smaller membership focussed more on active fishermen, but also including representation from scientists, environmental bodies (e.g. Wales Environmental Link) and Natural Resources Wales (Url13 Wales Environmental Link 2011; WG 2013).

4.3.1 Potential development for implementing an EA

Whilst it is still not clear *if* or *how* power can be shared through partnerships between WG and stakeholders, the commitment from WG to explore co-management approaches could form a key element of an EAFM (and marine management more generally) in Wales through enhanced stakeholder participation in **all** Phases of the implementation cycle (Figure 4.1). Particularly if progress is made towards Woolmer’s (2012) definition of a (true) co-management approach, in which stakeholders are part of the decision-making team, and work collaboratively with “traditional” managers and decision-makers, scientists, policy makers, etc. at appropriate geographical scales (see also Bloomfield et al. 2011b). Such progress would ensure that stakeholders were fully informed and involved in developments in all Phases of an EA (Figure 4.1), contributing to the potential for management success.

The WFA and others (including Seafish, other commercial fishing groups, and environmental Non-Governmental Organisations) have responded to this commitment and are currently working with WG and NRW to develop a project to implement a regional co-management approach on the Llŷn peninsula, based on the principles of the MSFD (WG 2013; FishMap Môn Project Conference, 10th December 2013). The intention is that this project will build upon lessons learned from the FMM project (section 4.1). For example, with relevance to Phase 1, the Llŷn project team are considering a similar approach to the FMM Guidance tool with the addition of

other (non-fishing) activities, and social and economic data (FishMap Môn Project Conference, 10th December 2013).

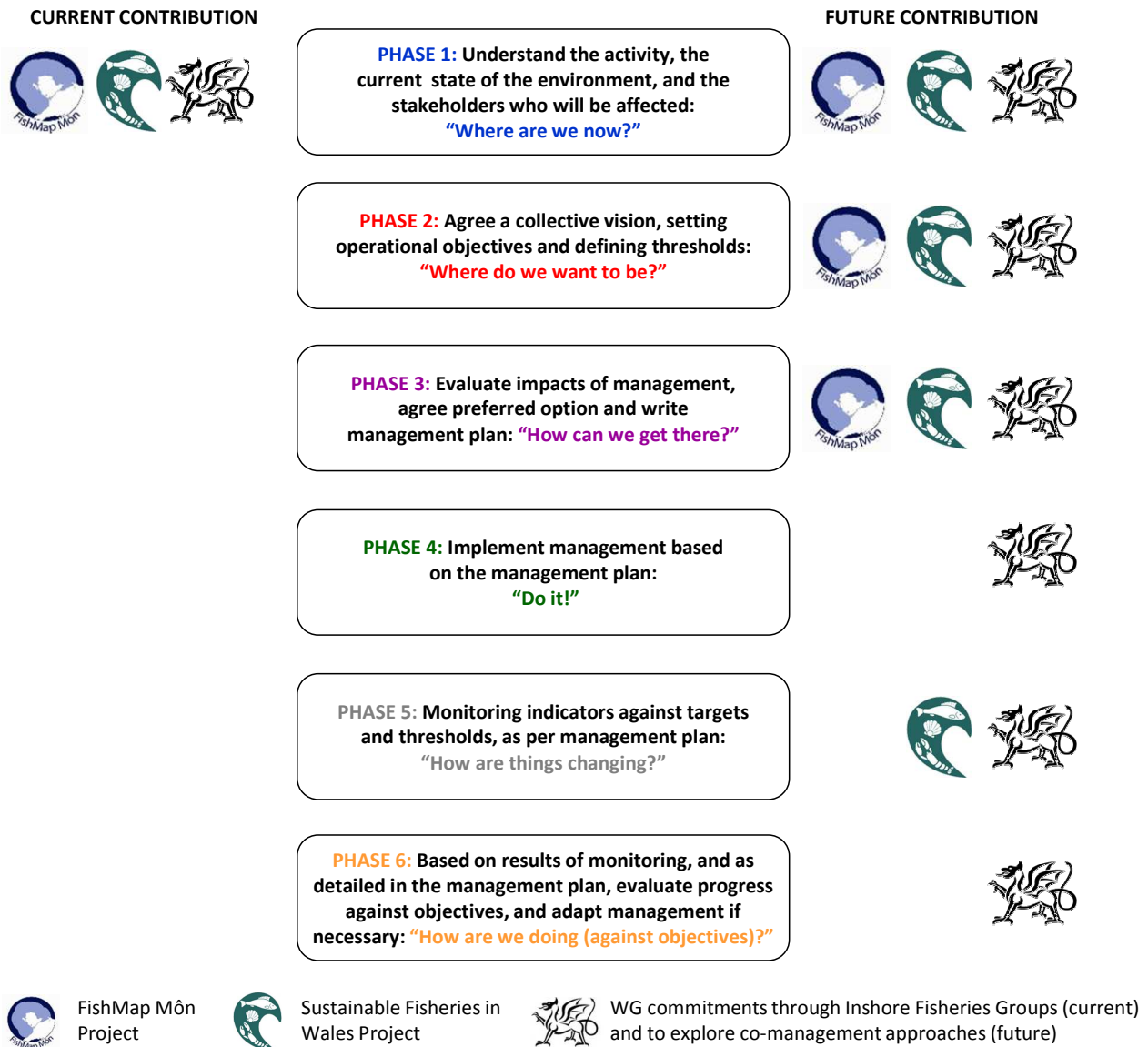


Figure 4.1 Phases of the EA implementation cycle, and the current (left hand side) and potential future (right hand side) contributions of a selection of projects and initiatives in Wales to implementation of an EA in the Welsh Marine Environment (see Sections 4.1 to 4.3 for further details on the FishMap Môn, the Sustainable Fisheries in Wales project and the Welsh Government initiatives respectively).

4.4 Summary

Reflection on this selection of existing projects and initiatives in Wales demonstrates that current activities are limited to making contributions to Phase 1 of the implementation cycle (Fig. 4). However there is significant potential to further develop approaches being used within these projects to feed into other Phases and efficiently assist in the implementation of an EAFM (and to marine management more generally) in Wales.

Key existing contributions to Phase 1, and the EA(FM) process more generally, stem from the networks and collaborative working relationships that have already been established in the *FishMap Môn* (FMM) and the *Sustainable Use of Fisheries Resources in Welsh Waters* projects. Stakeholder participation is deemed to be a key ingredient of an EA(FM), and these projects provide important lessons learned, about stakeholder engagement and collaborative working, that can be used to inform future projects. The commitment of the WG to explore co-management approaches would build upon this experience, and enable stakeholders, not only to be involved in all phases of the EA implementation cycle, but also to have shared ownership of the resultant management. The consensus is that co-management approaches are more likely to lead to management success (Bloomfield et al. 2011b; PISCES 2012; Woolmer 2012). Of note here, is that the focus of this review is on fisheries, and thus fisheries stakeholders. However, consideration of the impacts on fishing activities on other sea-users and the wider public, and impacts of other sea users on fishing activities should also be considered in keeping with an EA. It is also important that future projects (where possible) expand their focus to ensure that the collective vision and resultant operational objectives are in line with high level objectives and commitments from existing policies (e.g. MSFD objective to achieve GES based on 11 descriptors).

The data that has been collected by FMM, and is currently being collected by the *Sustainable Use of Fisheries Resources in Welsh Waters*, could make valuable contributions to Phase 1 in describing the current extent of activities or state of ecological components. The methods developed in both projects could be expanded to include more activities or more ecological components and make a wider contribution to Phase 1. In the future, these data could also contribute to Phase 2 in enabling indicators and thresholds to be selected; and Phase 5 in monitoring how things are changing following management implementation. However, careful consideration needs to be given to prioritise and streamline where further information is required, and utilise approaches that are able to deal with the best available evidence, or lack thereof, to ensure that implementation of an EA in Wales is not stalled by the need for “more data”. Significant resources also need to be allocated to further develop and implement approaches to collect social and economic data at appropriate spatial resolution, comparable to information on ecological components of the system, congruent with the overarching objectives of an EA of ecological **and** human well-being.

Given the number of potential projects seeking to secure stakeholder participation in line with the principles of an EA, it is crucial that there is effective communication among projects, and that where possible efforts are made to avoid duplication of tasks and resources (time and financial), which are likely to become increasingly stretched. Stakeholder investment of time, knowledge, expertise and resources

needs to be acknowledged, respected and valued in decision-making for successful EAFM (Short, *pers. comm.*, February 2014). A final point is the importance of appropriate management of people's expectations both in terms of clarity of the role of the different parties in the process, and in terms of the potential (long) timeframes that will be required to achieve objectives. An EA is not a quick fix in ecological, social or economic terms, and projects driven by an EA should consider both long and short-term objectives (and review periods), centred within an adaptive management framework.

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6. Appendices

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Appendix 1 WWF: Guidelines for implementing Ecosystem-Based Management in a hypothetical coastal fishery (Ward et al. 2002).

The table below provides a set of guidelines for implementing Ecosystem Based Fisheries Management in a hypothetical coastal fishery which could be adapted for implementation of an EAFM in Wales (Table 6, extracted from WWF's *Policy Proposals and Operational Guidance for Ecosystem-Based Management of Marine Capture Fisheries*; Ward et al. 2002).

Table 6 Guidelines for implementing Ecosystem-Based Management in a hypothetical coastal fishery

| Component | Involving | Intended outcomes |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Identify stakeholder community. | <ul style="list-style-type: none"> Fishery management agencies, conservation agencies, conservation NGOs, local community groups, scientific/academic research community, fisher associations or cooperatives, higher and lower levels of government, fish processing / distribution groups, indigenous representatives. | <ul style="list-style-type: none"> A formal network of interested parties with whom the fishery representatives will participate to prepare and review the management of the fishery. A transparent and fully accountable process enabling the participation of all interested parties in the process of managing the fishery. |
| 2. Prepare a map of ecoregions and habitats. | <ul style="list-style-type: none"> Conducted by the fishers, research community, fishery managers, stakeholders and partners. Covers the full area of fishery operations. The focus is on areas where the fish are, where they are fished, and any specific spawning, nursery or similar obligate habitats or locations. High resolution is needed in benthic primary producer habitats (such as algal beds, seagrasses, mangroves, coral reefs). | <ul style="list-style-type: none"> Maps of the ecosystems throughout the fishery at scales of resolution consistent with the scale of the fishery. Resolved habitats at a scale consistent with the potential impacts of the fishery. Coherent with other ecosystem classification initiatives (at both larger and smaller scales). Major features and exceptions documented (e.g. highly migratory species, oceanographic currents or features, boundary mismatches between taxa). Major uncertainties identified and documented as guidance for research and investigation programs. |
| 3. Identify partners and their interests / responsibilities. | <ul style="list-style-type: none"> Conservation, environment protection, and coastal planning agencies from all levels of government. Major users and managers of other, possibly co-located, resources (e.g. tourism, mining, oil/gas, transport, and communications). Directly affected local communities. | <ul style="list-style-type: none"> Clarify specific roles and responsibilities for management in the marine environment. Engage with other supportive interests. Promote the opportunity for coordination and integration, improved efficiency across government and better outcomes for marine management, better agency outcomes for lower cost, more accountability in government, more effective long-term solutions to marine ecological problems, and shared approaches to problems held in common. |
| 4. Establish ecosystem values. | <ul style="list-style-type: none"> Fishers, research community, fishery managers, stakeholders, partners and the public; designed to identify all major uses and all major natural and ecosystem values throughout the area where the fishery operates. | <ul style="list-style-type: none"> A detailed distributional analysis of the main attributes of the ecosystem where the fishery operates. A clear and agreed expression of the natural and use values, which could include: <ul style="list-style-type: none"> highly valued habitats; representative areas dedicated as reserves; protected species feeding, breeding, or resting grounds; fishing, spawning grounds, recruitment areas and migration paths for commercial species; highly productive areas such as upwellings; areas popular for recreational fishing or diving; areas used for ports and harbours; areas of high scenic and wilderness amenity; high cultural and historic value; traditional hunting grounds for Indigenous peoples; areas of high tourism value; areas used for dumping of dredge wastes, defence training etc. |

| Component | Involving | Intended outcomes |
|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5. Determine major factors influencing ecosystem values. | <ul style="list-style-type: none"> • Establishing cause-effect relationships; consider factors both internal and external to the fishery management system. • Conducted by the fishers, research community, fishery managers, stakeholders and partners. | <ul style="list-style-type: none"> • Identified hazards to marine ecosystems and their values from the full range of actual and potential human impacts that occur in the fishery region. • These could include: <ul style="list-style-type: none"> - extent of loss/damage of marine habitats; - effects of specific fishing gear on benthic habitats; - effects of pollution from coastal rivers on inshore habitats; - risk of marine pest invasion and disruption to critical habitat or fishing operations; - effects of the removal of the biomass of harvested species (in all fisheries) on trophically dependent species. |
| 6. Conduct Ecological Risk Assessment (ERA). | <ul style="list-style-type: none"> • ERA conducted with participation of all stakeholders and partners, fishers, research community and the fishery manager: <ul style="list-style-type: none"> - uses broad multi-disciplinary knowledge base; - identifies key areas of uncertainty; - open for public scrutiny and review; and - fully peer reviewed by independent authorities. | <ul style="list-style-type: none"> • Agreed estimates of high, medium and low risks of the fishery to the ecosystem values identified in step 5, such as the risk of the fishery to protected species, and to the ecosystem, habitats, species and genetic diversity. |
| 7. Establish objectives and targets. | <ul style="list-style-type: none"> • Fishers, research community, fishery managers, stakeholders and partners. • Performance objectives and targets established for: <ul style="list-style-type: none"> - high and medium priority risks from the ERA; - important aspects of the ecosystems (including protected species, critical habitat); and - stocks. | <ul style="list-style-type: none"> • Agreed and shared goals for specific elements of ecosystems. • Specific performance objectives and targets for important elements of the ecosystem. • Objectives and targets that are comprehensive and precautionary in terms of valued aspects of the ecosystems. • Could include: <ul style="list-style-type: none"> - maintaining or recovering population sizes of protected species; - maintaining the distribution, area, species diversity and trophic structure of important habitats; - reducing fishing effort in specific areas to help protect populations of benthic fauna; - increasing the distribution and diversity of benthic fauna considered to be affected by fishing; - rehabilitating marine ecosystems to a past (healthier) condition. |
| 8. Establish strategies for achieving targets. | <ul style="list-style-type: none"> • Fishers, research community, fishery managers, stakeholders and partners. • Focus is on identifying appropriate and workable strategies to achieve objectives and targets, and on specific capacity matched to responsibilities for implementing strategies. • Strategies designed based on best understanding of the cause-effect relationships developed in Step 5, and matched to highest priority needs for corrective actions identified in Step 6 (ERA). • Use of incremental strategies where necessary and unavoidable. | <ul style="list-style-type: none"> • Series of prioritised strategies that define workable activities and responses to achieve specific objectives and targets identified in Step 7. Includes who is responsible, what funds and time frames are involved, what controls are needed and where data/outcomes are reported and assessed. • Strategies could include: <ul style="list-style-type: none"> - declaring a network of sanctuary protected zones; - establishing buffer zones where only specific uses, or types of fishing, are permitted - research on improving gear design to reduce impacts on a sensitive habitat, or reduce the bycatch of an important species; - improved fishery-independent monitoring of catch, or bycatch; - reducing pollution from coastal rivers; - constructing fish escapement panels in trawl nets to avoid catch of a certain type and size of fish, or to reduce overall fish bycatch; - implementing an industry code of practice to reduce risks of bait discards to bird populations. |

| Component | Involving | Intended outcomes |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9. Design information system, including monitoring. | <ul style="list-style-type: none"> • Fishers, research community, fishery managers, stakeholders and partners. • Focus is on capture of appropriate data/information to determine if: strategies are working as expected; objectives and targets are being achieved; cause-effect models are correct; fishery impacts are being reduced. • Collaboration and contributions from partners identified. | <ul style="list-style-type: none"> • Efficient and effective fishery information system that provides data and information on stock and ecosystem performance (additional to information needed for stock management); identifies specific effects of fishery strategies on ecosystem values. • Could include: <ul style="list-style-type: none"> - Periodic mapping of important habitat distributions; - Population census of important protected species; - Species diversity in fished habitats; - Distribution of fishing effort by gear types and fine spatial scale; - Size/age classes in harvested species; - Species diversity in closed areas. |
| 10. Establish research and information needs and priorities. | <ul style="list-style-type: none"> • Fishers, research community, fishery managers, stakeholders and partners. • Focus is on identifying specific high priority areas of uncertainty, and on quality science outcomes, for both stock and ecosystem issues. • Collaboration and contributions from partners identified. • Research strategies are fully peer reviewed or independently audited. | <ul style="list-style-type: none"> • Comprehensive research programs targeted at resolving key ecosystem and stock issues in the fishery. Could include: <ul style="list-style-type: none"> - habitat mapping; - impact of fishing on specific habitat types; - effects of coastal development on recruitment of harvested species; - design of monitoring programs to resolve important changes in habitats; - biological data of key species (both utilised and non-utilised); - determining the dietary preferences of harvested species and their major predators; - species composition of bycatch with different gear types used in the fishery. |
| 11. Design performance assessment and review processes. | <ul style="list-style-type: none"> • Fishers, research community, fishery managers, stakeholders and partners. • Focus is on a process that is participatory and inclusive. • The locations, timing and resourcing enables partner and stakeholder participation in reviews of performance of the fishery in relation to stock and ecosystem values. • Performance outcomes peer reviewed by independent authorities. | <ul style="list-style-type: none"> • Periodic (but regular) forum for discussion, review and assessment of fishery performance by partners, stakeholders and the public. • Periodic (but regular) forum for review, assessment and revision of monitoring data, objectives and targets by stakeholders and partners. |
| 12. Prepare education and training package for fishers. | <ul style="list-style-type: none"> • Fishers, fishery managers, extension experts and stakeholders and partners. | <ul style="list-style-type: none"> • Outreach program to provide training and support for fishers about new fishery management, ecosystem or other EBM initiatives, and provide local technical support for assessment and resolution of ecosystem issues; to commence at the time of Step 1. |

Appendix 2 FAO: Steps for developing an Ecosystem Approach to Fisheries (EAF) management plan (FAO 2005).

The following is an excerpt from the Food and Agriculture Organisation of the United Nations report entitled “*Putting into practice the Ecosystem Approach to Fisheries (EAF)*” (FAO 2005). It describes the six steps to develop an EA management plan.

1. Define the scope of the fishery management plan under ecosystem approach to fisheries: A preliminary specification of the area concerned is necessary, if only to allow the identification of stakeholders with common or competing interests, in order to identify the broad issues. E.g. the geographic area, fishery or fisheries, and the stakeholders.
2. Compile and analyse background information: When all the broad issues have been identified. All information on the fisheries must be compiled and analysed to allow for the formulation of more detailed objectives
3. Set Objectives:
 - Setting broad objectives: these broad objectives provide a link between the principles and policy goals and the specific detail on what a particular fishery is trying to achieve, these will correspond to the “broad issues” identified in section 1.
 - Developing operational objectives from broad objectives: The broad objectives identified in step 1 need to be translated into more specific operational objectives, which should have direct and practical meaning for the fishery. Operational objectives should be measurable, achievable and linked to a specific time period. Consider the following:
 - i. Identify issues under each of the broad tasks,
 - ii. Rank the issues,
 - iii. Develop operational objectives for the priority issues.
4. Select indicators and reference points for each operational objective: Agree on indicators, reference points and performance measures for each of the objectives identified. Each indicator should be an ecosystem or population proxy that will be influenced by the impact of the fishery. Indicators should also take the technical, management and operational issues of a given fishery into account. Indicators must also be measurable by the agency.
5. Formulate rules: Develop a set of management measures to achieve each of the objectives.
6. Develop a monitoring, assessment and review process: The ecosystem approach to fisheries should include arrangements for undertaking regular reviews to assess the success of the management measures in attaining the agreed objectives. It will usually be necessary to conduct both short term and long term reviews. Short term reviews could occur annually to ensure that nothing unexpected is occurring in the ecosystem and allow for minor adjustments to the management measures where necessary. Long term reviews should occur every 3-5 years; these will be more comprehensive and may re-evaluate the entire management plan.

Appendix 3 Structured Decision-Making (SDM) approach to objective setting. From the West Coast of Vancouver Island (Espinosa-Romero et al. 2011).

The following is a summary and several excerpts from the case study used by from Espinosa-Romero et al. (2011) to demonstrate Structured Decision-Making (SDM), a systematic approach for stakeholders to agree a collective vision, and define operation objectives, indicators and thresholds to allow measurement of progress towards achieving the objectives and therefore the collective vision.

West Coast Aquatic (WCA) is a forum for coastal communities and those affected by marine management decisions, to participate in the decision-making process for managing the West Coast of Vancouver Island (WCVI) area. WCA includes Federal, Provincial, Local and First Nations governments; representatives of commercial and recreational fisheries; the aquaculture and tourism industries; and conservation organizations, among others (Espinosa-Romero et al. 2011).

The WCA adopted the Structured Decision-Making (SDM) approach to design a decision-making framework as part of their Ecosystem Based Management (EBM) strategy. Step one of the SDM approach is to make a wish list of what matters to the stakeholders. From this list or collective vision, the WCA defined eight objectives:

1. integration and collaboration;
2. sustainable economic benefits;
3. healthy ecosystems;
4. healthy, prosperous and safe communities and waterways;
5. First Nations, reconciliation and relationships- strengthening;
6. collection of knowledge, information and technology;
7. capacity building; and
8. good governance.

Table A3.1 shows the original set of objectives defined by the WCA from Espinosa-Romero et al. (2011). The initial objectives were described as “*involving important aspects for EBM; however, they were stated in a complex way, making their use for decision-making very difficult. Therefore, these objectives were reviewed and restructured in an operational way without losing or distorting their intended meanings*” (Espinosa-Romero et al. 2011). One of the paper authors, Denise M. Dalmer, as the WCA Executive Director, was involved in defining the initial set of objectives and therefore helped ensure the re-structured objectives still reflected the original WCA values.

Table A3.1. Original set of objectives and attributes of West Coast Aquatic (WCA) based on the draft goals for aquatic management on the West Coast of Vancouver Island (WCVI). FN means First Nations.

| Objectives | Attributes | |
|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Integration and collaboration | <ul style="list-style-type: none"> ● Collaboration with other states and global links; ● Shared responsibilities; ● Integrated and participatory management; | <ul style="list-style-type: none"> ● Efficient communication; ● Responsible and participatory decisions; ● Sustainable and holistic management consistent with traditional values. |
| Sustainable economic benefits | <ul style="list-style-type: none"> ● Opportunities for locals; ● Sustainable social, cultural and economic benefits; ● Balance ecological, social and economic aspects; ● Future generations; | <ul style="list-style-type: none"> ● Conservation first in fisheries management; ● Sustainable fisheries and aquaculture; ● Sustainable management; ● FN access to natural resources; ● Monitoring, enforcement and regulations. |
| Healthy ecosystems | <ul style="list-style-type: none"> ● Ecosystem productivity; ● Healthy, diverse and resilient ecosystems; ● EBM and values in planning and decision-making; ● Adaptive management; ● Integrity of fish and habitat; ● Genetic diversity (salmon and other species); | <ul style="list-style-type: none"> ● Conservation as a first priority; ● Precautionary approach; ● Plans for natural disasters; ● Adaptation to climate change; ● Network of marine protected areas; ● Species at risk protection; ● Waste water management (water pollution and disposal management). |
| Healthy, prosperous and safe communities and waterways | <ul style="list-style-type: none"> ● Safety (infrastructure, modernized transportation, and response services); ● Health (ecosystem health and community health); | <ul style="list-style-type: none"> ● Vibrancy (diversified economies, cultural practices); ● Partnerships; ● Traditional knowledge into decision-making. |
| FN reconciliation and relationships strengthening | <ul style="list-style-type: none"> ● Respecting aboriginal rights and title; ● Clear understanding of the needs of FN; ● Ensuring benefits for FN; ● Participation of FN in decision-making; ● FN as the second priority after conservation; | <ul style="list-style-type: none"> ● Ensuring FN access to natural resources; ● FN sharing the wealth of marine resources; ● Resolutions between FN and other governments. |
| Knowledge information and technology | <ul style="list-style-type: none"> ● Stewardship efforts; ● Expertise and knowledge from diverse sources; ● Integration of information and knowledge on ecosystem health; ● Education; | <ul style="list-style-type: none"> ● Passing on traditional knowledge; ● Training for users, managers, stewards, community capacity; ● Equipment and technology; ● Information gathering. |
| Capacity building | <ul style="list-style-type: none"> ● Safety and efficiency of marine transportation and shipping; ● Resource use and management; ● Improve FN economic self sufficiency and community stability; | <ul style="list-style-type: none"> ● Stakeholders participation in aquatic conservation; ● Modernization of the Canadian Coast Guard fleet; ● New industries; ● Strong FN cultures. |
| Good governance | <ul style="list-style-type: none"> ● Establishment of priorities; ● Public reporting; | <ul style="list-style-type: none"> ● Responsibility and accountability. |

The objective review and restructuring process involved the following steps, taken from the methods section of Espinosa-Romero et al. (2011):

- Fundamental objectives being separated from means objectives using the “why each objective is important” test defined by Clemen and Reily (2001)
- When an objective was important because it contributed to the achievement of another objective, it was defined as a means objective.
- When an objective was important because it represented WCA values, it was defined as a fundamental objective.
- The WCA goals and sub-goals documents were reviewed to understand the attributes of each of the eight objectives. Attributes usually appeared in more than one objective or were stated as fundamental objectives, this often occurs because stakeholders strive to elevate particular interests as much as possible in the objectives. The result is that operationalising the objectives is very difficult.
- Any attributes with the same meaning were combined
- Any attributes that better fit with other fundamental objectives were moved to those respective objectives.
- For objectives that were broadly described, attributes were suggested based on a review of existing literature and other case studies that expressed similar objectives.
- Indicators were suggested for the attributes of fundamental objectives. For attributes that were not informative for measures, such as ‘vibrancy’ of communities, indicators were selected based on a review of other case studies that measure those attributes.
- From the list of eight main objectives detailed above, four were considered fundamental objectives:
 1. foster economic benefits;
 2. foster healthy eco-systems;
 3. foster healthy communities; and
 4. foster good governance.
- Adaptive management (AM) was included as a fifth fundamental objective. It was part of one fundamental objective (“healthy ecosystems”), but from conversations with WCA it was agreed to include it as a separate objective due to its importance for the whole process rather than only for that particular fundamental objective, and because it represents an ethical principle for WCA.
- Three of the eight original objectives were identified as means objectives, as their importance relies on their contribution to the fundamental objectives:
 - ‘integration and collaboration’,
 - ‘knowledge, information and technology’, and
 - ‘capacity building, engagement and communications’
- Three attributes of the ‘integration and collaboration’ objective (i.e. shared responsibilities, collaboration with other plans, and participatory management) were re- identified as falling under the fundamental objective of ‘good governance’.
- All attributes of the last original objective ‘First Nations reconciliation and relationships strengthening’ proved to fit within other fundamental objectives. These attributes were thus made explicit within the other fundamental objectives. For example, ‘respect aboriginal and treaty rights’ was re-grouped within ‘healthy communities’; and ‘participation in decision-making’ was grouped under ‘participatory management’ as part of the ‘good governance’ objective.

Table A3.2 provides further details of each objective, its attributes and suggested indicators as well as details of Espinosa-Romero’s (2011) process of restructuring the objectives. Table A3.3 shows the resulting new objectives, attributes and indicators after this restructuring process.

Table A3.2 Framework for EBM: Fundamental objectives, attributes and indicators. Excerpt from Espinosa-Romero et al. (2011). Numbers in square brackets refer to references from the original article (not detailed in this report).

| Fundamental objectives | The Objective Explained | Suggested Indicators |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Foster economic benefits | <p>This objective includes generating benefits derived from the ecosystem and their fair distribution across present and future generations. Benefits can include profits and employment, but also the goods or services themselves, because trading is a traditional practice in the region. The retention of benefits by local communities, specifically First Nations, was stated twice in the original document of objectives, goals and sub-goals, and also emphasized in WCA planning process. WCA included as part of this objective the balance of ecological, social and economic components as well as sustainable management; one would think that both are related and represent what the decision-making process should entail rather than attributes of this particular objective. WCA also mentioned sustainable fisheries and aquaculture, monitoring, enforcement and regulations, which represent means objectives and may contribute not only to this objective. Conservation as the main priority for fisheries management was also included here; however, this represents a value or preference towards certain alternatives. First Nations access to natural resources was moved to the ‘foster healthy communities’ objective.</p> | <p>A commonly used indicator for profits is the net present value—aggregated benefits minus aggregated costs, discounted over time. Discount rates are applied to estimate the present value of future revenues or costs; and these rates can vary among individuals or social levels [25]. Net present value is a well-known indicator but insufficient alone, because it does not capture the distribution of benefits and costs among stakeholders [26].</p> <p>Income per capita has been also used to represent benefits [27,28]. For the case of employment, WCA could account for the number of skilled, unskilled, temporary and permanent jobs derived from each alternative [26,29]. For the case of the goods, WCA can consider the weight in pounds or kilograms. The proportion of these benefits and losses (in terms of net revenues, income per capita, employment and the goods themselves) retained by each stakeholder group (adapted from Philcox 2007) over time [26,29] can help measure the distribution of benefits and losses. WCA could also measure the proportion of benefits and loss retained among local communities or First Nations to evaluate if the most vulnerable groups are retaining benefits (e.g., [27]).</p> |
| Foster healthy ecosystems | <p>For this objective, WCA will focus on minimizing the adverse effects of human activities on the integrity of ecosystems. Based on the approach used by the Department of Fisheries and Oceans Canada (DFO) in the Eastern Scotian Shelf [30], WCA has defined three main aspects of integrity: diversity, productivity and environmental quality. Diversity includes species, populations and communities; productivity refers to primary and secondary productivity, as well as trophic and population productivity; and marine environmental quality involves physical, chemical and habitat quality [30,31].</p> <p>Resilience was mentioned as part of this objective. Ecological resilience is generally understood as the system’s ability to absorb shocks or disturbances while maintaining its function, structure, identity and feedbacks [32]. Resilience is often assumed to be good, as people often assume one desirable state and the ability of the system to maintain or go back to this</p> | <p>a. Diversity: species, populations and communities Species richness—number of species—within defined boundaries such as communities or habitats [33] and evenness—distribution of species biomass—have been suggested to measure diversity. However, the composition of biological communities is also important: while species richness may show a high number of species in the region, this number may also include introduced species, which are not members of the native community and can cause negative impacts to native species and ecosystems. Because it is very difficult to focus on all species in the community or habitat, it is necessary to select species or groups whose characteristics represent attributes of other species, the ecosystem and environmental conditions [34]; or groups that play an important role ecologically or culturally such as endemic species, species at risk, etc. Endemic species for example are important because they only occur in specific places, regions, ecosystems or communities [35]; and their populations are usually small and vulnerable to extinction [36]. Some studies demonstrate that the conservation of sites with high levels of endemism can capture large proportions of all identified species of a region [36]. Species at risk, can also be useful in the sense that it highlights</p> |

| Fundamental objectives | The Objective Explained | Suggested Indicators |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>state after disturbances. However, it has been demonstrated that many systems, including marine ecosystems, have multiple states or attractors (e.g. from kelp-dominated ecosystems to ‘urchin barrens’). Some states may be undesirable for societies; maintaining the resilience of these states may therefore not be desired. In addition, the resilience of an ecosystem is influenced by the feedbacks between social and ecological systems [1], a fact that applies not only to this objective but also to others such as ‘economic benefits’ and ‘healthy communities’. It is thus appropriate to consider resilience as a means objective for the fundamental objectives. It will be important for societies or groups to identify the desirable states for which resilience is sought. This objective included other means objectives such as the protection of species at risk, the establishment of marine protected areas, development of plans to respond to natural disturbances, and adaptation to climate change. Other considerations within this objective were conservation as a first priority, which represent implicit preferences towards objectives and alternatives. EBM and the integration of values in the planning and decision-making processes were included, which represent the overall objective. Adaptive management (AM) was included as a separate fundamental objective and the precautionary principle was moved to the ‘good governance’ objective.</p> | <p>biodiversity components that might be lost, but this measure can also be limited because of the political process of listing, and because simple species counts are far removed from ecological integrity. It is advisable to look at species richness and abundance across the selected groups, as well as the historical trends to evaluate if their populations are increasing, stable or declining [9]. The mean trophic level (TL) [37,38] is a well-known indicator that can be used as a proxy for the community composition. It is calculated by assigning species to trophic levels and using information on species’ catch and diet composition. The TL has been often used to indicate the impacts of fisheries [37,38]; however, it can be also used to analyze the trophic structure of an ecosystem by including non-target species’ abundance and diet composition. In terms of diversity, it has also been suggested to pay attention to community and habitat diversity [30] because their conservation can ensure the conservation of species [33].</p> <p>b. Productivity: primary, secondary, trophic level and population productivity. Abundance per trophic level can be used as an indicator of the productivity at trophic level [39,40] as well as for primary and secondary production. Historical catch and biomass of target species can also be used to measure productivity of species and populations [30] and provide insights on the status (increasing, stable, declining) of those species.</p> <p>c. Marine environmental quality: physical, chemical and habitat quality This can be accounted by evaluating the concentration of toxics in the water, sediments [30,40] and species (e.g., Harbour seals, pelagic and benthic fish, clams, mussels and juvenile salmon) [41] as well as the generation of noise and atmospheric pollution [30] derived from each of the alternatives. For habitat quality, WCA could select those habitats or communities that are important to conserve, and evaluate the potential impacts of alternatives on those habitats. This can be done by assessing the total area of ‘selected’ habitat impacted (e.g., [12]) or by identifying the main threats for those habitats (e.g. trawlers) and the magnitude of the particular threat (e.g., number of trawlers).</p> |
| Foster healthy communities | <p>This objective refers to avoiding adverse effects on the health, safety and vibrancy of local communities. Attributes for minimizing the adverse effects on health and safety can be related to people, private and public property [42]. Vibrancy is understood as those things that make locals stay in their communities as well as the survival of groups and traditions over time. After restructuring the original attributes, vibrancy include the ‘respect of First Nations rights and title’, which was part of the objective ‘First Nations reconciliation and relationships strengthening’, and ‘First Nations access to</p> | <p>Effects on human health and safety, specifically on people, private and public property can be measured by identifying risks, their magnitudes and probabilities, who (or what, in the case of private and public property) is exposed, and to what extent. This can be based on science and stakeholders’ perceptions [28]. Illness and deaths that could be associated with marine resources—in this case those associated to the management alternatives—have been suggested as a health indicator [41]. Attributes of vibrancy can be measured qualitatively using constructed scaled (e.g., 1–5; low, medium, high) indicators to answer questions determined by WCA. Some suggestions for scoring each attribute previously mentioned are presented below. For the impacts on access to natural resources including land: Are the conditions of access perceived locally to be</p> |

| Fundamental objectives | The Objective Explained | Suggested Indicators |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>natural resources', which was an attribute of the 'economic benefits'. Other attributes included in this objective are cultural practices [26,29] and aesthetics (adapted from [27]).</p> | <p>fair? If the conditions of access to locals are negatively impacted, is the compensation fair? (adapted from [29]). For the impacts on First Nations rights and title: Are the First Nations' rights, treaties and title respected? To what level of satisfaction according to local perception? (adapted from [29]). For the impacts on the cultural practices identified as important for locals (e.g., potlatch, festivities, transmission of traditional knowledge, language): What are the impacts of different alternatives on these practices (adapted from [27,41,43])? If a cultural form is lost or negatively impacted, for those who are affected, is the compensation fair [29]? For impacts on aesthetics: What is the perceived magnitude of the visual, odour and water quality impacts in the region (Satterfield, pers. comm.)?</p> |
| Foster good governance | <p>Good governance has been identified as a key element and a challenge for the implementation of EBM [2,3]. For WCA this objective includes participatory management, shared responsibilities (originally in the 'integration and collaboration' objective), compatibility with other plans and social agreements (originally in the 'First Nations reconciliation and relationship' objective), implementation of the precautionary principle (originally in the 'healthy ecosystems' objective) and public accountability. Attributes of participatory management include the following: representativeness, fairness and competence [44]. Representativeness means that all stakeholders are represented when making decisions. Fairness refers to the equitable access to participatory processes, equal opportunities to make and reject claims during deliberation, and the consideration of different sources of information. Competence means that all participants have a sufficient level of understanding of the consequences of each alternative, including knowledge, uncertainties and ambiguities [44]. Other aspects originally included in this objective were the identification of priorities, the responsible use of financial resources, and the evaluation of WCA performance on a regular basis, each of which represent means objectives.</p> | <p>The attributes of this objective can be measured qualitatively using constructed scales as suggested for the 'vibrancy' attributes. For the participatory management: Were all stakeholders represented in the process? Were there opportunities (e.g., forums, meetings) for the public and stakeholders to participate in the process? Was there a capacity building program and training opportunities for locals and other stakeholders to improve their competence [26,29]? For the responsibilities distribution: Do all the members agree with the distribution of tasks? Do the members have the capacity to do the work they were tasked with? For alignment with other plans: Were synergies and new partnerships with other organizations made during the process? For resolutions between First Nations and other governments: To what extent is there a respectful relationship and agreement between First Nations and other governments [26,29]? For the precautionary approach: Was there a comprehensive consideration of possible negative effects of human activities, including those with considerable uncertainty? Was a monitoring plan adopted to evaluate the harm on ecosystems and human health? Do proponents of potentially actions/activities have responsibility to demonstrate small likelihood of major negative effects? Were alternatives considered and adopted to reduce harm on ecosystems and human health? If uncertainty was a reason for inaction, was a concrete plan adopted to reduce uncertainties? For public accountability: Was information on financial resources available for all members of the board? Was information—on the impacts of management alternatives in relation to the objectives—available for all members? Are there sufficient measures in place to ensure transparency?</p> |
| Foster learning through adaptive management | <p>Adaptive management represents the ability to learn from other participants, from the process as new information arrives [24,42] and treating policies as experiments to explore possible outcomes [45].</p> | <p>Most attributes of these objectives can be also qualitatively measured with constructed scales to answer questions defined by WCA. Some examples are presented below. For learning from other participants: Did the board learn from conflict resolution (adapted from [29])? Did stakeholders learn from each other during the process? For learning from the process: Are members satisfied with the process? Was new information identified and integrated to the process? Were there opportunities to review and adjust agreements and policies [26,29]? Were there learning opportunities over time [12]? For</p> |

| Fundamental objectives | The Objective Explained | Suggested Indicators |
|-------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | learning through treating policies as experiments: Were key sources of uncertainty identified? Were opportunities to reduce uncertainties identified? Did members consider means for applying such opportunities in policy/management alternatives? Were those means implemented? |

Table A3.3 New structure of fundamental objectives, attributes and indicators for a decision-making framework for EBM. FN means First Nations. CS means constructed scales i.e. one to three or one to five scales.

| Fundamental objectives | Attributes | Attributes components | Indicators |
|----------------------------|-----------------------------------------------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Foster economic benefits | Distribute benefits and costs across stakeholders and over time | Net benefits | Net present value |
| | | Income | Net income per year |
| | | Employment | Number of skilled, unskilled, temporal and permanent jobs |
| | | Goods | Weight |
| Foster healthy ecosystems | Minimize adverse effects on ecosystem integrity | Diversity | Species richness and evenness within defined boundaries Community composition: species richness and abundance of selected groups Community composition: mean trophic level Community/habitat diversity |
| | | Productivity | Biomass per trophic level Target species catch and biomass |
| | | Marine environmental quality | Concentrations of toxics in sediments, water and biota Habitat quality (area impacted or magnitude of the activity that impact the habitat) Noise Atmospheric pollution |
| Foster healthy communities | Avoid adverse effects on health and safety | People | Number of people exposed, magnitude and probability of the risk Illness and death associated to marine resources or the alternative |
| | | Private and public property | Number of private or public property exposed, magnitude and probability of the risk |
| | Avoid adverse effects on vibrancy | Access to natural resources | CS: Are the conditions of access fair? CS: Are the conditions of access impacted? CS: Is the compensation fair? |
| | | FN rights and title | CS: Are FN rights, treaties and title respected? CS: To what level of satisfaction? |
| | | Cultural practices | CS: Impacts on identified cultural practices CS: Is the compensation fair? |
| Foster good governance | Foster participatory management | Aesthetics | CS: Perceived magnitude of the visual, odour and water quality impacts |
| | | Representativeness | CS: Were all stakeholders represented in the process? |
| | | Fairness | CS: Were there opportunities for the public and stakeholders to participate in the decision-making process? |
| | Competence | CS: Was there a capacity building program and training opportunities for locals? | |
| | Foster shared responsibilities | | CS: Do all members agree with the distribution of tasks? CS: Do the members have the capacity to do the work they were tasked with? |

| Fundamental objectives | Attributes | Attributes components | Indicators |
|----------------------------|-----------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | Foster alignment with other plans | | CS: Were synergies and partnerships made during the process? |
| | Foster social agreements | Resolutions between FN and other governments | CS: To what extent there is respectful relationship between FN and other governments? |
| | Foster a precautionary approach | | CS: Was there a comprehensive consideration of possible negative effects of human activities? CS: Was a monitoring plan adopted to evaluate the harm on ecosystem and human health? CS: Do proponents of actions/activities have responsibility to demonstrate small likelihood of major harm? CS: Were alternatives adopted to reduce harm? CS: If uncertainty was the reason for inaction, was there a concrete plan adopted to reduce uncertainties? |
| Foster adaptive management | Foster learning from other participants | | CS: How did the board solve the conflicts? CS: How did the board learn from conflict resolution? CS: Did stakeholders learn during the process? |
| | Foster learning from the process | | CS: Are the members satisfied with the process experience? CS: Was new information identified and integrated to the process? CS: Were there opportunities to review and adjust agreements and policies? CS: Were there learning opportunities over time? |
| | Foster treating policies as experiments | | CS: Were key sources of uncertainty identified? CS: Were opportunities to reduce uncertainty identified? CS: Did members define means of applying policies to realize such opportunities? CS: Were those policies implemented? |



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enquiries@naturalresourceswales.gov.uk
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